The Economy of Prehistoric Coastal Northern Chile:
Case Study: Caleta Vitor

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DECLARATION OF CANDIDATE

I certify that this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any university; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is given.

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ABSTRACT

Despite being within one of the driest deserts on earth, the coast of southern Peru and northern Chile has been inhabited by humans for over 10,000 years. Within a limited range of habitats, local cultures were characterised by an economy based on limited terrestrial and abundant marine resources. This thesis intends to address the question as to how such an economy can be defined. By examining the economic trajectory of coastal communities, this project will attempt to establish the base from which the local economy was originally derived and how it developed through time, looking particularly at the effects of migration and trade together with the dynamics of a distinctive environment and the cycles of El Niño weather patterns.

This research was based on a collection of archaeological material obtained from a number of sites at Caleta Vitor located on the coast approximately 30km south of Arica, Chile. This material was excavated from middens and includes food remains (eg shell, bone, plant material) as well as cultural material (eg lithic artefacts, textiles, ceramics, wooden implements). The analysis of this data was directed toward an understanding of what constituted the earliest economy, when this occurred and how the economy changed through time (the material at Caleta Vitor ranges in age from the Early Archaic (>9000 cal BP) through to the Colonial Period).

Findings indicate that although the original inhabitants of Caleta Vitor arrived from the north and already had a well-developed economy based on marine resources. There was little evidence of inland/highland contact during the earlier phases of occupation. Cultural developments accord with those of the sites immediately to the north and south – around Arica and the Azapa Valley and south at Camarones and Pisagua. The termination of the early cultural phase known as the Chinchorro saw the introduction of ceramics, simple textiles and major changes to funerary practices during the Formative Period. Later developments included the introduction of a material culture and agricultural products from highland groups and local inland polities during the Late

Intermediate. Inka influence was noted during the Late Period. However, despite significant cultural shifts, the economy at Caleta Vitor remained focussed on marine resources. There were relatively few changes to the techniques and technology that were employed to exploit a range of resources that did not vary to any great degree.

Over time, an increasing range of products became available to those living at Caleta Vitor. However, they chose to remain focussed on the sea and their affinity with it remains.

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Christopher Carter

DEDICATION

To my daughter Reneé. Had she been here, I know she would have been proud of her Dad and would have loved to have been able to help in any and every way she could.

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The Economy of Prehistoric Coastal Northern Chile

Introduction[1]

Economy – a) the complex of human activities concerned with the production, distribution, and consumption of goods and services. (www.thefreedictionary.com) *From the Greek word meaning household management* (www.dictionary.reference.com)

Despite being located along the edge of one of the driest deserts on earth, the coast of northern Chile has been inhabited by humans for over 11,000 years. Within a limited range of habitats, local cultures were characterised by an economy based on limited terrestrial and abundant marine resources. This thesis intends to address the question how such an economy can be defined and how it functioned. By examining the economic trajectory of a particular coastal community, this project will attempt to establish the base from which the local economy was derived, how it developed through time with a focus on the consequences of migration, integration and trade, and will also consider the dynamics of the environment.

Coastlines are impacted by both isostatic and eustatic variation. Sea-levels are constantly fluctuating, from a daily tidal range through to long-term variation due to climatic or tectonic activity (Dincauze 2000: 228). Coastal landforms are the product of long term erosional forces where wind and water impact on the landforms – from rocky sub-strate to sand deposits. Sea-level, climate change and tectonic activity affect the scale of impact. As sea-levels rise or fall, waves impact on different parts of the coast, all of which are subject to varying degrees of erosion; increased rainfall may contribute to increased erosion and fluvial deposition may in turn may be altered by wave action; tectonic uplift will impact on the shape of the coastline either as a gradual process or abrupt change. All landforms are in a state of constant flux however those on the coast are at the

[1] The illustrations at the beginning of each section/chapter are from the notebook of Oswald Evans, Taltal, Chile, 1904 – courtesy of the AMNH.

junction of two diametrically opposed forces. Such a dichotomy would not only have challenged those humans who first settled on the coast but must be considered by archaeologists who choose to investigate pre-historic coastal cultures. The current form of an archaeological site will differ significantly from that of the habitation or processing site as it was formed. The subsequent change through time must be considered when assessing what resources were available, how they were exploited and the impact this had on the culture and economy of its earlier inhabitants.

This thesis is primarily based on archaeological data obtained from sites at Caleta Vitor which is located on the coast of northern Chile approximately 30km south of Arica, the country's northern-most city (see Figure 1). The data was obtained from surface collections and material excavated from middens and includes food remains (eg shell, bone, plant material) and cultural material (eg lithics, textiles, ceramics, wooden implements). Caleta Vitor was known to contain Colonial artefacts and the midden deposits were of sufficient depth to suggest pre-ceramic settlement, from as early as the Archaic Period.

The analysis of these data was directed toward an understanding of what constituted the basis of this site's economy; when this occurred; how the economy changed through time; and how their economy differed from other sites in the region as well as those from further afield. The final discussion focuses on the range of causal factors that may relate to both geographic and temporal variation.

The aim of this investigation is to extricate the elements of this coastal economy to better understand its development, variables, constants and regional relationships.

Figure 1: Location of Caleta Vitor
Base map courtesy Instituto Geografico Militar, Chile

This thesis will contribute to a number of outstanding questions:

I. Other than some collections made in 1893 and superficial reconnaissance (survey) in 1961 that noted the extent of archaeological material, Caleta Vitor has not been the subject of a detailed archaeological investigation. Well-known sites are located to the north (Arica) and south (Camarones) and extensive archaeological investigations have been undertaken at these locations. There is a geographic gap in the archaeological record of the coast of northern Chile. Furthermore, Caleta Vitor has not been subjected to the development that has all but destroyed the archaeological sites now located beneath the city of Arica. Thus, Caleta Vitor may be able to provide an insight into the conditions that once prevailed around Arica prior to European settlement.

II. What was the significance of the impact of El Niño events on pre-historic coastal communities in this region and how did inhabitants cope with such impacts?

III. When did the first people settle this region of South America and what was the migratory pathway of those first inhabitants? The archaeological deposits at Caleta Vitor are of sufficient depth that they may provide evidence of early coastal occupation and further contribute to this debate.

IV. While there are extensive middens along the entire coast of Chile that offer access to 11,000 years of history, their faunal composition, structure, and dynamics remain largely unstudied (Rivadeneira et al. 2009). How are the middens at Caleta Vitor structured? What is their compostion? Do they differ from those to the north (Arica) and the south (Camarones)?

V. Despite regular use of the terms, the definition of a 'maritime' or 'coastal' economy has not been clearly established. Was the development of such an economy an adaptive mechanism of early, more generalised hunter/foragers or was it developed elsewhere and introduced by the first settlers?

It is imperative that work continues at Caleta Vitor as the archaeological resources are under threat. Chile, being no different than most countries in the world, is under pressure to provide for its population. The land at Caleta Vitor is under pressure from three fronts. Firstly, there is demand for increased agricultural land. The Armada de Chile controls the majority of the coastal area of Caleta Vitor, however, some local residents are [unlawfully] encroaching on Navy land as they expand their fields. Second, the Quebrada de Vitor contains deposits of copper and other minerals and an expansion of existing mining activities is a distinct possibility. Copper mining and processing have already obliterated an area in the northern sector of Caleta Vitor and mineral exploration has commenced immediately to the east of known archaeological sites on the southern flank of the *quebrada* (canyon).

Furthermore, an increased threat to the area has resulted from the Navy allowing public access and the beach is becoming increasingly popular with campers and anglers. Apart from direct impact through traffic (foot and vehicular), higher visitation rates have increased the looting of archaeological sites and such activities were noted during the fieldwork season.

* * *

The thesis is structured in three parts:

Part One will provide a background to the region including:

- a geographic and environmental overview and how that may have impacted on the lives of those living within it;
- an introduction to the history of archaeology within the region, together with a review of more recent investigations and current research that relates to local [coastal] economies;
- a cultural chronology of the region based on previous research;

- definition and description of a marine economy;
- description of a settlement model based on previous research.

Part Two will detail the archaeological fieldwork and analysis of material collected from the site including:

- fieldwork methodology;
- a site description including details of each excavated trench;
- sorting and recording methodology;
- dating of selected material (radiocarbon);
- description of resources known either to occur in the area today or that are known to have existed in the past;
- a synopsis of archaeological material retrieved.

Part Three will contain a discussion relating to the analysis and interpretation of data generated from the fieldwork and:

- discuss the settlement structure within the site;
- develop a chronology of the site based on dates from a number of separate loci;
- determine the extent and range of economic fluctuations;
- consider whether economic variability was the result of direct human agency (internal development or introduced technology), or adaptation to a changing environment;
- an updated settlement model and discuss its application in other settings.

PART ONE

Chapter One

As everyone knows, it is impossible to form an accurate conception of human history without a knowledge of the physical geography of the world. (Bird 1943: 183)

Environmental Background

This chapter provides a description of the physical environment of the area within which this investigation concentrates - coastal northern Chile between 18° and 28°S. To understand how the economy of the prehistoric occupants developed, it is necessary to provide some detail of the physical setting within which these events took place.

* * *

The geography of Chile is quite extraordinary and unusual in form. It covers several climatic zones due to its elongated, north-south alignment. The country stretches for over 4000km, from 18°S, where it adjoins Peru, to 56°S at the southern tip of Tierra del Fuego and the Cape Horn islands. Chile has a surface area of 756,102 sqkm (compared to the continent of South America which covers an area of 17,840,000 sqkm). It is flanked to the west by the Pacific Ocean and its eastern border follows the high peaks of the Andes. It has an average width of less than 200km (see Figure 1.1). Despite being so narrow, it rises abruptly from the sea to reach a maximum altitude of almost 7000m within 150km of the coast (Grosjean et al. 2003).

Figure 1.1: Continental South America showing major topography, political borders and main cities. Chile is contained within the dashed box (apart from a small area of the far south). From http://www.geographicguide.com/south-america.

This unique physiographical setting is the result of subduction of the Pacific floor under the continent that has generated the emergence of the Andes (Pankhurst and Hervé 2007: 1). Uplift and eastward migration of the Andean volcanic arc have created one of the greatest topographic matrixes in the world – from peaks above 7000m ASL to the offshore Peru-Chile trench which is over 7600m BSL (Berger 1997: 545).

Montgomery et al. (2001) suggest that the morphology of the Andes is the result of a combination of tectonics and climatic zonality, particularly 'strong latitudinal precipitation gradients'. The central Andean region has a far greater crustal thickness and mass than the north or south Andes, as erosion has had far less impact than it has in the north, where rainfall is far higher east and west of the range, and the south, where rainfall and glaciation have contributed to greater erosion intensity. They conclude that 'nonuniform erosion due to large-scale climate patterns is a first-order control on the topographic evolution of the Andes' (Montgomery et al. 2001: 579).

Physical Description

Northern Chile is characterised by five geomorphological zones:

- Coastal Cordillera – with an average elevation of 1500m ASL and a western flank formed by an almost continuous coastal cliff of 1000m ASL (average height) and maximum relief of 2000m ASL;
- Central Depression (Pampa) – generally dry with some sub-surface water, ranging between 1400m and 3000m ASL, punctuated by deep *quebradas* that run from the mountain to the sea;
- Pre-cordillera – a series of ridges and valleys between 3000m and 4500m ASL with some precipitation from weather patterns that cross the Main Cordillera from the east;
- Western (Main) Cordillera - overall highest elevations of the Andes with a mean of 4000m ASL and some mountains reaching over 6000m ASL;

- Altiplano and Puna (the highland valley between the Western and Eastern Cordillera of the Andes) – generally above 4000m ASL, with only a relatively small area within far northern Chile.

Coastal Cordillera

The Coastal Cordillera makes up the prominent forearc feature of northern Chile in the form of a 1-2km high, 25-45 km wide range (Gonzalez et al. 2003). The cordillera generally consists of volcanic rocks of Jurassic age with intrusions from the Cretaceous to Tertiary and smaller areas underlain by Precambrian gneiss and Triassic to Jurassic-aged sedimentary rocks. Slopes are often steep, covered with loose gravel and little soil or vegetation. This range has not been subjected to glaciation as it was lower than the Last Glacial Maximum (LGM) snow-line in the central Andes.

The prominent coastal cliffs along the cordillera are a topographic expression of long-term uplift and extend over 1000 km between 18°S and 28°S (Cembrano et al. 2007). Cliffs range from steep to precipitous. There is no coastal plain along the majority of the range. Occasional small bays or coves are found along the shoreline, particularly where the *quebradas* incise the range and the rivers reach the sea. Isolated beaches are located in some areas while in others, narrow coastal plains are located along the base of the cliffs or adjacent to river mouths. It is not possible to traverse the length of the littoral on foot, an important factor when considering early exploration along the coast. Away from the *quebradas*, there are a few coves and marine terraces that are accessible from the landward side (via steep cliffs) while others can only be accessed from the sea.

Late Pleistocene and early Holocene marine terraces at the feet of some of the cliffs result from uplift pulses which are expressed in a staircase pattern ranging from 3m up to 300-400m ASL on the Mejillones Peninsula, near Antofagasta.

Figure 1.2: Coastal Escarpment & Cordillera between Iquique and Pisagua, northern Chile. Photo: C. Carter.

Figure 1.3: Coastal zone – south from Caleta Camarone. Photo: C. Carter

Figures 1.2 and 1.3 are photographs which illustrate the coastal escarpment and Coastal Cordillera of northern Chile

Central Depression

Inland, the topography is marked by the eastern boundary of the Coastal Cordillera with the Central Depression, a basin filled in some areas with more than 1000m of Tertiary-Quaternary alluvial fan, fluvial and lacustrine deposits (Gonzalez et al. 2003). In this region, the Central Depression and the western slopes of the Andes are underlain by a series of ignimbrite sheets up to 1100m thick on the higher slopes to 300m on the coast near Arica (Wörner et al. 2002: 187). This deposit formed between 23 Ma[1] and 19 Ma. The Central Depression ranges in elevation from 1200 to 2000m ASL and from 70 to 85 km in width. In the northern sector, the Central Depression consists of flat to rolling pedi-plain (*pampa*) that is cut by east-west running *quebradas* up to 1700m deep that continue to the sea (see Figure 1.4). The main *quebradas* south from the Peruvian border are: Lluta, Azapa, Vitor, Camarones, Tana and Tiliviche.

Figure 1.4: - Central Depression, inland from Pisagua, view to east. Photo: C. Carter

These canyons are relatively deep (440-1700m) and have a stream bed along their bases. However they are mostly smooth sided and unrilled. This relief does not appear to have changed for some time and has been described as being 'erosionally paralysed' due to the hyper-aridity of this area (Oberlander 1997: 157).

The Lluta and Azapa valleys are the main trunks of a trellis drainage system which extends into the Pre-Cordillera, whereas the Vitor, Tana, Tiliviche and Camarones *quebradas* show sub-dendritic (branched) drainage patterns. The formation of canyons in this area has been caused by variations between sea level and the base levels of rivers in the Central Depression downcutting to meet lowered sea levels, especially during glacial maxima. Incision of these valleys would have commenced during local semi-arid climatic periods when runoff from the Western Cordillera increased (Garcia et al. 2011: 1058). Once rivers breached the Coastal Cordillera (becoming exoreic (open)), precipitation was sufficient under arid/semiarid conditions for canyon formation to occur. Garcia et al. (2011: 1058) suggest that incision rates in the area of the Lluta and Azapa canyons between 11 - 3 Ma varied between 100 and 120 m/My [2] (around 940 m in the Central Depression) (see Figure 1.5). There was no incision in that area between 11 – 15 Ma (when there was aggradation) and the rate over the last 3 Ma has been 25 ±17 m/My.

Kober et al. (2006: 85) calculated erosion volumes of the valleys in the vicinity of Arica as follows:

Valley	Drainage Area	Volume	Rate of Erosion
Rio Lluta	3500 km^2	360 km^3	13 m/My
Rio San Jose/Azapa	1700 km^2	220 km^3	17 m/My
Quebrada de Vitor	1620 km^2	90 km^3	7.4 m/My

Table 1.1: Erosion volumes from valleys near Arica. Kober et al. (2006: 85)

[2] m/My = metres per million years

Apart from their larger drainage areas, the erosion for both the Lluta and San Jose rivers was higher than the more southerly rivers due to the sources of those rivers being on the slopes of the Western Andean Cordillera, whereas the Quebrada de Vitor has its source on the Western Escarpment.

Figure 1.5 - Lluta Valley, view to south, approximately 25 km from the coast.
Photo: C. Carter

South of 19°40' S, as rainfall declines, and to the north of the Loa River, the drainage systems do not reach the Pacific Ocean. In that region the drainage systems from the western slope are endoreic (closed) and discharge into inland basins such as the Pampa de Tamarugal and the Salar de Atacama at a base level around 1000m ASL. (Kirk-Lawlor et al. 2013: 77; Garcia et al. 2011: 1049; Santoro et al. 2005: 247).

Some *quebradas* were also shaped by volcanic erosion - very violent flows of ash and rocks. The volcanoes in the Andes are andesitic, steep sided and tend to occasionally explode. In such an eruption, these volcanoes can create a pyroclastic flow of ash and rock mixed with super-heated gases, sometimes

Figure 1.6: Quebrada Vitor - Evidence of pyroclastic flow
Photo: Paul Willis

moving at speeds in excess 500 km/h. This flow, being full of abrasive material, cuts through the existing bedrock, enlarging or creating massive canyons, often in a single event (Branney and Kokelaar 2002).

The evidence of such a flow is visible at Caleta Vitor, where the overlaying ignimbrite (from the pyroclastic flow) 'swept' up the valley sides as it coursed down the valley. Figure 1.6 is a photograph of the southern flank of Quebrada de Vitor, a short distance from the modern shoreline. The darker rock is a basalt intrusion that forms part of the coastal cordillera. The buff coloured rock layer on the left side of the image is a remnant layer of ignimbrite from a pyroclastic flow as it exited the valley and swept up the slope against the harder basalt. This layer continues across the valley although the majority of this stratum is covered by several metres of alluvial sands.

Pre-cordillera

Immediately east of the Central Depression the Pre-cordillera rises rapidly to reach altitudes between 3500 and 4500m ASL to form the foothills of the

Western Cordillera. Annual rainfall increases from west to east across the Pre-cordillera where the altitudinal range exceeds 2000m. Some valleys within this region contain natural river terraces and benches suitable for agriculture. Snow melt, rainfall and subterranean sources provide water for irrigation. Figure 1.7 is a photograph of a typical pre-cordillera landscape with a section of the Western Cordillera visible in the background.

Figure 1.7: Pre-Cordillera, view south from Zapahuira, 105 km east of Arica, ~3,500 m ASL. Photo: C. Carter

Western Cordillera and Altiplano

The high section of the Western Cordillera is located approximately 120km east of Arica, along Chile's border with Bolivia. In this region, the range is dominated by a continuous volcanic chain reaching up to 6893m ASL (Cembrano et al. 2007). The western flanks of the range are very steep, often rising over 3000m within a relatively short distance. Apart from individual peaks, the eastern flanks are less severe and fall to the more gently sloping Altiplano. Numerous lakes, both fresh and salt, are located to the east of the main range. The snowline in this area is above 6000m ASL, highlighting the continued aridity of the region to a high altitude (Montgomery et al. 2001: 580).

The southern range of the Andes Cordillera divides into an eastern and western range at around 24° S. The area between the two ranges is a rolling plateau generally over 4000m ASL. This area is known as the high Puna or Altiplano.

Figure 1.8 is a photograph of Volcan Parinacota, one of several volcanoes in the region. The green pasture-like vegetation in the foreground is known locally as *bofedales* and consists of a range of hydrophytic plants. This grass-like vegetation is found around springs and soaks above 3800m ASL and is commonly utilised today as pasture for alpaca (*Vicugna pacos*) and llama (*Lama glama*). At this altitude, it is also favoured by wild vicuña (*Vicugna vicugna*).

As the eastern border of Chile follows the high peaks of the Western Cordillera, the major portion of the Altiplano is located within Bolivia and Peru. Lake Titicaca is located within the Altiplano between the western and eastern Andean Cordillera. The distance between Lake Titicaca (southern basin) and the coast at Arica is approximately 260km between.

The Humboldt Current

The Chilean continental margin is characterised by a narrow continental shelf, steep offshore continental slope and a deep-sea trench (Marchant et al. 2007: 291). In the north of Chile the continental shelf is very narrow, rarely exceeding 5 km. The Humboldt Current System (HCS) (also known as the Peru-Chile current) flows northward along the west coast of South America. Its origins lie in the Antarctic Circum-polar Current which flows clockwise around Antarctica. Various factors result in an upwelling of cold, nutrient rich subsurface waters along much of the Chilean shoreline (Marchant et al. 2007: 292). The impact of the upwelling on the marine biota is profound. From phytoplankton, through zoo-plankton, progressing to sardines and anchovies, and on to higher trophic levels, this was an incredibly rich bio-mass.

Due to its intensity and continuity, the HCS has produced an important and productive region – more fish per unit area are harvested from this area than anywhere else in the world (Montecino and Lange 2009). At its peak, during the early to mid 20th century, the maximum anchovy yield was estimated to be 100 tonnes per sqkm (Guillen 1992: 94). From a small fraction of the world's oceans, some decades ago the Peruvian and Chilean fisheries produced 22% of the world's total marine fish catch (Marcus et al. 1999).

The importance of the HCS cannot be overstated:

> The HCS is a large marine ecosystem whose dynamics permeate the social and economic sectors of the bordering countries. It is subject to large fluctuations in climate, ecosystems, productivity and fisheries on all time scales. For centuries, coastal communities have developed around and depended (and still do) heavily on its marine resources. (Montecino and Lange 2009: 76).

While this statement may specifically relate to the last few centuries, it can be extrapolated deep into the prehistory of western South America.

Flora and Fauna

Given the aridity of this region, its range of vegetation is limited. While the coastal strip receives virtually no rainfall, the *camanchaca* [fog] supports a unique occurrence known as *lomas*, an endemic and seasonal formation characterised by the presence of shrubs, cacti and annuals (Sandweiss and Richardson 2008: 95; Santoro et al. 2005b: 173). *Tillandsia* spp., also known as 'airplants', are an important species within this formation and extend along many areas of the Atacama Desert that are within reach of the coastal fogs (Crawford 2008: 57; Pinto et al. 2006;). Wild tomatoes (*Solanum* spp.) are commonly found within *lomas* stands (Peralta et al. 2008: 36).

Moving away from the coast and the reach of the fogs, absolute desert prevails until around 2400m ASL (Latorre et al. 2005: 75). Vegetation at this altitude is characterised by the appearance of columnar cacti, xerophytic shrubs, herbs and annual grasses with a greater diversity of species appearing above 2800m ASL. High Andean steppe grassland is found above 3900m ASL. The *quebrada*s support a range of plants dependent on the quality and depth of the groundwater and consistency of surface water. Trees and plants such as *tamarugal* and *algarrobo* (*Prosopis* spp.*)* are found along with *molle* (*Schinus molle*), reed (*Tortora* spp.) and a range of shrubs and grasses (Santoro et al. 2005: 248). To the south of the 'fertile coast', the central depression contains a closed hydrographic system which supports a broad expanse of forest (*Prosopis* spp.) over an area known as the Pampa de Tamarugal.

Generally, animal life in South America is abundant, however this is not the case in the coastal region of northern Chile. Terrestrial fauna is restricted by the limited water sources and, apart from marine species, the variety of birds and mammals is very low along the coast (Spotorno and Veloso 1990: 23). Species numbers increase with altitude and peak at the Puna Belt (between 3000 – 4000m ASL) and are higher within the High Andean Belt than on the coast. In the past, the *lomas* formations seasonally attracted a wide variety of animals and birds (e.g., camelids (*Lama guanicoe*), rodents and native foxes (*Desusicyon* spp.) (Spotorno and Veloso 1990: 246). The water and vegetation within the *quebrada*s attracted rodents, camelids and deer (*Hippocamelus bisulcus*), while the more stable and wider range of vegetation of the Pre-Cordillera supported larger populations of game. The following is an excerpt taken from a 1944 newspaper and was written by a former resident of Taltal in the Atacama region, to the south of Arica:

> ...A scanty seasonal growth of vegetation in the valley bottoms and hill sides where the mists condensed may have helped, and the small ground game must have fallen to their feeble bows and snares. The guanacos may have been more plentiful – even in my time they came down to the coast when the hill tops were thickly covered with wild mint and grasses... (Hardey 1944)

The coastal strip supports a variety of marine mammals, reptiles and avifauna including sea lions, 'lava' lizards, otters, pelicans, penguins, boobies, cormorants, terns and gulls (pers. obs.). These animals are attracted by the richness of the marine biota to such an extent that the seas off northern Chile and southern Peru support one of the world's richest marine avifaunas (Olsen Bruhns 1994: 32) Whales also feed in the Humboldt Current and are occasionally washed up on the beaches (C. Santoro pers. comm.). Sea turtles, including loggerheads, green and olive ridleys, are known in the area (Alfaro-Shigueto et al. 2004) and sea turtles are sometimes seen off the Chinchorro Beach at Arica (pers. obs.).

Tectonics and Volcanism

Geologically, Chile remains very active and this creates instability along the precipitous cliffs and mountainous coastline of northern Chile. The Chile-Peru subduction zone is one of the highest hazard zones for earthquakes in the world (Arango et al. 2011: 19). According to Allmendinger and Gonzalez (2010: 93):

> "This plate boundary periodically generates massive sub-duction zone earthquakes which not only affect local communities but also produce tsunamis that impact the entire Pacific Ocean rim. The rupture zone for large and great earthquakes lies beneath the coastal areas in northern Chile and southern Perú. ... The earthquakes are the culminations of cycles in which elastic strains

build up over a 100-150 year period as convergence continues but the plate boundary is locked."

Figure 1.8: Western Cordillera – Volcan Parinacota (6348 m ASL),view to north-east across Lago Chungara. Photo: C. Carter

Figure 1.8 is a photograph of Volcan Parinacota (6348 m ASL, 18°10'S) which is located on the border between Chile and Bolivia. This volcano has an eruptive volume of 46 km^3 (Hora et al. 2007). It was formed between 163-117 Ka [3] by andesitic lava, followed by the build-up of a rhyodacite dome between 47-40 Ka. There was a major event between 20-10 ka which resulted in a debris avalanche of 6 cubic kms, three times larger than that of Mt St Helens in 1980. While it is a dormant volcano, it is potentially active and an eruption occurred as recently as 3-2 Ka.

The coastline of northern Chile is located within a subduction zone with a complex pattern of vertical deformation and uplift (Ortlieb et al. 1996: 819).

[3] Ka = thousand years ago

Studies to the north of Antofagasta (south of Arica) suggest that uplift from about 330,000 years ago until the present has been about 240mm/1,000 years. Given that the coast of northern Chile has been occupied for at least 10,000 years, marine terraces along the coast may have risen 2.4m during that period, or around 2m from the period of highest sea-levels.

In Chile, tsunamis have occurred in the historic and recent past, e.g., 1605, 1868 and 1877 (Douglas 1878; Frezier 1717; Sandweiss and Richardson 2008: 95), with a major tsunami event in the south of the country on 27 February 2010 (http://www.abc.net.au/news/2010-02-27). Tsunamis are a constant threat to the coastal cities of northern Chile. Today, Arica has contingency plans and a warning system in place should an earthquake trigger such a wave. There is good reason for this city to be cautious as on 26 November 1605 the 'Sea being agitated by an Earthquake, suddenly flooded and bore down the greatest part of it [Arica].' (Frezier 1717: 150).

In 1868, much of the town was again destroyed by a massive tsunami. In 1878, James Douglas visited Arica and described reports of the tsunami resulting from that earthquake:

> "The splendid custom-house and public buildings ... the churches and the gardens ... all were overturned by an earthquake and then swept away by a wave, which left parts of the plain, once covered by iron and stone buildings, as level as a ploughed field.
>
> About five o'clock in the afternoon of August 13th 1868, an earthquake occurred, which, after two or three gentle vibrations, terminated in a shock which laid the town in ruins. As, however, there were very few two-storied buildings, and nearly all were adobe and roofed with mud, not many lives were lost. Those buried were being exhumed when the sea was

seen to recede and leave nearly a mile of bare coast. Soon a huge wave slowly gurgled up; the water was in a boil, and gradually rose till it reached its highest normal limit. The wave then invaded the land and flowed on into the interior, gathering force as it went carrying desolation in its track. The water stood at the shore line thirty-six feet[4] perpendicular above its highest tidemark, when the wave retreated with terrific force. Twice it returned before the sea recovered its equilibrium." (Douglas 1878: 216-217)

Figure 1.9 - *USS Wateree* beached some distance from the shoreline following the tsunami at Arica in 1868.
Photo courtesy of the AMNH.

Douglas went on to describe the broader impact of the earthquake and tsunami, stating that the parts of the town below the cliffs of *El Moro* were not badly affected due to their elevation. The northern part of the town was obliterated. Several ships were at anchor in the port and most were badly

[4] 36 feet = 10.97 metres

damaged, 'one was carried nearly two miles[5] inland' (Douglas 1878: 219) (see Figure 1.9 – the distance was actually more like 500m inland). Another earthquake, again followed by a tsunami, occurred on 9 May, 1877, and destroyed much of what had been rebuilt. These were not the first earthquakes reported in the area and others are likely to have occurred well into the past.

Fluctuating Sea Levels

Apart from uplift pulses, the prehistoric coastline has also changed as sea-levels have fluctuated. During glacial periods sea-levels were much lower than they are today. At the peak of the LGM between 22,000 and 19,000 years BP the sea-level was around 130m lower than today (Pope and Terrell 2008: 9). After 19,000 BP there was an abrupt rise of about 15m followed by a more gradual rate over the next 5000 years. Sea-levels continued to rise at a relatively rapid rate of about 15-16m per millenium except for the period between 12,000-11,500 BP (corresponding to the Younger Dryas cooling event) until about 8500 BP when they stabilised at their present levels (Pope and Terrell 2008: 20). Isla (1989) suggests that sea levels in the Southern Hemisphere were actually higher around 8500 BP than those of today. Known as the 'Holocene highstand', it has been estimated that sea-levels were up to 2m higher at times during that period (Blum et al. 2001).

A sea-level rise in the order of 130m would have had a significant impact on the morphology of the coastline. For example, Australia had a surface area 25% larger than present during the LGM and an exposed continent (Sundaland) connected Borneo, Malaya, Java, Sumatra and Vietnam in Asia and Beringia connected Asia and North America (Murray-Wallace, 2007: 3027). Bounded by high cliffs, northern Chile does not have such an extensive continental shelf and often has deep water close to the current shore line. A relatively broad shelf runs north of Arica into Peru, but to the south there are lengthy stretches where the cliffs plunge directly into the

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[5] 2 miles = 3.2 kilometres

sea. The 100m bathymetric line appears only a short distance (<2 km) off-shore along much of this area (see Chart 22205, Arica to Mejillones, 1994 edition, National Geospatial Intelligence Agency). In general, the continental shelf off Chile begins to break around 200m off-shore. It appears that during the late Pleistocene only a narrow coastal strip, if any at all, would have existed between the current shoreline (cliffs) and the sea along much of northern Chile.

Notwithstanding the presence of a narrow continental shelf, evidence of Pleistocene occupation along the shoreline of this area would have been inundated long ago. Sites located close to the shoreline would have been subjected to wave action as sea levels rose and unless they were located in sheltered areas (such as caves), the likelihood of locating evidence from intact submarine sites is very low.

Climate

With such a broad latitudinal range and an extraordinary topography, climatic variation within Chile is extreme. The north is characterised by the Atacama Desert, known as the driest desert in the world. The coast-line of the far south was formed by relatively recent glaciations that created fiords and archipelagos consisting of thousands of islands as a result of post-glacial sea level rise. Rainfall is measured in metres per annum in many coastal areas of the south whereas much of the north (Atacama Desert) receives little or no rainfall at all (Cruz Villalón 1988; Muñoz et al. 2007: 216: Pankhurst and Hervé 2007: 1).

Based on the Köppen climate classification, Arica has a mild desert climate. The following describes the typical [modern] weather for Arica over the course of an average year. It is based on data collected at the Chacalluta Airport between 2006 and 2012 (http://weatherspark.com/). This airport is located 15 km north of Arica and less than 1 km from the coast.

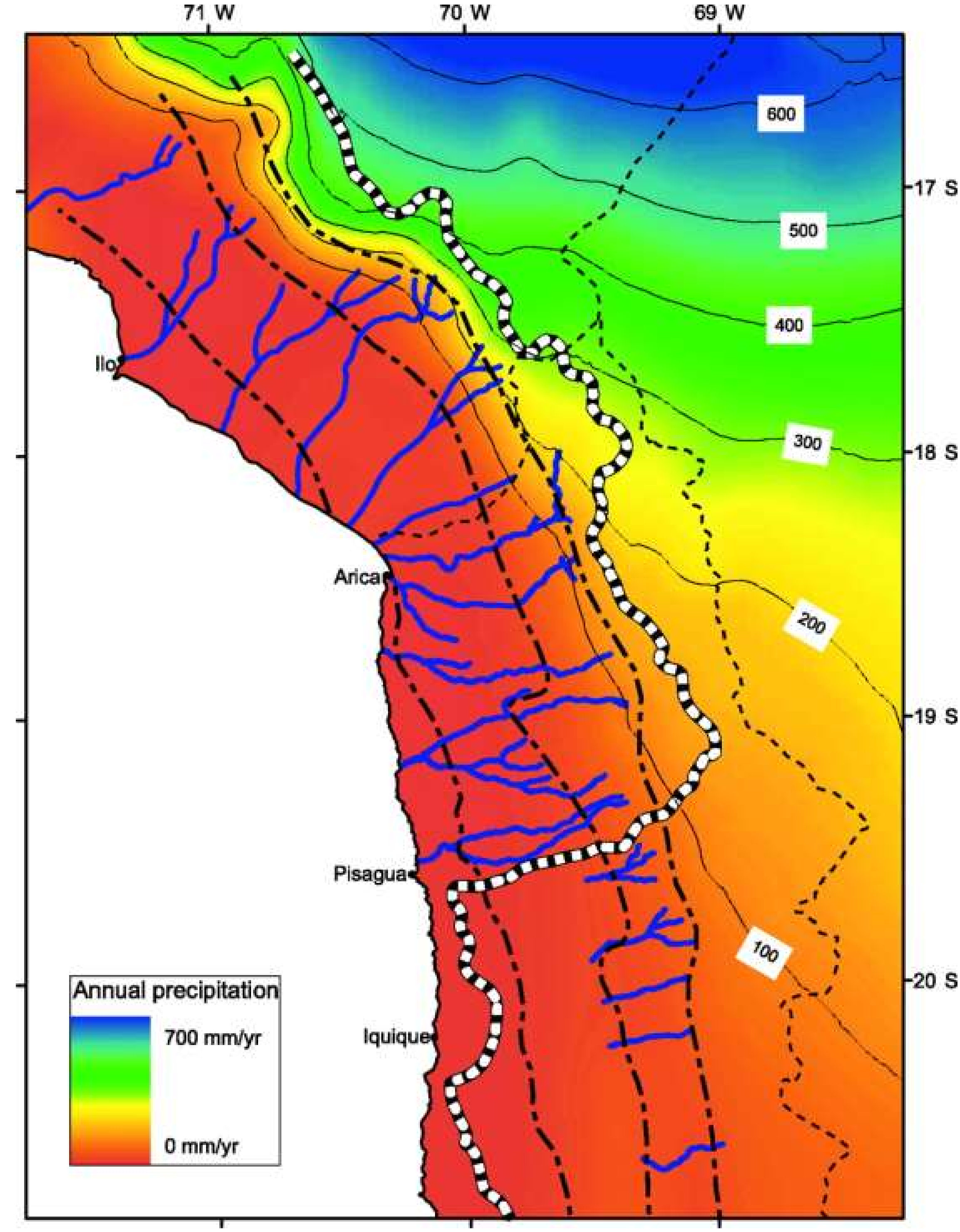


Figure1.10: Northern Chile - Distribution of the present-day mean annual precipitation, main canyons (blue lines) and main water divide (dashed black and white line). Contour lines are at intervals of 100 mm. (From Garcia et al. 2011)

Over the course of a year, the temperature typically varies between 14°C to 26°C and is rarely below 12°C or above 27°C. The warm season lasts from late December to early April with an average daily maximum above 24°C. The hottest time of the year is in February, with an average maximum of 26°C and low of 21°C. The cold season lasts from mid-June to October with an average daily maximum below 19°C. The coldest period of the year is July, with an average low of 14°C and high of 17°C.

Recorded wind speeds varied from 0 to 7 metres per second (m/s) (calm to moderate breeze). The highest average wind speed of 17 m/s (high wind) occurs in early September, at which time the average daily maximum wind speed is 6 m/s (moderate breeze).

The lowest average wind speed of 2 m/s (light breeze) occurs in early July when the average daily maximum wind speed is 5 m/s (gentle breeze). The most common wind direction is out of the south-west (30% of the time), from the south (24% of the time), and from the east (10% of the time). The wind is least often out of the north-west (4% of the time) and south-east (4% of the time).

The median cloud cover ranges from 74% (partly cloudy) to 96% (overcast). The clearer part of the year begins around mid-January. The cloudier part of the year begins around mid-April. No records of precipitation were available for the period 2006-2012.

Despite regular cloud cover, according to the World Meteorological Organization Arica has the world's lowest average yearly precipitation (0.8mm). No rainfall was recorded there between October 1903 and January 1918, this being the world's longest recorded period without rain (http://wmo.asu.edu) (see Figure 1.10).

The hyper-aridity of the Atacama region is due to a combination of factors including:

- The extreme rain-shadow effect of the Andes, which block the movement of tropical/sub-tropical moisture-bearing winds from the east;
- The restricted influence of winter storm tracking from the south blocked due to the presence of the stable South Pacific Anti-cyclone;
- A temperature inversion at around 1000m ASL caused by the cold, north-flowing Humboldt Current that limits inland penetration of moisture-bearing winds from the Pacific (Contreras et al. 2010; Latorre et al. 2007: 312; Ramirez de Bryson et al. 2001: 6; Berger 1997: 547).

Extremely arid conditions have prevailed in the Atacama Desert since the late Eocene with the current hyper-aridity being attributed to an increased up-welling of cold currents in the mid Miocene (Berger 1997: 547; Cembrano et al. 2007: 236). The Drake Passage, in southern Chile, opened around 23 Ma and by 15 Ma the cold Humboldt Current was flowing northward along the coast and northern Chile became hyper-arid (Wörner et al. 2002: 187). It had been arid to semi-arid prior to that period.

In the central Atacama Desert the activities of a number of rodent species have accumulated middens that contain evidence of both food and nesting material. Plant remains and faecal pellets from such midden deposits have been radiocarbon dated from as early as 45,000 BP and indicate a range of climatic conditions over that period (Betancourt et al. 2000; Latorre et al. 2002). Low plant species richness from 40,000 to 22,000 BP suggests an arid period, followed by an increase in summer rainfall between 16,200 and 10,500 BP. This increase led to an upward movement of steppe grasses by as much as 1000m in altitude. A dramatic decrease in grass abundance after 10,500 BP and an increase in plant species richness in general suggests a wetter period between 7100 and 3000 BP. While there is evidence to suggest climatic variability in the past, there are on-going controversies, particularly whether the mid-Holocene climate was more humid than it is today (see Grosjean et al. 2003; Pope and Terrell 2008; Smith et al. 2011).

In 2012, Gayo et al. published the results of an investigation of a site at Quebrada Mani (21°S) a [currently] hyper-arid drainage basin in the Atacama Desert. Based on plant macro-fossils and archaeological remains, they suggest that in what is now a sterile environment, 'riparian ecosystems and farming ... groups flourished' due to an increase in available surface water (Gayo et al. 2012: 287). Twenty-six radiocarbon dates from well-preserved plant and archaeological remains indicate that wetter periods occurred there between 2500-2040, 1615-1350 and 1050-680 cal BP. Their findings concur with similar results obtained from rodent middens from higher altitude Andean sites (Latorre et al. 2002). Other records indicate that these events were synchronous with pluvial stages at higher elevations and coincident with rises or falls in sea surface temperature (SST) in the tropical Pacific into and out of a *La Niña*-like mode, conducive to higher rainfall in the central Andean highlands with consequent flood events in low elevation watersheds. Gayo et al. (2012: 287) suggest that gradient changes in the SSTs of the tropical south Pacific have been the principle mechanism for climate fluctuations in the central Andean region.

The 'Walker Circulation' is an important factor contributing to the climate of the region. It is an airflow pattern that forms across the tropical [south] Pacific Ocean and is driven by east-west variations in SST (Contreras et al. 2010; Williams et al. 2008). This airflow is coupled to a westward circulation of surface water which promotes an upwelling of nutrient rich cold water off the coasts of Peru and Chile. Convective rainfall over northern and eastern Australia results from a strong Walker Circulation. However, this pattern results in the suppression of rain over coastal regions of Peru and Chile, and vice-versa. The stability of the Walker Circulation is dependent on SST and fluctuations in temperatures (known as the Southern Oscilllation Index or

SOI) determine its strength. These fluctuations are known as the El Niño-Southern Oscillation (ENSO) and this has a major impact on the climate of western South America.

A strong SOI is known as *La Niña* and is generally associated with heavy rainfall over Australia and the altiplano of Chile and Peru but dry conditions on the coast, a more 'normal' weather condition. *El Niño*, on the other hand, following a weakened Walker Circulation, suppresses the upwelling of cold waters of South America, creates drought in Australia and wetter conditions in South America (particularly northern Peru) (Beresford-Jones 2004: 39). Sea temperatures rise by as much as 10°C, killing phytoplankton which disrupts the entire food chain. *El Niño* occurs every four to seven years and, in most cases, leads to a water temperature increase of around 5°C (Urban 1994: 144).

The strongest *El Niño* of this century occurred during 1982-83 and the SST in northern Chile was up to 7-10°C above normal temperatures (Urban 1994: 140). Recorded *El Niño* events in northern Chile have had a major impact on coastal waters causing the collapse of local fisheries, mass die-off of marine organisms, torrential rainfall and flooding (Williams et al. 2008: 247). Recovery from such events varies between species and eco-zones: the inter-tidal zone can recover within two years, whereas the sub-tidal zone can take up to five years as kelps only begin to recolonise after about two years (Arntz and Tarazona 1990: 337). Not all species necessarily suffer negatively from the impact of *El Niño* events. During 1982-83, the Peruvian scallop (*Argopecten purpuratus*) thrived and created a short-term boom resource for local fishermen (Urban 1994: 140). Urban (1994) suggested that the water temperature tolerance levels not only vary between species, but will vary within the same species - those from Peru are more likely to 'acclimatise' and tolerate warmer waters as they are closer to the equator and more used to *El Niño* events than a Chilean cohort.

Based on research in northern Peru over the past 30 years, results have suggested that there were few or no *El Niño* events from ~9000 to 5800 cal BP; strong but infrequent *El Niño* events from 5800 until 3000 cal BP after which the current cycle emerged (Sandweiss and Richardson 2008: 100).

El Niño events from the recent past highlight their impact on coastal environments. The *El Niño* of 1982–83 recorded a flood discharge for the Rio Piura (northern Peru) as 2473m^3/s[6], the 1998 peak reached 4300m^3/s, whereas the normal mean is 340m^3/s (Wells and Noller 1999: 761). This flood event was coupled with an increase in sea temperature of between 6-8°C. The *El Niño* of 1982-83 not only had a catastrophic impact on Peruvian fisheries but its effects were felt across the Pacific and as far north as Alaska (Olsen Bruhns 1994: 33; Urban 1994; see also Glynn 1990). While *El Niño* events do affect the coast of northern Chile and southern Peru, it has been suggested that the impact is far less critical in northern Chile than it is further north (Guillen 1992: 300). However, there have been periods in the past where the impact of *El Niño* cycles varied significantly.

Ilo is located on the coast of southern Peru approximately 80km north of Arica. Research in that area suggests that there have been past *El Niño* events that have had a far greater impact than those of the recent past (Keefer et al. 2003: 41). Two serious events have been dated to between AD 1300-1400 and 1607-08. However, there are older deposits that indicated events of similar, if not greater, severity. The Late Pleistocene to Holocene record from three coastal, alluvial-fan sites near Ilo dated from 38,200 years BP onwards, has been dominated by flood and debris-flow deposits with features indicating generation by heavy rainfall in a currently arid environment. *El Niño* activity (as indicated by these flood events) appears to have been high between 12,000 and 8400 years BP but during the mid-Holocene (8400 to 5300 years BP) there were no large scale flood or debris-

[6] m^3/s = cubic metres per second

flow deposits (Keefer et al. 2003: 69). However, flood events have occurred in the recent past.

Severe flood events have occurred at Arica during the past decade or so. Such events have caused loss of life and economic damage along much the central Andean Coast. Records of more severe events in the past suggest that living in these coastal regions would have been hazardous. Keefer et al. (2003) suggest that a severe *El Niño* event was probably a major factor in the demise of an indigenous coastal culture in the Ilo region around 8400 years BP. Older extreme events, possibly in conjunction with earthquakes, would have had disastrous consequences for other prehistoric coastal populations as well.

Beresford-Jones (2004: 40), however, suggests that archaeologists must be cautious when attributing specific causes of high rainfall to evidence of debris-flow deposits. Flood events may be triggered by significant rainfall coming in from the east that was not at all associated with *El Niño* – the so-called *invierno Boliviano* (Bolivian winter – although it actually occurs in the summer) in northern Chile. For instance, Putre is located 180 km east of Arica in the Precordillera toward the head of the Lluta drainage system. Current average rainfall between January and April here exceeds 200 mm (combined four month average)[7]. Given the large catchment of this area, considerable water flows can be expected each summer and flooding is not uncommon. During his journey through southern Peru in the vicinity of Tarapaca, Bollaert (1851) reported on the arid conditions as well as floods stating that:

> " In general there is barely sufficient water to irrigate the land ... but when thunderstorms with their heavy rains occur in the Andes, great torrents or *avenidas* rush down the ravines, bringing with them masses of rock, trees, huts, cattle, indeed

[7] http://www.worldweatheronline.com/Putre-weather-averages/Tarapaca/CL.aspx

> all that may be in their way – leaving, after one of these sudden and destructive floods, nothing but a bed of stones.” (Bolleart 1851: 104)

I witnessed the results of flooding at Arica that occurred during the summer of 2012. The normally dry channel of Rio San Jose cuts through the city to terminate at the southern end of Chinchorro Beach. The discharge of silt and sand was so great following the floods of 2012 that the coastline was extended some 50m westward. Caleta Vitor also appeared to have experienced similar flooding in 2012.

Some arid areas receive precipitation via fog and dew. Along the coast of the Atacama Desert, fog often provides more precipitation than rainfall (Bullard 1997: 112). Dew is also common among stands of vegetation such as *Prosopis* spp., where the warmer air temperature within the canopy and the reduction of the ambient humidity causes it to form. The result is that precipitation beneath the trees can be up to eight times that in the open (Crawford 2008: 96). The fogs along the desert coast are known as *garúa* in Peru and *camanchaca* in Chile. While the fogs provide some precipitation, however slight, they also obscure the sun for days at a time. As such, the winter air temperatures along the fog affected coast are often substantially lower (~13°C) than in areas only a short distance away but above the fog line (~24°C) (Crawford 2008: 56).

Hydrology

Today, the presence of surface water in the Atacama Desert is almost solely due to events occurring outside the region. Convective air masses cross the Main Cordillera bringing moist air across the Altiplano from the Amazon Basin (Santoro et al. 2005a: 247). This phenomenon, the *invierno Boliviano,* produces runoff and groundwater that generally flows from the western slopes of the Andes toward the Pacific. Today, the *invierno Boliviano* often results in floods in the lower reaches of the rivers. Some of the major thunderstorms coming from the east penetrate the Western Cordillera and heavy rains fall on the western slopes.

In the north, rivers flow (intermittently) through narrow and deep *quebrada*s that incise the Coastal Cordillera to reach the Pacific. Five such *quebrada*s reach the ocean to punctuate the coastline from the Peruvian border south to Pisagua - Lluta, Acha, Vitor, Camarones and Tana/Tiliviche. From Pisagua no rivers flow into the sea until the River Loa, some 200km further south. The sector north of Pisagua is known as the 'fertile coast' and the strip between Pisagua and the Rio Loa is known as the 'sterile coast' (Santoro et al. 2005b: 173) (see Figure 1.10).

Today, the majority of the region's agriculture is dependent on subterranean water. This groundwater is largely composed of 'fossil' reserves that receive little or no recharge in today's climate. Based on dates from ancient wood from fluvial terraces in the Pampa de Tamarugal, located in the Central Depression of the Atacama, Nester et al. (2007) suggest that wetter conditions prevailed between 16,380 to 13,740 cal BP, which resulted in the most important recharge events of the last 18,000 years, and that a lesser recharge event occurred during the Holocene between 1070-700 cal BP.

Figure 1.11 is a photograph taken from the southern flank of Quebrada Camarones where the river meets the sea. Figure 1.12 is photograph taken from the headland between the port of Pisagua and Pisagua Viejo (Old Pisagua) where the Quebrada de Tiliviche/Tana meets the sea. While the landforms are very similar, the hydrology of these two *quebradas* is very different. Vegetation at Pisagua Viejo is limited to a few stunted shrubs. Quebrada Camarones contains a broad expanse of vegetation and at times a lagoon forms along the rear of the beach (pers. obs.). The lack of water reaching the coast does not necessarily indicate the amount of water entering the system as the Quebradas Tana and Tiliviche both have the remains of agricultural complexes less than 40km inland. Irrigated croplands remain in limited use, adjacent to the Panamerican Highway where colonial *haciendas* still stand.

These *haciendas* were established during the nitrate booms of the 19th century to provide fodder for draft animals working the nitrate *oficinas.* I conducted an archaeological survey along the Quebrada de Tiliviche in 2000 and evidence for prehistoric agriculture and irrigation was found along several kilometres of the *quebrada* some 20kms from the coast. This evidence included irrigation channels, numerous grindstones associated with artefact scatters and the remains of buildings. Nuñez (1975) excavated a number of remains of semi-subterranean houses and middens on a terrace at Tiliviche. This site was dated from the pre-ceramic through to the ceramic period and contained numerous grindstones. The site was located adjacent to potable water and while it was some distance inland, also contained remains of fish and shellfish.

The lack of surface water at the mouth of the *quebrada* at Pisagua is likely to be the result of the geology of the region. Water that is carried within the *quebrada* from further inland does not penetrate the Coastal Cordillera. Thus, Pisagua may be regarded as the northern boundary of the 'sterile coast'.

Groundwater resources in northern Chile flow westward from the Altiplano, moving through rocks of low permeability, and are mainly confined to river channels that accumulate in aquifers within the central depression (Muñoz et al. 2007: 222). The variable chemical composition of the groundwater from this area is such that its potability varies significantly (Muñoz et al. 2007: 227). Apart from increased salinity, boron, arsenic and cyanide are in relatively high concentrations in some areas. Arsenic is released into the water from volcanic rock and soils (Bundschuh et al. 2012: 15), and is present in both water and soils in northern Chile in varying concentrations.

Figure 1.11 Shoreline adjacent to Caleta Camarones – 19°11'S.
Photo: C. Carter

Figure 1.12: Pisagua Viejo 19°36'S, shoreline where the Tana/Tiliviche drainage meets the sea
Photo: C. Carter.

Concentrations in the Lluta Valley vary from 0.03-0.28 mg/l in water and 32-40 mg/kg in soils and those in the Rio Camarones vary between 0.92-1.24 mg/l (water) and 100-300 mg/kg (soils).

The World Health Organization (WHO) does not recommend drinking water where concentrations of arsenic within the water exceed 10 µg/l (Arriaza et al. 2010: 1274). Prolonged exposure to low doses of arsenic, through drinking water, can cause cancer of the skin, lungs, bladder or kidneys, diabetes mellitus, neurological disorders, hypertension, hyperkeratosis and cardio-vascular problems (Cornejo-Ponce et al. 2011: 1274). The results of these afflictions are often fatal, or at least a reduced lifespan. Another common symptom of arsenaisis are pre-term stillbirths.

Arsenic can also accumulate in the tissue and membranes of fish and shellfish. This arsenic then transfers through the food chain via consumption. In northern Chile, non-migratory fish and shellfish from Camarones were found to have a higher concentration of arsenic than those caught at Caleta Vitor (Cornejo-Ponce et al. 2012: 1281). Three fish species from Camarones had arsenic concentrations higher than the WHO acceptable limit of 1 mg/kg.

A number of samples of human bone from Caleta Vitor were tested for the presence of arsenic. The samples ranged in age from the Archaic Period (>3,000 years BP) through to the Late (Inka) Period around 600 years BP. Out of twenty-one skeletal samples, seven contained concentrations of arsenic indicative of chronic arsenic poisoning (>1 ppm), ranging from 1.064 ppm to 5.993 ppm with a mean of 2.376 ±1.702 ppm. Arsenic concentrations of soil samples ranged from 10.159 ppm to 26.008 ppm with a mean of 16.591 ±6.005 ppm (Swift et al. 2015). It was suggested that the poisoning was most likely due to the presence of arsenic in the drinking water.

* * *

Such a dynamic and extreme environment must have had a significant impact on the developing lifeways of the inhabitants of this region. From the basic necessities – food and water – through to the dynamism of its geology, inhabitants of the coastal zone of northern Chile had to adapt their economy and settlement patterns to allow for the perturbations of the environment. Along the coast, the scarcity of water generally limited their settlements to the *quebradas, lomas* fog-meadows and around local springs; their hunting and foraging range was similarly limited as faunal and floral resources were so restricted.

Tremors are regularly felt throughout the region and landslides are often the result. Such seismic volatility is likely to have had an impact on the inhabitants and their settlement patterns. Flash floods would have made camping adjacent to watercourses hazardous. Tsunamis would have pushed settlement back from the immediate shore-line. Landslides and rock-falls, ranging from a few falling stones to massive slides with thousands of tons of loose rock falling over hundreds of metres, should have made settlers wary of camping beneath rocky cliffs.

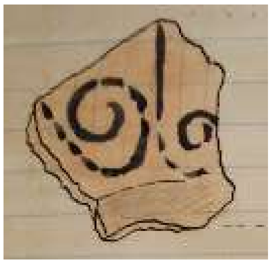
These factors must have impacted on those living along the coastal strip and, in turn, would have created a 'memory of landscape' that helped to shape the on-going structure of a community. Prehistoric communities living below cliffs on the coast would have been in constant fear of earthquake, falling rocks and of inundation by tsunamis (Berenguer 2008: 91). Erupting volcanoes, earthquakes and tsunamis would have had catastrophic consequences for some communities and certainly would have an impact on any others living in the vicinity.

The HCS also plays a significant role in this thesis – it is not only vital to the food chain but has also had a major impact on the climate, both important factors contributing to the success of any coastal settlement. With the arrival of the first settlers, the economy that developed relied heavily on marine resources that were supported by the nutrients carried by the current. This thesis will concentrate on this economy and seek to clarify how its trajectory, initially based on marine resources, was affected by cultural and technological advances such as the introduction of agriculture and domesticated animals.

While humans were able to adapt to a range of ecosystems, in areas of extreme environmental conditions, such as northern Chile, we cannot move away from the notion that the environment determined much of the behaviour of those who settled within it. This is because 'we [humans] are part of a natural eco-system, whether we like it or not' (Hodgson in Beresford-Jones 2004: 5) and it can be argued that environment and culture are 'inextricably entwined' (Sandweiss 1996: 127).

Steward (1955: 35) suggested that environments are permissive or prohibitive, but not creative. There is a cultural interface between human activity and the environment; where specific objectives are met through the utilisation of knowledge, experience and technology. While the environment may prevent the settlement of certain areas (such as those without water), humans are not passive bystanders, they are creative. Reactions will differ between individuals, groups and cultural foundations. A group may simply abandon a site that is too dry or alternatively they may adapt, utilise available resources and modify the human/environment balance in their favour. A small group may not be able to adapt as efficiently as a larger, more established group, so while a site may be abandoned at one time, it may later be successfully settled as either technology, strategy or the environment allows.

The economy that developed through time along the coast of northern Chile combined the residual 'baggage' of its first settlers with subsequent internal developments and external cultural infusion along with adaptive responses to local environmental conditions. It is hoped that this investigation will determine how much of the original economy survived through time and what change was manifest in the archaeological record.



Chapter Two

> *Writers are now generally agreed that the peopling of the New World has been from Asia … but at a very early period.* (Bollaert, 1854: 137)

Settling South America

The antiquity of the settlement of the Pacific coast of South America is under constant review. Toward the end of the 20th century several sites in southern Peru were dated to the late Pleistocene and/or early Holocene. These include Quebrada Tacahuay (Keefer et al. 1998), Quebrada Los Burros (Lavallée et al. 2011) and Quebrada Jaguay (Sandweiss et al. 1998). Tiliviche 1, some 30 kms inland from Pisagua and about 130kms south of Arica has also returned an early date (9679 BP) (Standen and Santoro 2004). While not located on the coast, investigations at Quebrada de Mani (21°05'S), located in the Atacama region of northern Chile some 200kms south of Arica, have returned dates between ~11,900 and 12,700 cal BP (Santoro et al. 2011). Further south at Quebrada Santa Julia (31°29'S), within the northern semi-arid zone of Chile, a well stratified site has provided dates as early as 13,350-12,880 cal BP (Jackson et al. 2007: 725). This site is also the only known Paleoindian site in the region that has fluted projectile points clearly in association with extinct megafauna.

Arica is thus flanked to the north and south by late Pleistocene sites and further sites from that period are highly likely to be found along this section of the coast. As such, there is a high potential for sites to provide archaeological data that relate to continuous occupation within a limited area over a period exceeding 10,000 years. This is particularly significant when considering the appearance of the first settlers in southern Peru/northern

Chile and the development of their economies. The study of such sites will also contribute to the broader discussion relating to the arrival of the first inhabitants of the New World and their migratory path once they had entered South America.

Figures 2.3 and 2.4, at the end of this chapter, show the general locations of sites mentioned in both North and South America.

* * *

For most of the 20th century, it was firmly believed that the first people to enter America originated in Asia and were hunters specialising in big game. They were armed with spears fitted with stone points that became known as 'Clovis' points (after the site in New Mexico where they were first found) (Willey 1966; Dillehay 2000; Dixon 2001; Meltzer 1989, 2004, 2009; Rothhammer and Dillehay 2009; Dickinson 2011; Bawaya 2013). The 'Clovis First' hypothesis developed from early discoveries of an elongated lanceolate point, fluted on each face and then hafted onto a spear shaft (Meltzer 2004: 548). 'Clovis First' suggested that the first migrants arrived in North America around 13,500 cal BP, travelling over land via the Beringia land-bridge, most likely through an ice-free central corridor between the Cordilleran and Laurentide ice sheets of Canada that was open around that time.

During the 1960s, while there were claims of a pre-Clovis presence, archaeologists "were starting to show signs of a deep-rooted scepticism about accepting any such claims ..." (Meltzer 2004: 539). For several decades the evidence for 'Clovis First' was so compelling that "few archaeologists even contemplated an alternative" (Bawaya 2013: 42). For some time authors argued that linguistic and physical anthropological evidence was far more complex than the 'Clovis First' model, requiring far more time to explain the observed levels of diversity in the Native American population today (Dillehay 2001: 13). Genetic studies have also contributed to the argument and suggested that the first settlers crossed Beringia sometime after 16,500 years ago but well before the Clovis period (Goebel et al. 2008: 1497).

While there had been other claimants, for some time the oldest securely dated site in the Americas was Monte Verde in the south of Chile (36°S) dated to over14,500 cal BP (Dillehay 2000: 160; Dickinson 2011: 201) and possibly as early as 19,000 cal BP (Dillehay et al. 2015). This site was a permanent settlement and is located some 70km inland on the banks of the Chinchihuapi Creek relatively close to the modern city of Puerto Montt. Dillehay presented his findings in the late 1970s, but it was not until the late 1990s, after much argument and criticism, that these dates were more broadly accepted (Dillehay 2000: 2). By 2000 there was a 'growing consensus that the first settlers [in the Americas] arrived before the Clovis culture' (Masson et al. 2000: 12).

Meltzer (2009: 133) stated that while there must be sites earlier than Monte Verde, the "earliest sites of the first peoples [in the Americas] will be rare, hard to find and may never be found". However, the search continued and by 2012 Erlandson suggested that the Clovis-First hypothesis was "in full retreat". More recently, Dillehay et al (2015) stated '… that the old Clovis-first model of human entry around 13,000 years ago no longer explains the peopling of the New World …'.

In 2012 Dillehay et al. reported several Pleistocene dates from excavations at Huaca Prieta, a well-known preceramic site in northern Peru. While this area has large mound structures from a later period, the oldest dates came from excavations well below the mound levels and include a date of 14,827 – 13,924 cal BP (2 sigma, deer bone, Beta310272). While this site is now located close to the coast line, during the Pleistocene it was around 20 kms inland (Dillehay et al. 2012a: 422). Remains associated with human occupation include unifacially flaked stone tools, marine mollusc shells and bones of sea lion, deer and bird.

With the acceptance that the first settlers arrived in the Americas during the Late Pleistocene, possibly around 16,000 BP (Bellwood 2013: 90) theories relating to the early migratory pathways are now coalescing and this is of particular significance to this thesis.

Asia is generally accepted as the origin of the first American settlers. However in the late 19th century it was proposed that the first humans to arrive in the Americas were a European population. While few supported the theory at the time, more recently Bradley and Stanford (2004; 2012) have argued that the first settlers skirted the ice-sheets extending out of western Europe to cross the Atlantic during the LGM (between 23,000 and 19,000 years ago) and that a "Solutrean Palaeolithic maritime tradition ultimately gave rise to Clovis technology" (Bradley and Stanford 2004: 473). While a few archaeologists have suggested that Bradley and Stanford "make a plausible case" (Bawaya 2013: 45), the majority do not believe that the evidence supports their claim (Pitblado 2013: 355). Apart from more detailed evidence, Meltzer (2004: 547) suggested that both the physical (Atlantic Ocean) and temporal (>5000 years) separation between the Solutrean and Clovis cultures was simply far too great.

As it stands now, few would argue against Asia being the source of the first Americans. Genetic research has established that Native Americans have five major mtDNA haplogroups (Fiedel 2000: 67; Straus et al. 2005: 522). All of these groups are shared with Asian groups, including haplogroup X which was used by Bradley and Stanford (2004) to suggest a genetic link between North American and European populations. Haplogroup X2a has also been identified in groups living in Central Asia (Straus et al. 2005, 522; Kashani et al. 2012: 35). Kashani et al. (2012: 35) suggest that the relatively restricted distribution of haplogroup X2a was because it entered North America via the ice-free corridor and not along the coast. Another rarely studied haplogroup, D4h3a, is restricted to the Pacific coast of North and South America. This is suggestive of at least two waves (and routes) of migration.

Using the Y-chromosome haplogroup Q, Regueiro et al. (2013: 345) suggested that the results of their studies show a single major pre-Holocene migration into the continent from Asia as a 'trans-continental trek across Beringia then southward to traverse the length of the Americas'. While results share some common ground, genetic evidence from modern populations often provides differing conclusions relating to the antiquity, timing and number of migrations into the Americas (Meltzer 2004: 556). Figure 2.1 contains a map of mtDNA distributions with timing based on estimated mutation rates (see www.MITOMAP.org). The data used in that figure suggest several waves of migration and also include an early entry of haplogroup X into the continent with its only link back to central Europe. Research not included in this map has identified haplogroup X in a central Asian population (see Kashani et al. 2012; also Bellwood 2014: 88-89).

The 'Clovis First' theory suggested that the first people to arrive in the Americas crossed from Siberia to Alaska across the Beringia land-bridge (Mandryk et al. 2001; Meltzer 2004; Bawaya 2013). Toward the end of the LGM as the climate warmed, the ice sheets that blocked entry into North America began to retreat leaving an ice-free corridor that led to the east of the Rocky Mountains. This occurred around 13,500 years ago.

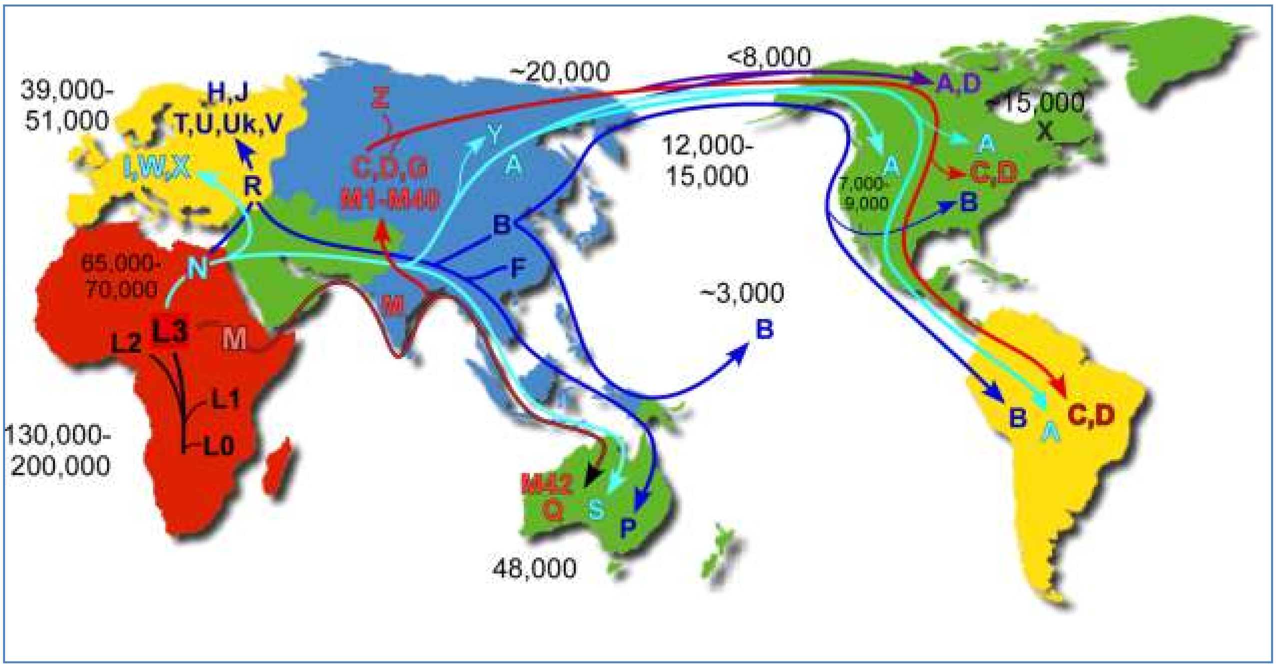


Figure2.1 Human mtDNA Migrations. Mutation rate = 2.2 – 2.9%/million years
Time estimates are years before present.
From **MITOMAP, 2013.**

Given the distance of Monte Verde from the far north of North America (Alaska - the accepted entry point of the first settlers), how long did it take these people to travel that distance (over 14,000kms)? There does not appear to be a consensus on such a timeframe. One set of models has suggested that the first colonisers could have moved through the continent very quickly (Meltzer 2003: 222; see also Bellwood 2013). Such a model was based on the claim that having megafauna as a major resource would have allowed hunters to move through ecozones without having to learn much more about their resource base or be hindered by new landscapes. Meltzer (2003) suggested that this *could* (his emphasis) have occurred, however there is very little archaeological evidence to support such a claim.

In 1967 Martin (in Gamble 1994: 209) argued that as soon as the first explorers negotiated the northern regions, they entered a rich biome and armed with Clovis points they quickly adapted to a big-game hunting culture.

What followed was a rapid, 'blitzkrieg' expansion and the entire breadth of North and South America was settled within 1000 years (albeit with a relatively low population density). This may well have been a viable scenario across the Great Plains, however to suggest that a similar hunting model was able to persist over 14,000kms to southern Patagonia fails to take into account the diverse range of environmental conditions, some of which required significant economic modification through changing landscapes (rainforests, montane, deserts, wetlands). Each biome would have to be separately negotiated in order to make the journey. Meltzer (1993: 160) suggests that the 'blitzkrieg' model fails to recognise a number of other issues including "demographic and selective factors that may have constrained initial colonisation, or to the question of how quickly foragers could have moved across rich but unknown continents". He suggests that the migration would have taken several thousands of years at least. Considering that migrations were likely to be latitudinal as well as longitudinal, with groups moving inland as conditions allowed, it is likely that such a spread would have slowed the pace of southward migration and extended the time necessary to reach the extremes of the continent.

However, if people did enter the continent via the ice-free corridor, how did they get to Monte Verde by 14,500 cal BP or even earlier? This was a period when the ice-free corridor did not exist. The first settlers could not have arrived overland unless they crossed the icefields. The only accessible route available at that time (prior to 13,500 cal BP) would have been via the Pacific coast, either on foot or by boat (Meltzer 2004; Meltzer 2013; Bellwood 20134).

Following the initial migration from Asia into the Americas, once groups had moved beyond the arctic regions, the choice of route would have impacted on the pace of migration. So how long did the first settlers take to colonise lands from Alaska through to Patagonia? Which path did the majority follow?

The Coastal Route

Theories relating to a coastal migratory path from north-east Asia into North America have been considered for some time. In 1979 Fladmark suggested a coastal route for some of the first settlers and also stated that "maritime cultural adaptations may have been among the first to arrive south of Canada" (Fladmark 1979: 55).

In 1991 Wright discussed the environmental conditions that faced the first settlers and considered that the coastal route "seems unlikely" (Wright 1991: 118). Likewise, Dillehay and Meltzer (1991) suggested that the coastal migration route was untestable and the North American coastline would have been difficult to traverse. By 2001 Dillehay had changed his view to suggest that there was a possibility that the first Americans came by sea following the coastline and that the first settlers were "likely tied to the development and spread of a maritime pathway" (Dillehay 2001: 16).

The discussion gathered momentum when research indicated that the Laurentide and Cordilleran Ice-sheets blocked the interior route into North America between 28,000 and 12,000 (uncal) BP (Meltzer 2009: 129). Furthermore, once it became ice-free it would have been a rather hostile environment for some time. Studies to determine resources within the corridor revealed that those available to humans were "below the minimal nutritional needs of a socially viable population between 18,000 and 13,000 BP" but increasingly abundant after 12,000 BP (Mandryk et al. 2001: 304).

In 2009 Meltzer stated that, given that the Laurentide and Cordilleran ice sheets obstructed the interior route, early settlers of the Americas must have entered before the LGM or travelled via the coastal route (Meltzer 2009: 129). Once the first explorers/settlers managed to get around or over the North American ice sheets, such conditions would not have impeded their movement until they reached the high Andes or high latitudes of South America.

In 2012, Misarti et al published their results from lake cores taken from Sanak Island in the western Gulf of Alaska. Their investigations provided the first radiocarbon dates from the continental shelf of the Northeast Pacific and pollen data suggest an arid, terrestrial ecosystem by 16,300 cal BP and that ice sheets would not have blocked movement along the southern coast. Deglaciation of this area had occurred almost 2000 years earlier than previously thought.

Erlandson et al. (2007) coined the term 'the Kelp Highway' to support a hypothesis to tie the coastal migration theory with marine ecology to understand better how the continents were first settled. They suggested that the kelp forests provided very productive habitats with "high primary productivity, magnified secondary productivity and ... a diverse array of marine organisms" (Erlandson et al. 2007: 161). Kelp beds extend around the northern Pacific from Alaska to Baja, California, with a break along the west coast of Central America before they reappeared along the Andean coast of South America, continuing to the far south to Tierra del Fuego. The Pacific Coast would have provided an almost unobstructed, linear migration route from the north to the far south. The break in the tropical zone would have been supplemented by near-shore mangrove forests and coral reefs which in themselves are very productive.

While the evidence of earliest settlement of the Americas is scarce, the evidence for a coastal migration route is even harder to find. Given that during the late Pleistocene the sea-levels were as much as 130m lower than present, the coastline and coastal plain that would have provided the route of the coastal migrants has been inundated. Camps of the early coastal explorers and settlers are likely to have been close to the coast, in places providing some shelter and close to water, such as around river mouths, estuaries and bays. Most of these sites would now be on the submerged continental shelf. Deglaciation of the more northern areas resulted in isostatic rebound which, in some cases, resulted in sites remaining above sea-level. The arid coast of

South America was glacier free and was not subject to such rebound. However, some sections of the coast have been subjected to uplift where the coast borders a subduction zone (see Chapter One).

Evidence of the earliest settlement is likely to be found in coastal areas that have a narrow continental shelf or in refuge locations, once located near the coast but now above the current sea-level (Sandweiss et al. 1998). While maintaining contact with the sea, early settlers may have moved inland to areas providing more shelter or closer to freshwater sources. Tsunamis may have also made groups wary of living too close to the coastline. Exploratory forays inland by the early hunter/gatherers would have left scant evidence of their activities, although permanent settlements that moved inland as sea-levels rose would have left more discernible traces.

While some geneticists subscribe to a single migration out of Asia (Meltzer 2004: 545; Regueiro et al. 2013: 345) Pitblado (2011: 351) suggested that there is sufficient genetic, osteological, and archaeological evidence to support a model of colonisation that involved at least two major migrations events. This model suggested that the first inhabitants arrived via the Pacific Coast around 16,000 years ago and utilised watercraft and followed the northern Pacific coast of Alaska and North America. Following the coastal path, they may have divided at the Isthmus of Tehuantepec (Mexico), one course continuing south toward South America with another heading north along the coast of the Gulf of Mexico. The southward push divided again at the Isthmus of Panama to follow both the east and west coasts of South America. The movement down the coast left the inland areas generally open for the first groups that arrived via the ice-free corridor. Later arrivals, coming in around 14,000 – 13,000 BP, developed the Clovis tool kit and settled much of North and Central America by the end of the Pleistocene (see also Erlandson 2001; Mandryk 2001). Figure 2.2 contains a map of North and South America showing possible migratory pathways and the extent of the ice-sheets while the ice-free corridor was open.

While much of the preceding argument has little direct impact on the investigation presented in this thesis, it is imperative to understand its nature in order that appropriate consideration may be given to the evidence that relates to early (i.e. Pleistocene) settlement and its economic base. Even evidence from Holocene coastal sites may be able to indicate the original direction of settlement.

The earliest material within a site will indicate the nature of the founding economy. Evidence of a marine economy at its base, with little or no terrestrial or inland resources evident, would indicate that settlement arrived via the coast. Alternatively, evidence of a terrestrial economy arriving on the coast from inland/highland regions would tend to be made up of terrestrial resources with weaponry and a tool kit designed for hunting terrestrial game or collecting plant foods. Marine resources may have been present but are likely to be mixed with those from the inland. If a coastal settlement moved inland as sea levels rose or arrived from other coastal locales, the economy of that settlement is likely to be marine based. Settlers who had their origins inland would have as its base a terrestrial economy or at least a mix of marine and terrestrial if its origins were more locally based. It is the 'mix' of such an economy that is of importance here, particularly its variability and the causal factors relating to change.

Figure 2.2 – Map showing migratory routes from Beringia into the Americas. Red line denotes coastal path, green line denotes route through the ice-free corridor. The dashed white line shows approximate extent of ice sheets around 14,000-13,000 cal BP.

Settling the Coast

The first explorers moving across Beringia did not enter a foreign environment. They entered a land that may have been somewhat alien in character, but not essentially so. The two ends of Beringia – Chokotka (in Asia) and Alaska (in North America) would have been very similar, in terms of both environment and resources.

In all probability an established economy would have been adaptable, at least in part, to allow adjustments as dictated by the changing environment. Erlandson (2001: 288) suggested that "humans are the ultimate generalists and opportunists who thrived in the widest range of earthly environments". As such, the need for economic adaptation, as long as environmental change was gradual, would not have presented an insurmountable barrier to exploration. Movement inland, apart from the physical barriers, would have presented a different array of resources, many of which would have been foreign to explorers.

Movement through a continuous landscape type, with change in familiar physical features more apparent than resource variability, would not present a significant barrier to migration. As mentioned, Erlandson et al. (2007) put forward such an argument with the 'Kelp Highway' hypothesis which suggested that coastal groups relying on a marine economy were likely to move along the coast more rapidly than their inland counterparts. Small groups could explore coastlines by boat and cover great distances within a few generations as resources further afield were identified as being familiar and easily exploited. Coastal resources generally show less variation than do terrestrial resources and adaptation along coastlines would be far less arduous than moving inland (which also required a move to higher altitudes along the west coast of both North and South America).

Given that the coastal migration theory now has some currency, its potential economic base should be considered. The first settlers of the New World were hunter gatherers. Moving along the coastal plain and/or through its waters by boat, exploration groups would have been living in areas where maritime resources could have been exploited and were likely the base for their economy.

The coastline of western North America contains a rich biomass including shellfish, fish and marine mammals. The coastal plain, particularly in northern North America is studded with rivers and fish that were particularly abundant during the salmon runs. The temperate forests would have also provided a range of plant and animals resources. Changes to the marine resource base as groups explored/migrated southward would have had little latitudinal variation, at least for some distance, and would have been gradual in most instances. Economic adaptation to new environments would not have been necessary along much of this area. Early explorers could have followed rivers inland although the Rocky Mountain chain would have formed a formidable barrier in physical terms as well as having a different resource base as altitude increased. Once the mountain regions had been penetrated, changing environments would have again required appropriate adaptive responses prior to any continued migratory efforts.

If the early explorers followed the coastline south, adaptations would have been far less restrictive. Coastal species may have changed over distance but the means by which they were hunted or collected would have been similar. Likewise, environmental change following the coast is generally far more gradual than that encountered when following a path inland (east) where altitudinal variation results in far more abrupt change.

Clovis points appear to have moved across North America in less than 1000 years – a rate of 10-20 kms per year (Meltzer 2009: 213). At first glance this suggests that rapid migration did occur However, if people had already settled within the landscape (as most evidence suggests), the spread of the

Clovis point technology (but not necessarily the people themselves) could have been rapid without the need for 'landscape learning'.

The argument supporting slower migration rates suggested that while people could have moved through the continents quite quickly, there was no reason to do so. The first settlers of the New World arrived in a continent that was devoid of people. Humans having to adapt to new landscapes depend on learning times that vary between habitats (Steele and Rockman 2003: 131). It has been suggested that anyone arriving with a limited environmental knowledge was better suited to hunting animals, whereby shortages in food would result in relocation – "high residential and logistic mobility and high range mobility" (Steele and Rockman 2003: 142). Steele and Rockman argue that the first entry into North America required moving through an area during a period of low value on the index of effective temperature. Modern hunter/gatherers in high latitude environments tend not to rely on plant foods – they hunt and fish. This model appears to work well with a hunter model but places less emphasis on the 'gatherer/forager' segment of such an economic system. However, even in the late Pleistocene, the Americas were not entirely subjected to areas with a low effective temperature. Hunting/fishing would not have been solely restricted to large game. The importance of plant foods or smaller animals (reptiles, rodents, shellfish, birds) in such an economy must also be considered.

Consider the path south along the North American coast, once a way around the ice field had been negotiated (no mean feat in itself) the path southward was not only open but also contained a rich marine biomass. The kelp beds of North and South America would have provided the resources required by the early explorers/settlers. Some landscapes would have been more conducive to settlement than others. Sheltered bays and river mouths with adjacent coastal plains and/or forests would have provided ideal conditions for settlement. Southward exploration - on foot in clear areas and by boat along the more rugged sections of the coastline - could have been rapid if these groups had the need or desire to do so.

It is likely that the early settlers of the New World followed both coastal and inland routes with varying rates of advance. Given that there was far less demand for adaptive strategies along the coast, such a group of explorers could have moved more rapidly, in a linear fashion, and it was from these core groups, following the west coast of the continent, that the first people arrived in South America. Furthermore, people that had crossed the Rocky Mountains in the north were likely to have spread throughout a broad landscape, thus slowing their movements southward. If their route inland commenced further south, moving east from the west coast of Central America they would have encountered the deserts of northern Mexico, then the highland plateaux before having to contend with the dense jungles between the Tehuantepec and Panama Isthmuses. When they had entered South America, more formidable physical barriers existed for those exploring the inland. Progress through the Andean Cordillera or jungle regions of Amazonia would have resulted in far slower progress than if they followed the coastlines.

The evidence to support these claims is difficult to find. As mentioned, rising sea-levels at the end of the Pleistocene would have flooded early sites located on the coastal plain. However, evidence of prehistoric coastal occupation is almost continuous along the west coast of the South America. Wherever there are locations suitable for habitation, sites containing evidence of human settlement abound. The Peruvian coastal plain contains some of the richest archaeological areas in the world (eg Chan Chan, Sipan, Paloma, Moche Valley, Paracas, Lima). While these sites are generally dated to the Holocene, they evolved from a base that was considerably older – and closer to a coast that is no longer accessible. Some have argued that these sites are those of a developed culture that was based on an agricultural economy (see Lanning 1967; Moseley 1975). In 1975 Moseley suggested that the development of complex Peruvian centres was predicated on an economy based on maritime resources, although support for his theory was not widely accepted (see Osborn 1977; Wilson 1981; Scott Raymond 1981; Yesner 1980).

As mentioned, Huaca Prieta is located close to the coast of northern Peru. This site contains monumental architecture (mounds) dating from the Late Preceramic period (~5500 and 4200 cal yr BP) (Dillehay at al. 2012a: 418). However, more recent investigations suggest that settlement occurred much earlier, over 14,000 cal BP, well before the mounds were constructed (Dillehay et al 2012 a&b).

As sea-levels stabilised during the early Holocene, the economies that developed at such sites, may have been stable and secure enough to allow technological developments beyond those of the hunter/gatherer. More recently there has been an emphasis on the significance of marine resources, from the perspective that such resources were sufficient to support sedentary populations of some size that could easily adopt such innovations as agriculture, ceramics and metallurgy (Quilter and Stocker 1983; Erlandson 2001; Harvey Koutts et al. 2011). Moseley's 1975 theory may be valid after all.

While Chile does not have monumental sites such as Chan Chan, Sipan, Caral or Pachacamac, the archaeology of its coast is also very rich, with sites ranging from the Late Period (Inka) through to the early Archaic (Early Holocene and Late Pleistocene). As mentioned, Quebrada Tacuay and Quebrada Jaguay (in southern Peru) have both produced dates in excess of 11,000 cal BP. Further south, other sites have produced dates in excess of 7000 cal BP (eg Camarones, Huelequen, Las Conchas, Quebrada Santa Julia).

Given that the current sea level was reached some 6000 years ago, earlier sites located directly adjacent to the coast would have been flooded. In some cases, early sites may have been located some distance inland perhaps for reasons of shelter or to be close to permanent water sources. Such sites, particularly in areas with a narrow coastal shelf, may be the only ones that will provide direct evidence for Pleistocene settlement.

Finding such sites may be considered a gamble. However, sites contemporary with the arrival of sea level at its current height may be able to provide an indication of the dynamism of the early occupants and their patterns of mobility.

Figure 2.3: Map of North America showing general location of sites mentioned in this chapter

Figure 2.4: Map of South America showing general location of sites mentioned in this chapter

The Economy of Prehistoric Coastal Northern Chile

Chapter Three

> *The mounds and their contents ... as disclosed by the mattock and spade, serve to reflect light more particular upon their customs, and the conditions of the arts amongst the nations who built them. They are the principal depositories of ancient art, and hide from the profane gaze of invading races the altars of the ancient people.*
> (M. Squier in Hutchinson1874: 11).

Archaeological Background

This chapter provides a general context and background for the archaeology of northern Chile in general and Arica/Caleta Vitor in particular. It begins with an overview of the history of archaeological research in the region and followed by a summary of more recent investigations.

Interest in the prehistory of northern Chile began shortly after the arrival of Spanish colonists. Several of these foreign settlers reported on the indigenous people, querying their origins and describing their habits, customs, living conditions, but generally compared them with their own (eg Vivar 1979 [1558]; Vasquez de Espinoza 1948 [1628]; Frezier 1717).

As far as archaeology is concerned, early (pre-20th century) interest in this area often centred on the collection of exotica and antiquities, including mummified corpses. Many museums throughout the world have archaeological specimens, including mummies, collected from northern Chile. They include the American Museum of Natural History (AMNH), the Peabody

Museum (Harvard University, Massachusetts), the Smithsonian Institution (Washington D.C.), the British Museum (London), Pitt Rivers Museum (Oxford), the Cambridge University Museum of Archaeology and Anthropology, the Macleay Museum (University of Sydney), the Swedish Museum of Ethnography (Göteborg) and the National Museum of Ireland (Dublin).

Charles Mead, a former director of the anthropological collection of the AMNH, was one of the first to synthesise the results of early investigations around Arica (Mead 1946). While it was never published, the following is largely based on the theme set by that report (Mead's report is currently held by the AMNH).

The Peabody Museum, Cambridge, Massachusetts, contains a collection of material collected from Arica in 1836 following John Blake's excavation of a cemetery located about two kilometres to the south of the town (Mead 1946: 11). Blake described the graves as "all circular and vary in size from three to five feet in diameter, and from four to five feet in depth. Some of them are walled with water-worn stones, laid up loosely, and all have linings of coarse flag mats. ...". He stated that all the bodies were in a sitting position, knees drawn up with their arms crossed over their chests. He also noted that many of the crania were deformed, and were both "rounded (brachycephalic) and elongated (dolichocephalic)" in shape. Mead concluded that "... we can safely refer Mr Blake's collection to the Inca[1] period."

J. J. de Tschudi spent five years in Peru in early 19th century. During 1844 he spoke before the Ethnological Society of London and outlined his observations of the "Ancient Peruvians" (de Tschudi 1848: 79). This presentation concentrated on cemeteries and tombs with detailed descriptions of mummies. While he speaking about Peru in general, one

[1] The spelling 'Inka' is preferred by the author, however 'Inca' is used when quoting or discussing the work of others.

particular comment is worthy of repeating - he stated that "Captain Banckley … could obtain any quantity of mummies at Arica".

The collection of antiquities for museums was often a task of the 18th and 19th century expeditions, but there were others who took opportunities to purchase or simply collect relics and/or mummies for their own personal gain. Captain George Duniam was one such character.

As a ship's captain, Duniam sailed along the west coast of South America in the 1830s and visited Arica (then part of Peru) where he obtained a mummy. On his return to Britain in 1839 he was able to sell it to the Royal Irish Academy in Dublin (Wilde 1839). The mummy was purchased on behalf of the Academy by Sir William Wilde, a surgeon who was an active antiquarian (and father of Oscar Wilde). Wilde published descriptions of the mummy in the *Proceedings of the Royal Irish Academy* in 1839 after he had 'unwrapped' it at a public presentation. The mummy is now held by the National Museum of Ireland.

In the early 1840s Captain Duniam sailed to Australia and he later became involved in a scheme to import alpaca from Arica. A team of investors financed this enterprise and in 1851 a ship was chartered to sail from Sydney to Arica where alpaca would be purchased (*Sydney Morning Herald* 6 January 1851). The scheme failed as the government of the day in Peru had foreseen the value of alpaca to their country and introduced laws to prohibit their export.

Duniam, being unable to execute his duties, appears to have abandoned the original plan and developed one of his own. He personally excavated two mummies and their accompanying grave goods at Chacalluta (a few kilometres to the north of Arica) and returned to Australia with them in 1853. Following his arrival, Duniam placed the mummies on display and collected a fee from members of the public to enable them to see these 'wondrous' figures and artefacts (*Sydney Morning Herald* 3 November 1851). He then tried to sell the mummies to the Australian Museum. He failed in this and the mummies were later seized by a pawnbroker to secure an unpaid debt. A 'Peruvian' mummy now held by the Macleay Museum (University of Sydney) is likely to be one of those brought to Australia by Duniam.

In 1868 Arica suffered the effects of an earthquake and subsequent tsunami. A visitor to the area who witnessed the results of the destruction commented on the prehistoric remains, including mummies that were exposed by the force of the tsunami. The AMNH, New York, has material donated by J.V. Cooper who collected archaeological material at Arica following the tsunami in 1868. The collection includes a textile bag, a number of 'squid' eyes and a beaded necklace, along with photographs of stranded vessels and the impact of the wave. A witness to the disaster in 1868 described ancient mummies thrown up at the foot of El Morro:

> "Many have refused to credit the story of mummies thrown up from the earth. It is, however, entirely true. Near the foot of the "morro" the mummies were seen in great numbers - some thrown completely out of the ground, and sitting upright; while some were partially, and others were wholly underground. No one had ever heard of there being any- thing of the kind in Arica, and the supposition is that they were buried there in the time of the Incas, and had been preserved by some process known to that people. We carried one on board our ship [USS *Wateree*] and boxed it up, afterwards sending it to the United States." (Sturdy 1872)

The fate of the mummy loaded on the *Wateree* is unknown as remains of the ship are still located some distance from the sea near Arica. The cargo obviously did not travel to the USA on that vessel.

Hutchinson (1874), Consul of the United Kingdom in Peru, visited Arica in 1871 and was told by the British Vice-Consul of the impact that the 1868 earthquake and tsunami had had on ancient mummies. He acquired several archaeological relics excavated in the Arica region. "At all events, many bodies have been found here; and they are constantly being exhumed through the search of treasures all through the Arica country to Tacna" (Hutchinson 1874:313).

Later, more focussed collections were made by specialists who were either commissioned by museums or were collecting artefacts with the idea of on-selling to individual collectors or public institutions. Between 1893 and 1903 Adolpho Bandelier travelled through Peru and Bolivia collecting relics for the AMNH (Mead 1946: 13). In July 1894 he was sailing from Trujillo to Mollende [Peru] when weather forced the vessel to continue on south to Arica. While he was waiting for the weather to abate Bandelier made the most of his time and,

> "... made arrangements for visiting a site near this town, where a great many bodies have been exhumed a short time ago. That site is known under the name of La Lisera, also as El Gentilaque; and lies 1½ miles south of here [Arica], on the sea-shore. We found the graves completely disturbed, dug up, but to our surprise the handsomest textile fabrics, entire garments etc. were still scattered over the surface. The diggers had paid no attention to such valuable remains, and had left them, taking with them only the bodies and whatever objects of silver, copper, and other material that struck their fancy..." (Bandelier 1894)

He later made arrangements with a 'trustworthy individual' to go and collect more antiquities from place known as Vitor, located on the shore 'about nine miles' south of Arica. Bandelier's schedule only allowed him one day at Vitor but he was able to collect sufficient material to dispatch four crates to the AMNH containing, *inter alia*, four mummies, one with a feather head-dress, a 'splendid flint knife', pieces of cloth, fishing implements, needles, pottery and wooden implements. Amongst the paraphernalia shipped with the mummies, Bandelier thought it important to mention one particular piece, that being 'a letter being found in the lap of the corpse' . He thought that it deserved 'SPECIAL ATTENTION FOR PRESERVATION' (his emphasis). The letter found with the mummy was a 'Proclamation of Indulgences', signed by the Licentiate Pedro de Valarde and dated 1578 [in Spain]. A complete translation has not been undertaken at this time. Several other European articles were found in association with these mummies including a brass thimble, needles and glass beads.

During 1916-17 a Swedish expedition undertaking a biological survey of the Chilean Pacific region, stopped in at Arica. Carl Skottsberg, a Swedish biologist and explorer, mentioned in his report that "having obtained permission to make a few excavations and to collect for Swedish museums he proceeded" (Skottsberg 1924: 27). After he made his report the remains, including a Chinchorro mummy, were deposited and then forgotten in the Swedish Museum of Ethnography (Göteborg). They were not rediscovered until late in the 20th century (Gustafsson 2001).

The situation regarding the collection of human remains along this section of the coast is well summed up by the comments of Oswald Evans made when he visited the north coast of Chile in 1906:

> "Nothing struck me more forcibly on my arrival than the number of opened graves; for miles along the coast bleached and crumbling fragments of human bones 'knaved out of their graves ' bear witness to the ignorant curiosity or avarice which has ransacked these poor resting places of the despised 'infidels'." (Evans 1906).

While collecting continued, by the turn of the century archaeology became a more serious, academic pursuit in this region. Max Uhle was one of the first to seriously study the early cultures of the region and make some attempt to understand their development. He was later given the distinction of being one of the first archaeologists to recognise that there were important cultures within the Andean region that were far older than the Inka (Katz 2000: 87).

Using the term '*Aborigenes de Arica*', Uhle discovered mummies buried in an extended position quite close to the city centre and several others near a beach to the north (Arriaza 1995: 5; see also Uhle 1974[1919]). Uhle described these mummies as:

> "...buried in a fully extended dorsal position. The viscera and brain had been removed, and their sites filled with packing material. The removal of the internal organs was effected through an incision on the right side of the body which was then sewn up. Within the body wooden sticks had been introduced ... These mummies were painted red and generally provided with a mask of *barro*[2], on which the features were indicated. The limbs were usually separately wrapped and the arms extended along the side of the body. Many of the mummies were sewn in skins and some had artificial wigs."
> (Uhle [1919] from Dawson 1928: 134)

Uhle classified the mummies into three categories:

Type 1: Simple: naturally dried with no deliberate alteration;

Type 2: Complicated: including evisceration, defleshing limbs and artificial restoration of body form with variations including paint, masks and wigs;

Type 3: Clay-covered – bodies are simply covered in a mud coating, few are eviscerated (Aufderheide 1993: 189).

These burials were later to become known as the 'Chinchorro' mummies (the cultural label taken from Chinchorro Beach where early examples were

[2] *Barro* – clay or mud.

found). The earliest evidence of artificial mummification has been radiocarbon dated and found to be over 7000 years old[3] making them the oldest artificial mummies in the world (Arriaza 1995a, 1995b; Santoro et al. 2005).

By the 1920s, Uhle and others, including Augusto Capdevilla, had established that the prehistoric inhabitants of the coast around Arica had 'existed there since ancient times' (Mead 1946: 5). Uhle excavated other sites in southern Peru and northern Chile and he established a chronology covering seven periods:

1. Primeval period. Few stone implements of paleolithic type.
2. Aboriginal race. First centuries of our era.
3. Period contemporaneous with the ruins of Chavin. 400 - 600 AD
4. Period of Tiahuanaco 600 - 900 AD
5. Indigenous Atacama period 900 - 1,100 AD
6. Chincha – Atacama period 1100-1350 AD
7. Inca period 1350-1540 AD

When Skottsberg visited Arica in 1917 he excavated a number of tombs in an 'Old Necropolis' at Arica and collected about 250 artefacts for the Museum of Ethnography at Göteburg (Gustafsson 2001). He excavated at least six tombs and concluded that the graves ranged in age from Uhle's second period to the later Atacaman and Inca periods (Mead 1946: 20). Amongst the material returned to Sweden were 'twin' mummies that had been found earlier but left *in situ* as they had been damaged. The twin mummies were later classified as belonging to the Chinchorro culture. Other mummies were contained within stone-lined tombs and wrapped in textiles. Skottsberg provided a description of each tomb excavated and made comments regarding the artefacts located therein (Mead 1946: 20-22). Worthy of note was that Skottsberg commented:

[3] Camelid fur wrapping the mummy 'Moro I, T7C1' has been dated to 7231-6226 cal BP (I-13653).

> '...Some of them are very like those used by the aborigines of Arica. It is easy to understand that the same implements must have been taken up and probably perfected by later invading tribes, as life on the coast cannot be sustained without an intense use of marine resources. ... fish, sea urchin and crab-spears are found in all but paleolithic graves. Today they are used to procure sea food exactly as they were many centuries ago, and their form does not appear to have changed at all. (from Mead 1946: 22).

With regard to textiles, Skottsberg stated that they show 'unmistakable signs' of patterns from the mountains and highlands of Bolivia.

Latcham commenced investigations in the Atacama region in the 1920s (Arriaza 1995: 10). Not only did he increase the number of known localities of Chinchorro mummies but he also realised the potential for cultural material found along the coastline to provide evidence relating to the diet of the original inhabitants and how marine fauna changed through time.

In 1941, under the auspices of the Institute of Andean Research, Junius Bird, assisted by Grete Mostny, excavated a number of sites in northern Chile, including adjacent to Arica (La Lisera, Los Gentiles and Quiani), Pisagua (Punta Pichalo) and Taltal, further to the south (Bird 1943). These were extensive excavations, concentrating on midden material, as at Quiani where "... about fifty cubic metres of refuse was passed through the sifter. This probably yielded a true sample of what the midden contains although to secure a really representative collection, about twice that quantity should be removed" (Bird 1943: 233).

By today's standards, Bird's excavation and retrieval methods were rather coarse. He used a ¼ inch 'screen sifter' to sieve the excavated material, which he referred to as 'refuse' (Bird 1943: 181), presumably targeting larger, intact artefacts (eg ceramics, implements and textiles, along with human remains).

Figure 3.1 is a photograph of Bird's trench at Punta Pichalo. While it shows the depth of the trench, it does not show its breadth and does not convey the full extent of his excavation. The trench remains open today (pers. obs.).

While Bird recorded the stratigraphy in some detail, he made no attempt to collect the smaller faunal specimens and made only a few comments regarding the larger faunal and floral items that he did retrieve. In fact, his plans were curtailed somewhat when 'it became apparent that sampling the ancient middens yielded only a **meagre** amount of study material' (Bird 1943: 179; my emphasis). The remains of his excavation at Pisagua indicate that the site contained a huge amount of 'study material', but as the focus of his study appeared to be more on the artefacts, much of the material that could have provided a detailed insight into the nature of their economy was generally ignored.

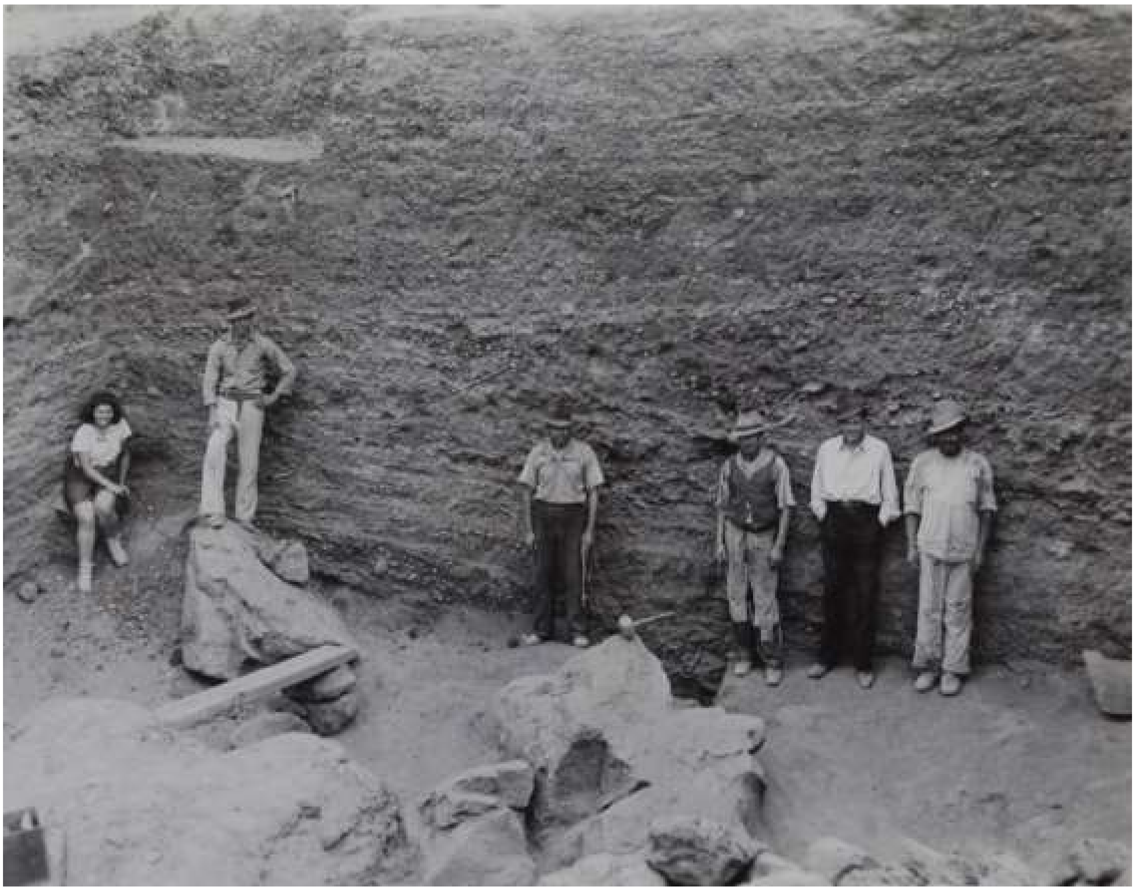


Figure 3.1 – Trench excavated by Junius Bird in 1941 – Punta Pichalo. Grete Mostny at left
Photo from Bird's diary and notes Vol. II. Courtesy AMNH.

Despite such criticism, Bird made a significant contribution to the early archaeology of this region. He concluded that the early inhabitants relied heavily on marine resources and that, based on fishing technology, there were two distinct periods: the First Pre-Pottery Phase (characterised by the presence of shell fish-hooks) and the Second Pre-Pottery Phase (cactus fish-hooks) (see Figures 3.2 & 3.3). Radiocarbon dating was not available to Bird during his investigation, but Mostny later revisited Quiani and dated two hearths. She was able to establish that people were living at that site from at least 6000 BP (Arriaza 1995a: 10).

Later studies divided the early (hunter/gatherer) cultural phases of northern Chile into three stages termed - Early, Middle, and Late Archaic (Rivera 1991: 12). They spanned a period from 10,000 through to 4000 BP. The earliest known burials in the near region come from Acha, a series of sites located 5.4 kms inland from the coast near Arica. Acha 2 is a habitation site consisting of the remains of a group of huts and is dated to the early Holocene (10,000-9500 BP) (Standen and Santoro 2004). Burials located at Acha 3 (a site linked geographically with Acha 2) have been dated to 7580-6700 cal BP (Body 1, 7500-6700 cal BP, Beta-40957, human muscle; Body 3, 7580-7200 cal BP, Beta-88041, human muscle) (Standen and Santoro 2004: 92). The burials at Acha 3 were not artificially mummified but the remains were intentionally laid out, generally extended (supine), in elaborate funerary bundles, with bodies wrapped in sea lion and camelid skins. They are indicative of a move away from naturally preserved bodies and simple burials toward a more sophisticated treatment of the dead

Evidence suggests that around 7000 BP, the Chinchorro began to mummify their dead in a 'sophisticated and evocative manner' (Arriaza et al. 2008: 45).

Figure 3.2 - Selection of shell hooks from Bird Collection. Courtesy of ANMH

Figure 3.3 – Cactus hook –
Bird Collection. Courtesy of ANMH.

The mummification processes ranged from the complex (Black and Red mummies) to the simpler mud-coated mummies. The Black mummies are the oldest that were artificially mummified (from around 7000 BP) yet are the most complex (Arriaza 1995b). Studies indicate that while artificial mummification was not universal, it appears that all infant burials were subjected to complex treatment (Arriaza et al. 2005: 670).

Black mummies, as their name suggests, were coated in black (manganese) paste. The bodies were disarticulated, their organs removed and the cavities stuffed with grass, ash and clay (Aufderheide 1993; Arriaza 1995b; Llagostera 2003). Their heads were removed and brains taken out after breaking open the cranium. The cranial cavity was filled with ash and/or vegetal material and bound back together with twine before being coasted with mud. A 'wig' was placed on the head and, in some cases, a mud mask placed over the facial area. The disarticulated bodies were later re-assembled using thin wooden poles to reinforce the limbs and vertebral column. The wooden poles were left protruding from the neck and the head secured by placing the poles into the foramen magnum. Sexual organs were sometimes modelled in clay. The original human skin was replaced, where possible, and on some occasions animal skins were utilised to patch the body. The mummy was finally coated with manganese paste. Figure 3.4 is a photograph of a Black mummy.

Figure 3.4 – Black Mummy
Museo San Miguel de Azapa, Arica,
Photo: C. Carter

Figure 3.5 – Red Mummy
Museo San Miguel de Azapa, Arica
Photo: C. Carter

The Red mummies were coated in a red ochre paste (Arriaza 1995: 45-46). They date from about 5000 BP and were less complex than the black. Red mummies were not disarticulated as were the black mummies and their limbs were left intact. Wooden reinforcing sticks were introduced under the skin in one piece whereas black mummies had each limb individually reinforced with sticks prior to being reassembled and coated with mud. In both types, the body cavities were filled with ash, hair, feathers and/or grass. One variation of the Red style is that of a 'bandage' wrapped mummy (Arriaza 1995b: 46). Figure 3.5 provides an example of a Red mummy. Another version included wrapping the body with a feather 'cloak' – bird skin.

The simplest mummies were mud-coated. Some were eviscerated and dried (naturally or via the use of fire) before being coated with a layer of mud to which a binder of blood (human and/or animal) had been added.

Chinchorro cultural practices, as defined by the evidence of their marine economy and toolkit, can be traced back to over 9000 years ago and continued to develop over a period of at least 5500 years (see Figure 3.10) (Arriaza 1995b: 52). The practice of artificial mummification lasted for over 3500 years – from around 7000 BP until a decline from about 3500 BP (Arriaza et al. 2008: 56). There are no antecedents for such complex and unique mummification techniques so this practice is likely to have developed locally, most likely in the Arica-Camarones area.

The Chinchorro culture has been defined as that of a preceramic, pre-metallurgical, fishing society based along the Pacific coast of northern Chile and southern Peru (Arriaza 1995a: 15). This culture has attracted a great deal of research since the beginning of the 20th century and continues to do so (see Rothhammer 1990; Rivera 1991, 2008; Aufderheide et al. 1993; Arriaza 1995a, 1995b, 2005; Standen 1997, 2003; Standen and Arriaza 2000; Arriaza and Standen 2002; Standen and Santoro 2004; Arriaza et al. 2008; Arriaza et al. 2010; Standen et al. 2014). Apart from studying the mummies themselves, research has spread to investigate their origins, economy and general lifestyle (see Arriaza et al. 2008).

Early theories believed that the Chinchorro were mobile groups of hunter/gatherers. It is suggested now that there were sedentary populations occupying select coastal locales with a maritime based economy (Arriaza 1995b: 52; Arriaza et al. 2001: 31; Arriaza et al. 2008: 47; Santoro et al. 2005). It was also once suggested that the Chinchorro originally came from the [eastern] tropical lowlands via the Andean highlands (Rothhammer 1990: 45; Rivera 1991: Arriaza 1995a, 1995b). While some may have come from the highlands, recent research proposes that the initial migration followed a coastal route from the north (Santoro et al. 2005).

The Chinchorro subsisted on a diet harvested mainly from the sea and supplemented by the hunting of terrestrial game. The archaeological evidence of their subsistence patterns can be seen in the large shell middens that accumulated along the coast around Arica including Quiani and Playa Chinchorro-Las Machas and further south at Caleta Vitor, Pisagua Viejo and Quebrada de Camarones (Arriaza et al. 2008: 47). These remains reveal a diet of shellfish, fish, marine mammals and wild camelids. Today guanaco are generally found above 2500m ASL and vicuña rarely venture below 4000m ASL. Historical records indicate that guanaco used to graze at lower altitudes and even made their way along the valleys to the coastal areas during the summer (Hardey 1944). As mentioned in Chapter One, guanaco also grazed on areas of *lomas* vegetion in coastal areas. At Quebrada Las Conchas, a coastal site near Antofagasta, northern Chile, camelids were hunted as early as 9500 radiocarbon years ago (Llagostera 1979). However Bird (1943) found very little camelid bone (three fragments) in his excavations at the Preceramic site at Playa Miller (Arica).

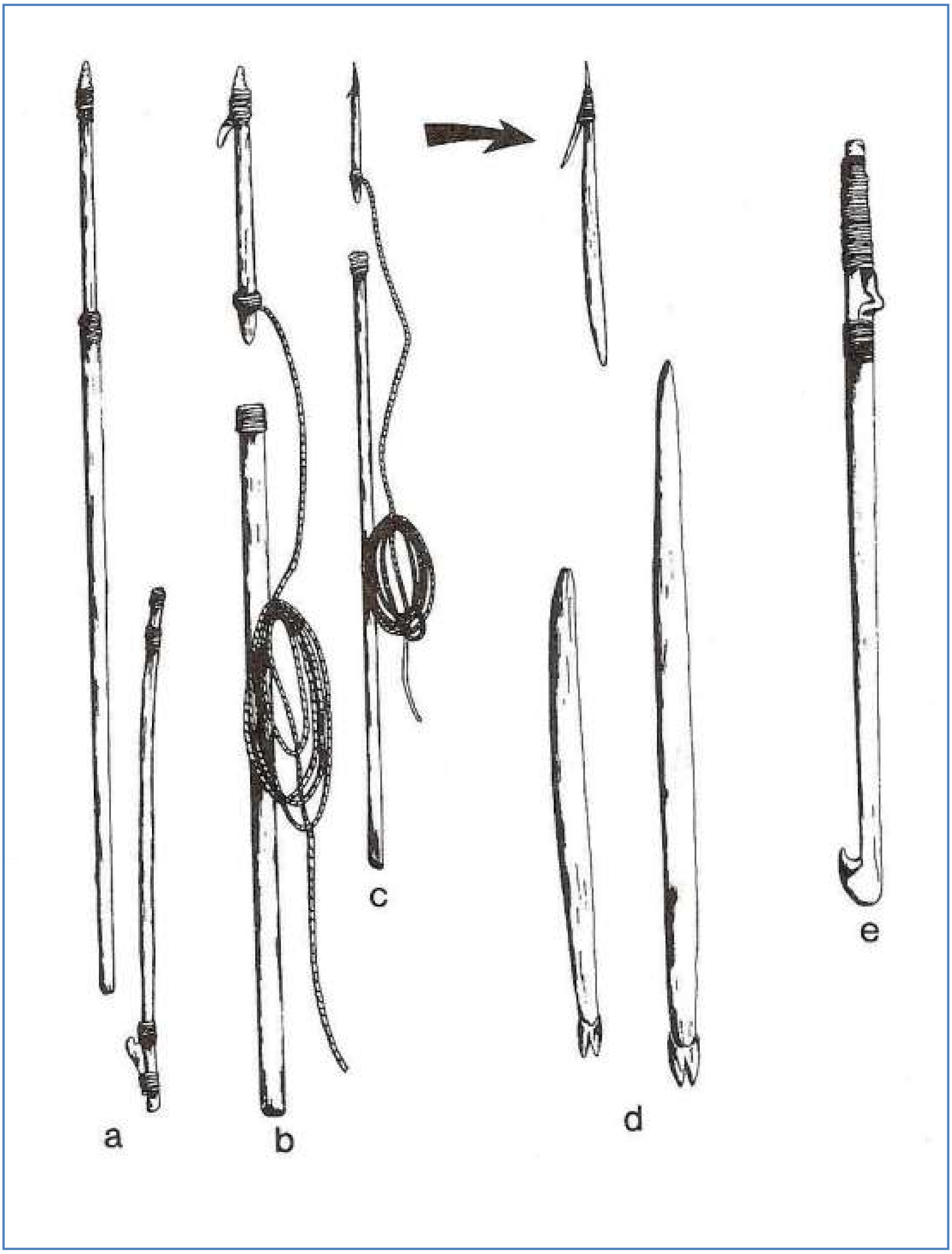


Figure 3.6: Examples of Chinchorro (Archaic Period) harpoons and atlatl (spear throwers)

a Harpoon and atlatl
b & c- Harpoon and detachable points (~1000 mm long)
d - Detachable harpoon heads (~250mm long)
e - Atlatl with thumb holder (~460mm long)
From Arriaza, 1995a: 89

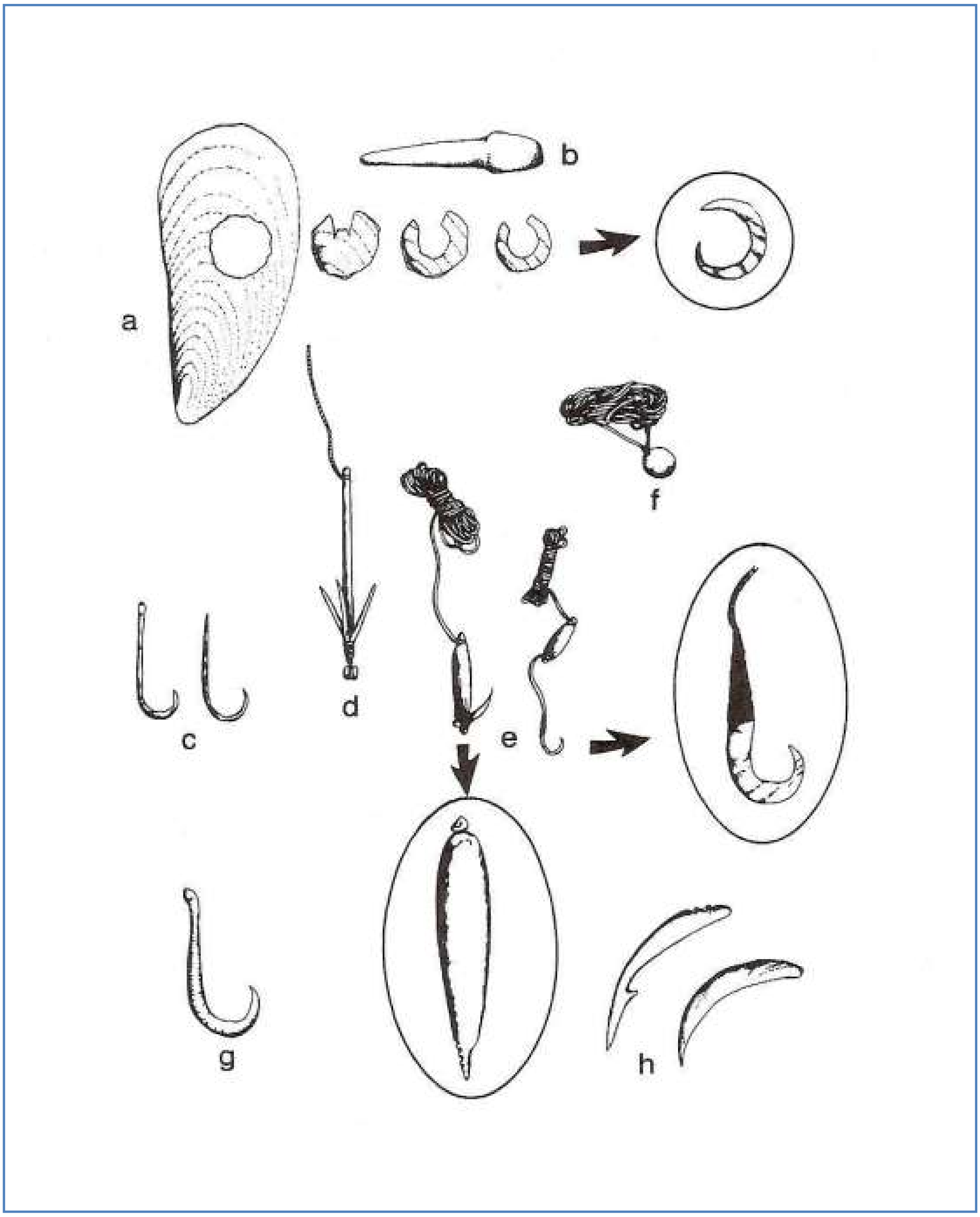


Figure 3.7: Examples of Chinchorro (Archaic Period) fishing gear

a- Shell fishhook manufacturing steps
b- Stone file to polish shell hooks
c- Two cactus thorn hooks
d- Composite hook
e- Two hooks with stone sinker/lures
f- Cord with stone sinker
g- Bone hook
h- Bone hook
From Arriaza, 1995a: 45

Dillehay (2000: 155) stated that the Chinchorro were the 'first true maritime economy' [in South America]. By 7000 BP they had developed a tool-kit specifically developed to exploit marine resources. Their lithic technology included bifacially flaked lanceolate points which were often fitted to harpoons with detachable heads (see Figure 3.6). These harpoons were used for hunting sea-lions and large birds (such as pelicans) and were used in association with an *atlatl* (spear thrower) (Arriaza 1995a: 88). Harpoons were sometimes fitted with bone barbs. Spear throwers had bone, tooth or wooden 'hooks' attached (bound with string or sinew) that fitted into the end of a spear (Uhle 1909: 626). Fishing gear included cotton line and one-piece hooks made of cactus spine, shell or bone, as well as composite hooks (Arriaza 1995a; Santoro et al 2005a: 251). They used sinkers and/or shanks shaped from basalt. Another commonly found implement, known as a *chope*, was used by the Chinchorro to prise shellfish from the rocks. *Chopes* were made of bone, generally sea lion rib, about 200-250mm long, with a ground leading edge and a handle formed with bound twine (see Figure 7.9 for an example). Figure 3.7 depicts a range of fishing gear excavated from Chinchorro sites.

The resources required to manufacture the Chinchorro tool kit were all available locally. Timber for harpoons and spears; siliceous stone (primarily chert) that outcrops along the sides of the *quebradas* for lithic inserts ; wild cotton from a native species growing in the *quebrada* for twine; local reeds for mats and basketry; coastal basalt for sinkers and lures; and cactus spines, shells and bone for hooks. Apart from the desire to make contact with other communities, there was no practical requirement for trade in such raw materials from further afield.

Other than their tool kits, Chinchorro material culture was limited and simple. They produced little in the way of art apart from their sophisticated and elaborate mummies. The few grave goods included harpoons, *atalatls*, fishing gear (hooks, sinkers and lines), beads and brushes (Arriaza et al.: 2008: 50). Their textiles were simply twined vegetable fibre mats.

Interestingly, as mummification practices changed through time, the reed mats that covered them remained a fundamental feature with little variation.

The Chinchorro culture declined during the Formative Period (from around 3500 BP) and by 3000 BP evidence of the Altiplanic or Andean tradition, from the Lake Titicaca region, appeared in the coastal valleys of northern Chile (Rivera 1991: 10; Aufderheide 2003: 147). This period may provide the context in which genetic material from the east entered the coastal population.

After 3500 BP, the mummification practices of the Chinchorro were gradually replaced, and the deceased were interred in a flexed (or semi-flexed) position, either seated or laid on their sides. The 'Quiani' style burials, from this period, were semi-flexed and laid on their right sides (Aufderheide 2003: 141). The abrupt change in funerary practices around 3500 BP marked the end of the Chinchorro phase. Ceramics became more common around this time and the simple agriculture practiced by the hunter/gatherer Chinchorro graduated to more intensive crop management and trade.

It is likely that plant domestication in South America began in the Andes during the early to mid-Holocene. Squash (*Curcubita* spp.) and gourds (*Lagenaria* spp.) were some of the first cultivars in South America (Dillehay et al. 2007: 1892). The Late Archaic Period (also known as the Cotton Preceramic) was a dynamic period of cultural change that witnessed the emergence of complex societies in Peru and northern Chile (along with much of South America) (Shady Solis 2001: 723). Located to the north of Lima on the central coast of Peru, Caral is one of the oldest known urban sites in South America. The centre arose between 4000 and 3600 BP with monumental architecture and irrigation agriculture. Domesticated plants recovered from that site include squash, beans, *lucuma* (*Lucuma obovata*), guava (*Psidium guajava*), *pacay* (*Inga feuillei*), sweet potato (*Ipomoea batatas*) and cotton (*Gossipium barbadense*) (Shady Solis 2001: 725).

Potatoes, maize, squash, beans, manioc, cotton, and chilli are often considered as the primary 'founder crops' of the Andes (Dillehay et al. 2007: 1890). The cultivation of plant resources (squash) began as early as 9000 BP in Ñanchoc Valley, northern Peru. Other dated plant remains from these sites include peanut (*Arachis* spp.) 7840 BP, quinoa (*Chenapodium* spp.) between 7500 and 8000 BP and cotton from 5490 BP (see also Piperno and Dillehay 2008). Following the development of irrigation in the dry coastal areas, there was an increase in crop richness during the period 4500 – 3500 BP, with the number of cultivated plant species increasing to range from nine to fifteen along the Peruvian coast.

Between 5000 and 4000 BP, the economy of the coastal hunting and gathering groups in northern Chile began to change following the introduction of crops such as manioc (*Manihot esculenta*), sweet potatoes and *achira* (*Canna edulis*). There was also an increase in local production of cotton, squash and chilli. These crops are typical indicators of this period along the Pacific coast, and were probably introduced from the coast of northern Peru and southern Ecuador where they had been domesticated much earlier (Dillehay et al. 2007; Perry et al. 2006; Piperno and Dillehay 2008).

After 3500 BP the Formative Period was associated with the arrival of ceramics, metal-working and woollen textiles, creating one of the most dynamic phases in the prehistory of northern Chile. During the Alto Ramirez phase (3500-1500 BP), the first migrants from the highlands introduced agriculture and pastoralism to the coastal valleys, with a geographic spread in northern Chile from the Azapa Valley in the north to Caleta Huelen in the south, as well as inland to San Pedro de Atacama (Rivera 1991: 21). Populations increased, food surpluses were produced and villages appeared. Material culture included metal ornaments, including silver and gold, metal and wooden spoons, spatulae, wooden boxes, bone tubes and trays for use with hallucinogenic materials, pottery, sophisticated basketry and textiles. Rituals involved human sacrifice with burials associated with constructed mounds.

Agriculture included new crops such as maize and beans (Santoro et al. 2005: 181).

During the Alto Ramirez phase the coastal and inland zones have been regarded as a continuum with a complex system of redistribution (Rivera 2008: 964). Non-metric dental traits have been used to determine biological distances between regional populations, but the results indicate little genetic variation between the coastal Archaic period and later populations (Sutter 2000: 62). The people of the Alto Ramirez phase were probably direct descendants of the Chinchorro, who adopted new ideas and technology that originated in the highlands. Grave goods included newly introduced items such as ceramics and woollen items, along with Chinchorro artefacts including harpoons, hooks, *chopes* and mesh (cotton) nets. Stable isotope analysis (nitrogen and oxygen) of skeletal remains suggest that the economy during the Alto Ramirez phase was a continuation of the earlier, marine-based regime, with a diet supplemented by agricultural produce (Aufderheide 2003; Roberts et al. 2014).

During the Late Formative (ca 2500-1500 BP), the Alto Ramirez Phase was also associated with the construction of mounds, *túmulos*, made up of alternating layers of reeds, grass and soil (Muñoz 1980: 60; Wise et al. 1994: 213; Rivera 2008: 965; Núñez and Santoro 2011). Burials were often placed within or outside the mounds but clearly associated with them. One such mound, within a complex known as AZ-70, was located some 15 km inland on a terrace of the Rio Jose, which flows through modern day Arica (Muñoz 1980). Samples from burials within the AZ-70 mounds provided a mean age of 2500 BP (Rothammer and Santoro 2001: 61). Several burials within the *túmulo* were marked by timber posts.

Túmulos have also been reported from 44 cemetery complexes found during a settlement survey around Moquegua in south Peru (~160 km north of Arica), and attributed to the Huaracane Tradition (2335 - 1510 cal BP) (Goldstein

2000: 348). They were constructed with alternating layers of sand, stones and vegetal matter, and were between 2 and 7m in diameter and up to 3m in height, in clusters, adjacent to terrace habitation sites. No ceramics were located within these mounds. A number of C14 samples from Moquegua *túmulos* have been dated between 2335 and 2130 cal BP.

One particular style of burial from the coast of Arica is referred to as the 'Quiani' style, which includes flexed burials in single graves within cemeteries that often had individual grave markers (Wise et al. 1994: 213; see also Bird 1943; Daulesberg 1974).

In 1941, Bird carried out a series of excavations at Punta Pichalo, near Pisagua, to the south of Caleta Vitor (Bird 1941; 1943: 253-278). Apart from investigating a deep midden deposit, he excavated a total of 39 burials from a cemetery to the south of the main midden. All of the bodies were interred in a flexed position, either upright or lying on reed matting (Fig. 3.8). All were buried associated with woven reed baskets and, in the case of infants, were buried within them. Each body was placed unwrapped on a reed mat, and 'square, sleeveless shirts' commonly adorned the corpse. Only one grave contained pottery. Of the 39 burials, 17 were marked with an upright timber post. The posts do not appear to have been installed in an obvious pattern or alignment (based on Bird's sketch plan - Fig. 3.9). Several other posts were found lying horizontally within the excavation. Bird (1943: 275) commented that the use of posts to mark burials had not been reported previously in northern Chile. Based on grave goods and funerary style, these burials date from the Late Formative Period.

Burial mounds ceased to be constructed in northern Chile during the Cabuza Phase (1700-1300 BP) which is identified by a ceramic style which includes a black-on-red ware with geometric designs (Rivera 1991: 29). This period reveals the early influence from Tiwanaku, with some changes to mortuary practices. Interments continued to be flexed and wrapped in textile bundles, wearing woollen shirts. Braided hair was replaced by woven cotton or wool turbans, and beautifully woven woollen caps with four points (Rivera 1991: 29; see Muñoz 1980: 92 for a drawing of a cap from AZ70, Azapa Valley). Textiles become more advanced in technique and decoration, and the range of grave goods expanded to include wooden objects (*keros*, boxes, trays, spoons), metal and leather goods.

Villages from this phase contained storage facilities such as storehouses and silos, suggestive of an economy that was able to produce a surplus and supported through trade.

Tiwanaku influence can also be seen in sites from the Maitas phase which existed in both the northern valleys and around San Pedro de Atacama (Rivera 1991: 30). Some archaeologists see the Tiwanaku colonisation process as planned (eg Dauhlsberg and Berenguer in Rivera 1991) while others suggest that interaction between Tiwanaku people and coastal populations was complex and highly variable (Knudson 2008: 3). In some instances (eg the Moquegua Valley, to the north of Arica), there is evidence of immigration from the Lake Titicaca basin (the Tiwanaku heartland) while in others (eg San Pedro de Atacama, to the south of Arica) it appears that the local population adopted Tiwanaku material culture to strengthen economic and ritual ties.

Figure 3.8: Staked burials, Punta Pichalo
Courtesy AMNH

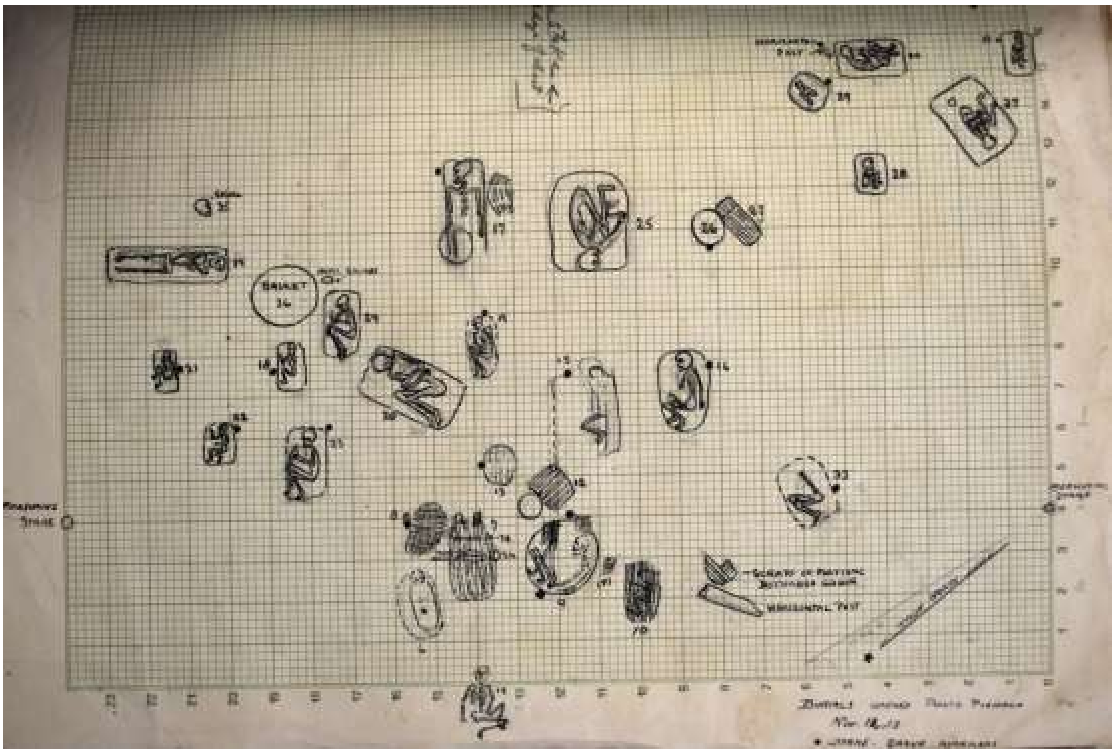


Figure 3.9: Plan of burials at Punta Pichalo. Drawn by Junius Bird, Nov. 1941.
Field notes courtesy of AMNH

Sutter (2000) looked at dental traits from a number of skeletons from Moquegua and the Azapa Valley. He found that the Moquegua population had genetic traits similar to those of Altiplanic groups, whereas the Azapa population appears to have descended from a Chinchorro population that had settled inland. Blom et al. (1998) studied craniometric deformation in a highland Tiwanaku population and another from Moquegua. Their results indicated that a section of the Moquegua Valley population displayed similar traits to crania from the highlands, but also that some maintained a local tradition of deformation.

Burial practices during the Tiwanaku period were characterised by the presence of hallucinogenic snuff paraphernalia, including trays and tubes, together with metal goods, weapons, and iconographic representations on ceramics and textiles (Torres-Rouff 2008: 330). Tiwanaku influence may have resulted either through direct colonisation by Tiwanaku peoples from the highlands, or via the adoption of Tiwanaku material culture alone by resident local populations. The burials from cemeteries in Moquegua suggest a direct link with Titicaca populations (via aDNA), whereas human remains from San Pedro de Atacama, in inland northern Chile, suggest that the local population adopted Tiwanaku methods and materials without significant immigration (Knudson 2008: 17).

In 2004, I was involved in a site survey along the coastal terrace between the outskirts of Arica and Chacalluta, a locality five kilometres to the north of Arica at the mouth of the Rio Lluta. Tombs were located on a river terrace where it met the coastal plain, on the southern flank of the Rio Lluta, but were badly disturbed and looted. The terrace consisted of a fluvial deposit of sand and gravel, naturally cemented to form a hard, stable strata. Several bell-shaped tombs were excavated directly into this deposit. Almost all of their contents had been removed, leaving only a few sherds, fragments of bone (including human bone), cordage and textiles. These tombs have since been destroyed through industrial quarrying.

Gallinazo Norte is an expansive site adjacent to, and to the west of Chacalluta. The 2004 survey located a broad settlement zone containing tombs and silos on the terrace immediately to the north of the Rio Lluta. Surface artefacts included fragments of ceramics and textiles, along with human bone and food remains (bone and shell).

Two tombs were examined in 2004 and 2005. They were constructed below ground level and both contained human remains along with textiles, ceramic fragments, cordage, basketry and maize cobs. Tomb construction required the excavation of a bell-shaped pit approximately 1.2 m deep, 800 mm in diameter at the base and 550mm at the opening, with a river cobble pavement on the circular floor. Ovoid cobbles were placed upright around the perimeter of the floor, and this course of standing stones was then topped with nine horizontal courses of smaller cobbles to a level just below the ground surface. The courses were corbelled toward the top of the chamber to form the 'neck' of the tomb. The final course of stones consisted of larger cobbles laid flat to form the entrance (circling the mouth of the tomb). Several other stone lined chambers were noted in this area, but they were cylindrical rather than bell-shaped, approximately 1400mm in diameter, and contained no evidence of burials.

Although disarticulated, the human remains located within the tombs indicated that the bodies were flexed, in a seated position and wrapped in textiles. Both tombs and the mummies had been badly disturbed. One tomb was more closely examined. The skeletal material from the upper portion of the mummy had become disarticulated, and had collapsed around the pelvic girdle. The feet remained directly below the pelvis, the right foot still in a leather sandal, the left disarticulated. The nail on the first phalanx on the right foot had been pedicured to form a rounded tip with no signs of wear. Plaited hair was located within the tomb, but appears to have been in two sections, that is, it had been extended with the addition of plaits, possibly with hair sourced from another person. A human mandible was located on the floor of the tomb, and a cranium was located in a shallow pit adjacent to the tomb opening. Both the mandible and the cranium articulated and had corresponding tooth wear. The cranium had signs of cranial deformation. Grave goods included a woven cane basket (~250mm diameter) containing maize seeds and cobs and a *chuspa*, a woven textile bag also containing maize cobs.

A sample of bone taken from this cranium was dated to 635 ±30 BP (human tooth, S-ANU27638). Stable isotope levels suggest a terrestrial diet (-16.83 ±0.544 δ13C). The date indicates that the burial occurred during the Late Intermediate Period.

No other material has been dated from the sites investigated in 2004 but the visible evidence suggests that the area had been occupied for some length of time and that it was an active agricultural site. The survey concentrated on archaeological evidence visible on the ground surface and at least six silos (*colcas*) were located along with at least five tombs. Apart from remains on the ground surface, maize cobs were found in both tombs and silos and suggest that agriculture was an important component of the local economy.

People in the Arica region, in particular, and northern Chile, in general, used to practice cranial deformation (Munizaga 1980; Soto-Heim 1986). The earliest cranial deformation noted comes from the Chinchorro culture dating to the late the Archaic. A recent study by Manríquez et al. (2006) shows that the frequency of cranial deformation increased through time. There were also variations in the methods and apparatuses applied that resulted in 'deviations' from the simpler methods. During the Late Intermediate Period (900-600 BP) more than 90% of the population had deformed crania while in the Archaic period only a minor proportion (less than 30%) received the treatment (Manríquez et al. 2006).

A period of prolonged drought in the Late Intermediate Period has been suggested as the reason for the fall of Tiwanaku influence (Rivera 1991: 34).

As a result, regional centres developed during this period along with fortified settlements known as *pukara*, that were perhaps built as defence against populations moving out of the Lake Titicaca region (Rivera 2008: 970). Economic activity was such that goods from a range of ecozones – including tropical forests, the highlands and the Pacific Coast – are found in the these sites. *Pukara* were centred within agricultural complexes, but the art and craft specialisation associated with them became highly distinctive and stylised (Rivera 2008: 971).

Specific Late Intermediate ceramic styles from the Arica region include San Miguel (c. 1000 BP) and Gentilar (c. 650 BP), followed by Pocoma, which extended as far south as Pisagua and Taltal. The complexity of the region is revealed by circumstances in which some groups who show similarities in ceramics, textiles and burial practices are genetically distinct, whereas other groups who are genetically similar display different cultural traditions (Sutter 2000: 64).

The valleys of northern Chile were eventually brought into the realm of the Inka state system (Rivera 2008: 973; Covey 2000: 119). Villages and administrative centres were incorporated into networks centred in the Andean highlands. The Inka eventually took control of the economic resources of the coastal region, including not only maize production but also the flows of guano and fish into the highlands (Covey 2000: 133). There are no monumental Inka structures in the Arica region, but the Inka presence can be detected in the archaeological record through the presence of Inka-style ceramic plates and *aryballos.*

Initially radiating out of Cusco, the Inka maintained a system of roads and *tambo*s (storehouses and administrative centres) that allowed the distribution of coastal goods to the highlands, as well as important highland products (e.g., coca) to coastal centres (Carter and Santoro 2002). Inka agricultural centres in the highlands were also dependent on links to the coast, where guano was harvested as fertilizer (Covey 2000: 126).

While there may have been some direct Inka influence in coastal regions, it appears that the local elite were allowed to maintain a degree of autonomy. As with Tiwanaku, the Inka administration operated within a system using varying degrees of influence and control over coastal populations. In 1653, Cobo, a Spanish chronicler, stated that the Inka were adamant that ethnic groups within their region of control should display their ethnicity and maintain traditional dress and hairstyles (Sutter 2000: 43).

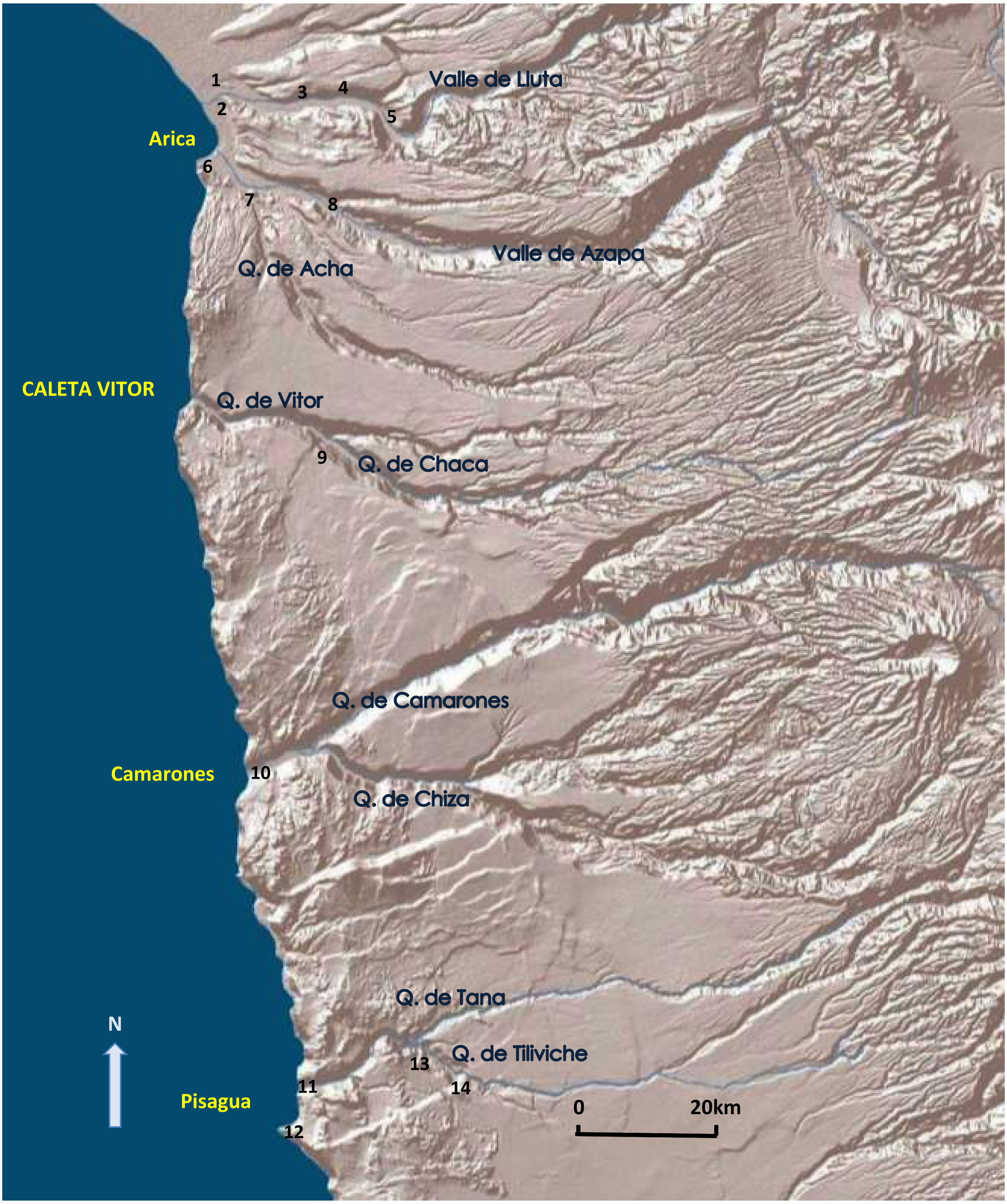
As mentioned, Inka influence on the populations of coastal northern Chile did not include architecture. The Inka built substantial structures in coastal Peru (e.g., Pachacamac, Tucume, Tambo Colorado). However, monumental architecture at these and other coastal sites preceded the Inka by several thousand years. The Inka either modified existing buildings or constructed new ones adjacent to or independent of existing centres. This did not occur in the region of Arica.

Colonial influence in northern Chile began with the arrival of the Spanish in the mid-16th century. The decline of Inka domination during the first half of 16th century was clearly evident, particularly following the fall of Cusco in 1536. However, the presence of local cultural material that reflected Spanish influence, such as the artefacts found at Caleta Vitor by Bandelier in 1894, indicates that the indigenous inhabitants maintained at least some of their cultural traditions for some decades after the arrival of the Spanish.

Table 3.1 details a general chronology for the cultural phases of coastal northern Chile. It is assumed to apply also to Caleta Vitor, the locus of this investigation.

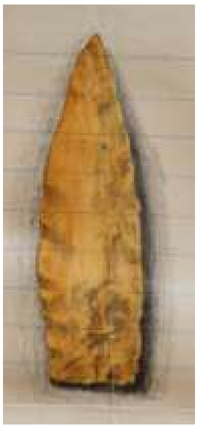
Time period (cal. BP)	Period	Phases
13,000–7500	Early Archaic	Acha, early Chinchorro
7500–6000	Middle Archaic	Chinchorro
6000–4000	Late Archaic	Late Chinchorro
4000-1500	Formative	Azapa phase (4000-2500 BP) Alto Ramírez (2500-1500 BP)
1500-900	Middle Horizon (Tiwanaku expansion)	Cabuza Maitas Chiribaya
900-600	Late Intermediate	San Miguel, Gentilar
600-500	Late (Inka Empire)	

Table 3.1 – Chronological periods relating to Northern Chile (from Santoro 2011)



No.	Site	No.	Site
1	Gallinazo Norte	8	Azapa Valley sites
2	Ponderosa	9	Quebrada Chaca
3	Colcas	10	Caleta de Camarones
4	Lluta 13	11	Pisagua Viejo
5	Molle Pampa	12	Punta Pichalo
6	Arica sites	13	Tiliviche
7	Acha sites	14	Hacienda de Tiliviche

Figure 3.10: Map showing locations of sites in Northern Chile
Base map courtesy of Instituto Geografico Militar, Chile.
Modified by C. Carter



The Economy of Prehistoric Coastal Northern Chile

Chapter Four

> *"Man in the first stage of his existence took much of his food from the water ... If on certain stretches of land intersected by rivers, dotted by lakes or bordering on the seas, shell-fish, cetaceans and fish were found to the exclusion of land animals, primitive man might have been forced to depend upon the art of fishing. After brute instinct, which is imitativeness, came adaptability."* (Morris 1938: 258)

Defining a Maritime Economy

The first settlers of coastal Peru and Chile have been variously described as:

- people able to exploit the sea with remarkable effectiveness (Llangostera 1979: 309);
- people for whom the ocean … provided most of the animal protein (Burger and Salazar-Burger 1991: 276);
- people who were 'based on the sea ... relying on fish and shellfish, learning the secrets of how to extract food from the ocean' (Arriaza 1995a: 5);
- having a maritime economy complemented with camelid hunting, and gathering of edible plants obtained from the coastal lomas (Santoro et al. 2005: 176);
- people who had the possibility to select from a bountiful marine coastal environment, with a long and almost unlimited list of resources (Santoro et al. 2012: 648).

It has also been suggested that by 7000 BP the Chinchorro of southern Peru and northern Chile probably represented the practitioners of the 'first true maritime economy' in South America (Dillehay 2000: 155).

In 1980 Yesner suggested that as a sub-set of more generalised hunting and gathering, maritime hunter/gatherers can be 'considered those for whom marine foods form the largest portion of the intake of either calories or protein in the diet' (Yesner 1980: 728). Here I argue that a maritime economy is based on more than its diet but as a measured response to environmental conditions which result in cultural adaptation. Marine resources would certainly underpin the argument but we need to move away from diet alone – beyond 'meals and menu' (McNiven 2004: 330). Humans respond and adapt to changing landscapes and environments. Their diet reflects such change but is also predicated on learned behaviour and cultural history.

A more comprehensive definition of a maritime or marine economy would therefore require connection with the sea and extend beyond resources and commodities to include a combination of the following:

- Resources – including most if not all available food resources available from the sea and coastal zone (but need not exclude terrestrial flora and fauna);
- Technology and techniques – a toolkit and range of techniques that was capable of successfully harvesting available maritime resources which may include tools that have been specifically adapted as well as those more universal in their design;
- Settlement of and adaptation to a coastal location;
- Transport that includes the use of watercraft and pathways that generally follow coastlines;
- Art that reflects an affinity with the sea along with depictions of marine figures;

- Ritual including burial practices and ceremonial sites with a focus toward the coast and sea;
- Environmental knowledge – evidence to indicate adaptation to and knowledge of the complete range of maritime conditions.

The following discussion provides a general description of the constituents of such an economy and discusses the development of marine economies. It also discusses examples of early maritime based groups in the Americas (particularly the west coast of South America).

The development of a maritime economy

It is now widely accepted that humans have exploited marine resources deep into antiquity (see Erlandson 2001; Erlandson and Fitzpatrick 2006; Thomas 2015a, 2015b). Archaeological evidence indicates that settlements associated with aquatic resources were widespread during the Pleistocene: through Europe and the Mediterranean, Asia, Africa, Australia and into Melanesia (Erlandson 2001: 306-309). At Pinnacle Point, southern South Africa, there is evidence to indicate that ~164,000 years ago, modern humans expanded their diet to include marine resources and that shellfish were an essential part of that diet (Marean et al. 2007: 905). Walter et al. (2000: 64) found evidence that humans were exploiting near shore marine resources by 125,000 years ago on the Red Sea coast of Eritrea (east Africa).

Stringer (2000: 27) has suggested that 'it may have been the coasts that provided the first and fastest routes of migration before moving inland up river valleys'. Erlandson and Braje (2015) suggested that mangrove forests and marine habitats may have provided rich ecosystems and resources that provided humans with the means to migrate out of east Africa, following what has become known as the 'southern dispersal route' (Erlandson and Braje 2015: 2). In much the same way as the 'kelp highway' provided the resource to allow an initial migration south along the Pacific coast of the Americas, the 'mangrove highway' provided an array of familiar resources that would have lured early settlers along the coast of south-east Asia and, eventually, to Australia.

Early maritime economies in the New World

Until the 1990s, researchers had concluded that coastal sites in the New World did not attract extensive settlement until after 5800 BP and that marine resources did not make up a significant portion of the economy earlier than that date (Lanning 1967, in Sandweiss and Richardson 2008). Lanning argued that prior to that time, marine resources were utilised in an *ad hoc* manner to supplement a terrestrial diet obtained via foraging and hunting.

More recent research has suggested that such a theory was erroneous as it was based on evidence obtained from sites that were well inland during the Pleistocene when the sea-levels were up to 120m lower than they are today (Dillehay 2008: 32). The sites Lanning studied were in areas where the continental shelf was quite broad and the terminal Pleistocene coastline was several kilometres from its present location. Indeed several sites on the west coast of North and South America clearly demonstrate that coastal communities had well developed and complex fishing strategies, including off-shore capabilities, in the late Pleistocene and early Holocene. A maritime based economy was a significant factor in the settlement of the coast of the Americas.

As an example, the Channel Islands are located off the coast of California (see Figure 4.1). Since the LGM they have been separated from the mainland by a strait ranging from 7 to 20 kms wide. Sites from a number of these islands contain evidence of human occupation dating back to the late Pleistocene.

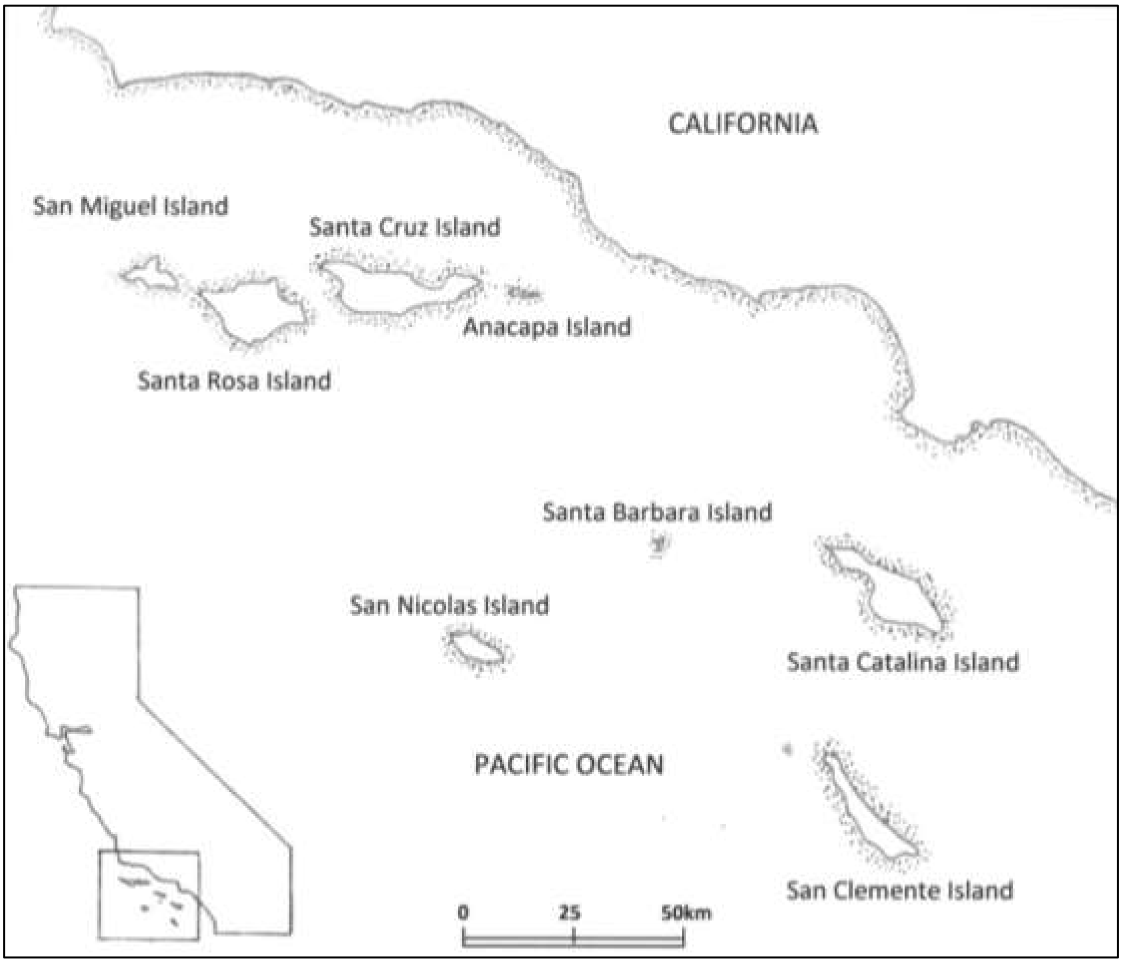


Figure 4-1. Map showing location of Channel Islands off the coast of California
Drawn: C. Carter

In 1959 human remains were located at a site known as Arlington Springs on Santa Rosa Island, one of the Channel Islands (Erlandson et al. 2011: 1181). These remains were later radiocarbon dated to ~ 13,000 ± 200 BP. While other Pleistocene dates have been reported from sites on the islands, they relate to shell middens that provided little technological evidence. More recently the archaeological investigation was expanded in order to better understand the nature of the economy and technology of the early inhabitants of these islands. In 2011 Erlandson et al. reported more Pleistocene dates from Santa Rosa Island - from as early as 12,920-12,630 cal BP (charred twig, OS70638). These dates were obtained from midden deposit that contained a variety of shellfish (including abalone, mussel, chiton, *tegula* and crabs), birds (including geese) and some fish. They also recovered 52 stemmed bifacial points that indicated a well-developed lithic technology.

Daisy Cave is located on San Miguel Island (another of the Channel Islands). Evidence there indicated that fish and marine resources were exploited from 11,950-12,780 cal BP (charcoal, CAMS9094) (Rick et al. 2001: 598). Excavations revealed quantities of fish bone which included 18 taxa, including two species of shark. The range of taxa and the presence of 30 bone gorges indicated that the occupants of this site had well developed and complex fishing strategies. Furthermore, they must have used boats as San Miguel Island, now around 19 km off-shore, would have been at least 6 km off the coast during the late Pleistocene. The residents of Daisy Cave had a diet where fish provided between 50% and 65% of the edible meat. Shellfish were also part of their diet and boats and nets were probably used for fishing.

Another midden on San Miguel Island (CA-SMI-507) provided a date of 9750-9090 cal BP (abalone shell, OS27945) (Erlandson et al. 2005). Rocky shore shellfish were dominant in that deposit with mussel providing 70.6% by weight and 57.7% by MNI followed by abalone with 17% by weight and 7.6% by MNI. Bone gorges and stone points were also retrieved. Another midden, CA-SMI-608, provided early Holocene dates, from around 9550-8700 cal BP (shell, OS44638) (Erlandson et al. 2005: 679). Again, rocky shore shellfish dominated the assemblage with a wide range of species present including limpets, abalone, clams, crabs, chiton, slipper limpet, barnacles, urchin, turban, with Californian mussel (*Mytilus californianus*) being the most abundant species overall. The midden also contained marine mammal, fish and bird bone. Lithic artefacts from that site include eleven bifaces (out of a total of 202 lithic items). One artefact of particular interest was a small, stemmed dart point with a triangular blade and barbed corner – similar to points found within an Early Holocene deposit from Daisy Cave. The majority of lithic pieces were from locally available stone but several pieces were chalcedonic chert found about 75 km east of the site on Santa Cruz Island. Unless there was a local source that is no longer accessible, the presence of this stone indicates that travel (by boat) to nearby islands was necessary to obtain the material. A bone gorge was also located at CI-SMI-608 and it was similar in form to those found at Daisy Cave.

The Channel Islands have provided a range of late Pleistocene and early Holocene dates and collectively the evidence from these sites demonstrated a complex marine based economy indicative of seafaring abilities along with well-developed fishing and hunting technologies. Erlandson et al. (2011: 1184) also argued that the stemmed points and crescents from Santa Rosa are similar in form to those from Paisley Cave in southern Oregon (~14,300 cal BP) and contemporary with Clovis (see Figure 2.3). This lithic tradition was, therefore, a parallel development and not descended from Clovis and may even be linked to the stemmed point traditions of Northeast Asia, the Northwest Pacific coast and South America.

During the past few decades, a number of sites along the west coast of South America have also provided dates from the early Holocene and as early as the late Pleistocene.

As previously mentioned, Huaca Prieta is an extensive coastal preceramic site located in northern Peru (7° 50'S, see Figure 2.4). In the 1940s, Junius Bird investigated a large mound from that site and excavations revealed evidence of a marine based economy supplemented by agriculture that dated from ~5500-4200 cal BP (Dillehay et al. 2012a: 418). More recent excavations on a coastal terrace, but beneath the mound level, have provided dates from as early as 13,794-13,459 cal BP (wood, Beta299536) (Dillehay 2012b: 56). Occupation of the Mound Phases continued until at least 3823–3483 cal BP (charred material, Beta247696). While the coastline was located at least 20 km away in the late Pleistocene, marine species are dominant throughout all time periods, with fish and shellfish being the most abundant and diverse remains including 34 shellfish species and 19 fish species (Dillehay 2012b; SOL: 7). Eight mammalian species were identified including sea lion, whale and dolphin. Maize remains have been found at Huaca Prieta and nearby Paradones and dated to as early as 6775 - 6504 cal BP (maize husk, OS8602) (Grobman et al. 2012: 1757). While there are dates to indicate that agriculture was practiced during this early period, the diversity of marine taxa including fish, shellfish and mammals, supports the notion that the economy remained focussed on marine resources and that this was the base from which later economies developed.

Quebrada Jaguay is located in southern Peru at 16°30'S. The archaeological site QJ280 was located on an alluvial terrace on the north bank of the *quebrada*. Excavations there have provided a number of dates from the late Pleistocene from as early as 12,797-12,515 cal BP (charcoal, BGS1702) (Sandweiss et al. 1998: 1830). The site is now 2km from the coast but during the late Pleistocene it would have been 7-8km inland. Despite being some distance inland, the site contained midden deposit with remains of fish and shellfish (crustaceans and molluscs) with only a few bones from terrestrial fauna. The dominant fish were Sciaenids (mainly *Sciaenia deliciosa*). Based on otolith size, the average length of this species was 172mm. Due to their size and habits, it was highly likely that nets were used in their capture. The presence of a few fragments of knotted cord also support this argument.

The dominant shellfish from QJ280 were *macha* (*Mesodesma donacium*), a sandy shore species that made up 99% of the molluscan assemblage. Sandweiss et al. (1998) concluded that the late Pleistocene and early Holocene inhabitants of Quebrada Jaguay had a well-developed and specialised maritime subsistence strategy. However, obsidian flakes in the lithic assemblage indicated at least some connection with the highlands.

The Ring Site (17°39'S) is located 7.5km south of Ilo on the coast of southern Peru. It contains a stratified shell midden on a marine terrace about 750m from the coastline. The basal layers date from 12,100-11,140 cal BP (shell, SI6793) although the majority of the deposit dates to the Middle Archaic (around 5600 cal BP) (deFrance et al. 2009). The majority of the deposit contained fish and shellfish with few plant remains.

Quebrada Tacahuay (17°48'S) is located a few kilometres south of the Ring Site and contains evidence of human occupation dating from 12,860 - 12,460 cal BP (charcoal, BETA 108692A) (Keefer et al. 1998: 1835; de France et al. 2001: 413). The economy there was also based on marine resources. However, in this case, the bones of butchered sea-birds (including cormorants and boobies) made up much of the assemblage along with fish and shellfish.

Quebrada de los Burros is located south of Quebrada Tacahuay at 17°8'S and has been dated to the early Holocene, from 9857-9496 cal BP (organic sediment, Gif10632) (Carré et al. 2009; Lavallée et al. 2011). The site was located 1.8km from the coastline on the south bank of the *quebrada*. Fish made up the bulk of the diet based on MNI and estimated calorie intake. Shellfish included echinoderm and rocky shore species but *macha* was the most common species in the older levels. *Loco* (*C. concholepas*), a large gastropod from rocky shorelines, became the dominant shellfish species from around 7500 cal BP. This site is located adjacent to areas of *lomas* and also contained evidence of camelid and cervid exploitation.

The oldest dated site from Arica (18°29'S) is Acha I which was settled by 10,800-9500 cal BP (human muscle tissue, KE15082) (Standen and Santoro 2004: 92). This site is an open camp-site and located 5.4km from the coast within the Quebrada de Acha, just beyond the urban spread of Arica. Archaeological evidence indicated that its occupants had a marine based economy and included the remains of fish and shellfish along with shell hooks, cactus spine hooks and composite bone hooks (Arriaza et al. 1995a: 38; Standen and Santoro 2004: 203). Early views held that the early occupants were highly mobile groups but evidence (including a diet dominated by marine resources; a tool-kit based on maritime activities; cemeteries; and the existence of circular huts at Acha 1) has suggested that they resided on the coast year round rather than seasonally, as was previously thought (Arriaza et al. 2008: 47).

The above examples are not intended to provide an exhaustive list of early marine based sites along the coast of the Americas but provide a temporal context for the evidence likely to be found at Caleta Vitor. The evidence showed that by the late Pleistocene the arid coast of southern Peru and northern Chile was settled by people who had established a marine based economy that did not rely on terrestrial resources to any great extent. It is clear that the Pleistocene settlement of the Channel Islands required the use of watercraft. As such, watercraft may have been used to further the migratory efforts as groups moved southward, although there is no evidence, as yet, to indicate that watercraft where used by the first settlers in southern Peru or northern Chile. The presence of large, oceanic pelagic species (marlin, swordfish and mako shark) in midden remains at Copaca 1 (22° S, south of Tocapilla) in central northern Chile implies that watercraft were in use by at least the Middle Holocene (where specimens were dated between 7866 and 5040 cal BP) (Olguin et al. 2015: 13).

Figures 2.4 (p. 60) and 3.10 (p. 91) contain maps showing the location of sites mentioned.

The Mechanics of a Maritime Economy

Just as terrestrial hunter/gatherers must go through a period of 'landscape learning' when entering new or unfamiliar lands (see Meltzer 2003; 2009), a similar process is required by those who focus on the sea. In simple terms, the development of a marine based economy must involve 'seascape learning'. This knowledge would include:

- knowledge of available resources;
- feeding/foraging habits of each taxon;
- when they are available (seasonality);
- the influence of tide and weather;
- the skills required to get to the resources (in-shore, off-shore or diving);
- management of risks associated with each procurement technique.

A coastal ecosystem may, at first glance, appear to be relatively simple. Caleta Vitor may be viewed in such a light. It contains a beach flanked by rocky shores. The valley itself contains a little water and sparse vegetation. However, within the overall ecosystem, a plethora of habitats exist, each within its own microcosm and conditional set. The sandy beach appears simple but the depth and bottom shape immediately off-shore impacts on wave pattern which in turn affects which species inhabit the area. Shallower sections provide a different suite of conditions, as do areas closer to the rocks or within the lee of the headland. Similarly, the rocky shoreline contains a complex conglomerate of ecosystems.

The depth of the water immediately off-shore, whether the bottom is shelving or flat, and the bottom type (hard or soft), all affect the type and range of benthic communities. The local geology will also affect habitats, e.g., soft, rough textured rocks allow for stronger foothold by aquatic plants than do hard, smooth rocks. This impacts on species diversity, the range of trophic levels and relationships between resident species. Rising sea-levels during the late Pleistocene) would have also affected the nature of littoral resources – what was once a rocky bottom may have become sandy as beaches formed or *vice versa*. Through time, albeit gradually, the economy of local residents would have had to adapt as conditions changed.

Marine habitat range is, in effect, multi-dimensional. Firstly, the horizontal range offers the conditions that are required for a given species to be present in a certain location. Horizontal spread runs in two directions – along the coast and from the shoreline out to sea. Some species will range broadly from off-shore to close in-shore; other species are found only near the shore in shallow waters; others are only found off-shore, whatever the depth of the water (oceanic); while some will never venture far from the shoreline (neritic/territorial) (Medina et al. 2004).

Vertical distribution relates to the depth of water preferred by each taxon - some are bottom dwellers (benthic/demersal); some prefer open waters which may include the sea surface (pelagic) and others may establish a range based on a specific feature (reef, cave or rock pool). Horizontal and vertical distributions are often correlated, whereby certain species prefer deeper waters but specific beds eg hard (rock or reef) or soft (sand or mud) bottoms, while also being dependent on water depth and temperature. Sea conditions may affect both horizontal and vertical distribution as rough water may attract some species to a shore line to benefit from food that may be washed into the water while other species move off-shore to stay away from turbulent or turbid areas.

Periodicity spans from sub-daily to annual cycles but also includes irregular events from sudden squalls through to tsunamis. At a basic level, a receding tide can be utilised to allow certain species of molluscs to be collected along the water's edge and rock-pools may trap unwary fish as water levels subside. Tides also influence the movement of marine species. Tidal movement and currents move nutrients and food sources and their strength and direction affect where species may move to benefit. While the tidal range in northern Chile (generally less than 1m[1]), it is sufficient to alter the accessibility of some resources. Some will move as a result of diurnal and nocturnal fluctuations, some will use the darkness to provide protection and allow foraging in shallower or less protected waters. On a broader scale, seasonal changes may also influence the movement of fish over short distances (feeding) or long distance (migration/breeding cycles). Longer periods that impact on both population densities and movement are the *El Niño* and *La Niña* cycles (Sandweiss 1996: 135; Williams et al. 2008: 247). In such cases, thermal anomalies may have catastrophic consequences for some sections of the food chain that impact more broadly across most, if not all, trophic levels.

Fish species differ in both form and behaviour. Colour and morphology generally relate to habitat. Sedentary benthic species may be coloured or patterned for camouflage while pelagic species are shaped to swim in open waters, using their speed as a defence mechanism or to capture prey. As with other animals, fish can be classified as herbivores, omnivores and carnivores, while some species feed mainly on detritus (detritivores) (Masse 1989: 125).

Developing the knowledge about where species congregate, their habits and what conditions they prefer is a necessary component of any fisher's skill-set.

The examination and identification of faunal remains can assist understanding of how prehistoric people developed an economy based on such resources. The identification of species (and, hence, their habits) can indicate both the techniques required to catch or collect them as well as where the fishing took place (inshore/offshore, reef/beach). Variations in species number and distribution may indicate changes in resource

[1] http://www.tide-forecast.com/locations/Arica-Chile

availability (seasonal variation or depletion as a result of climatic or anthropogenic factors); improved or introduced technologies; cultural influences or simply their desirability.

Intermittent events may impact on harvesting as well as increasing risk of injury or death. An ability to understand weather patterns and foresee storm events can be gained through experience after living or working in an area for a time. Risk reduction strategies could then be introduced should indications predict rough weather and dangerous seas. While coastal storms are not common along the northern Chilean coast, off-shore storm events generate huge waves that do make their way to shore (pers. obs.). Tsunamis (historically recorded along the coast of Chile) could have a long lasting impact on coastal populations. The immediate impact of a tsunami could be catastrophic and in a worst case scenario, completely destroy a settlement and all who live within it. In less severe cases, those who witness the impact and survive may change their view of coastal settlement. This may result in settlements and daily activities being moved to higher ground beyond the reach of such waves. Those who carry the memory of such events may have been be reluctant to live permanently close to the shore. However, after a few generations and as memories fade, settlements may move back toward the shore-line as it appeared safe and closer to the day-to-day activities of fishing and shellfish gathering. This may also occur when settlers moved into an area from further afield, e.g. from the highlands. Without the historical knowledge of tsunamis, why would they not take up residence in locations that otherwise appear ideal.

Berenguer (2008: 92) (citing Llagostera 1982) stated that:

> People penetrated successive fractions of marine environment over time: first the seaside, then deeper water, finally the open ocean. Marine gatherer, early fisherman, late fisherman.

If the migratory route into northern Chile was via the coast, we could assume that the first settlers were already adapted to a maritime culture and, given the time elapsed, would have had an economy that was more advanced than a simple 'marine gatherer'. Rick et al. (2001) argues that maritime technologies (boats, nets, fishhooks, fish spears) were in place 12,000 to 10,000 years ago as implied by the earliest well-documented occupations of the Pacific Coast of North America. The fact that Australia was settled over 50,000 years and that the first settlers had to have used watercraft to cross stretches of ocean demonstrated that watercraft were in use at least that long ago (Bellwood 2013: 71).

Perhaps the early coastal inhabitants of northern Chile were 'early fishermen' if not 'late fisherman' using watercraft and a range of technology suited to such an economy. The early 'marine gatherer' was perhaps left somewhere in the far north.

Whatever the genesis of the local economy at Caleta Vitor, the archaeological record should reveal developments over time as new skills and technology developed and new ideas and commodities introduced from the broader population (trade and/or colonial influences). Human communities are not static and evidence should also reveal cultural and technological evolution as the economy continued to develop.

Middens

Middens are anthropogenic features that result from the accumulation of discarded shell, bone, plant and artefactual remains along with naturally deposited material such as sand and soil. They are perhaps the most commonly seen archaeological feature found on coastal sites. Middens, in general terms, consist of concentrations (dense or sparse scatters) of shell and other food remains associated with either settlements or spot camps. Middens often contain hearths, burials, foundations and other cultural features. Such sites are a rich source of data that relate to the economy of coastal groups and the environment within which they interact (Erlandson and Braje 2011; Marquet et al. 2012; Thomas 2015a, 2015b).

Many are simply referred to as shell middens as shell is often the most obvious or visible items, mainly because they are the most robust and largest items that survive within a deposit. Shell is often bleached white, obvious and clearly visible. However, 'shell' middens rarely consist of shell alone. They are generally refuse dumps associated with domestic situations and are likely to contain a range of material indicative of the major components of the diet of the local inhabitants. Bone from fish and mammals along with plant remains are commonly found amongst the shell, although environmental conditions affect the preservation of less robust material which, in turn, affects the final composition of the surviving assemblage. The shells themselves can protect material from deterioration, the hollow interior of a gastropod may become a repository for smaller, less robust items such as seeds and small bones.

Middens often contain more that refuse and features within the structure of a midden may include hearths, burials and other cultural features that provide data relating to technological continuity and/or change, social organisation and ritual behaviour (Marquet et al 2012; Latorre et al in press).

Figures 4.2 and 4.3 are photographs of middens showing the nature and extent of such deposits from northern Chile.

Figure 4.2: Exposed midden- Caleta Camarones. This deposit was cut by road construction. Note the presence of vegetal material along with shell and bone. Photo: C. Carter

Figure 4.3 – Exposed midden – Punta Pichalo. This is the trench excavated by Junius Bird in 1941. Note the distinct layering of ash, stones, vegetal material. Photo: P. Heath

Shell middens can be investigated to provide information across a range of questions. Firstly, the contents can be used to study resource exploitation, as well as providing a time-frame for the period of use - from short-term, seasonal, exploitation through to long-term occupation associated with environmental or anthropogenic change. They may be representative of: individual events – either a single meal or a group feast; or communal sites where food is regularly processed, prepared and consumed, either at a household or group level. They may also be associated with other activities such as tool-making or weaving; or refuse dumps that consist of shell and bone accumulations, generally associated with or in the vicinity of settlements; or processing sites where meat may have been removed from the shells and transported some distance away prior to consumption; or ritual settings where ceremonial feasting was connected to a specific place that may be associated with burials, sacrifice or similar rites.

Discarded (either accidental or intentional) artefacts are also found within midden deposits. Tools used in harvesting or processing foods may be left on site and buried within a deposit if not removed; breakages may result in the intentional discard of items (eg broken pots); food processing or consumption sites may also be social gathering points where other activities occur. This may result in the deposition of artefacts not necessarily associated with food processing or consumption. For example, lithic tool production or maintenance may occur nearby and knapping debitage may be evident; weavers may set up in the vicinity of communal hearths where food preparation is going on, thread off-cuts, whorls and needles may be left behind.

The taphonomy of a midden varies greatly from site to site, region to region and between economies. The stratigraphic dimension of middens is generally discernible as a series of discard events that build up through time. Individual units within a deposit may range from a few shells and bones that represent the remains of a single meal of one individual through to the dumping of rubbish that may have accumulated as a result of several days feasting by a large group of people. Material may have been discarded at the scene of the event or carried from one locus of activity to be dumped at another. A limited range of material may suggest specific use, perhaps by an individual or group undertaking a specific task, e.g. butchery or shucking a collection of molluscs. A very mixed collection of material suggests a coming together of people, e.g. a home base where males and females comingle and food remains are deposited along with the detritus of domestic activities. Careful analysis of midden material, excavated via discrete stratigraphic units, should reveal evidence of whether the remains were discarded as the result of singular events, communal gatherings or communal dumping.

The physical location of middens may also be used to determine whether environmental events such as floods (where sites are situated on river terraces); tsunamis or severe storms (sites located adjacent to the coastline); or landslides (sites located at the base of cliffs) were taken into account by the local inhabitants.

In some regions shell middens are interpreted as places of ritual and ceremony (Alvarez et al. 2011). The specific location of a midden may attest to its ritual significance. Those located very close to where resources are procured are likely to there for practical reasons. Those further away may also have been located for practical reasons – to be nearer shelter or habitation sites. However middens located on high ground or prominent locations that are not necessarily close to the source or in sheltered places may well be sited for ritual purposes.

Burials are common in shell middens (Ceci 1984: 64; Santoro et al. 2005: 339). They are a common feature in the large shell mounds (*sambaquis*) of the Brazilian coast (Alvarez et al. 2011) and Bird (1943) encountered numerous burials in his excavations of middens at Arica, Pisagua and Taltal (actually he seems to have targeted them).

Near Arica, the site of Quiani is located at the base of a steep slope about 75m east of the high-water mark a few kilometres south of the modern port. Much of this area has been developed and little (if any) of the original midden remains. Bird stated that 'this midden is somewhat more compact and consolidated ... the upper three fifths consists approximately of half shell and half sandy dirt and ash ... Fish and bird bones were scattered throughout ...' (1943: 235). His excavation removed about 50 cubic metres of deposit to an average depth of about 2 m. He found twelve mummies there but not all were from the excavated trench as several were already exposed in the vicinity. The use of the site as both a midden and burial ground is evident at this location.

In 2006, construction at a hotel near the Arica CBD (Calle Yungay) resulted in the discovery of a number of prehistoric burials. A salvage excavation took place and sixteen Chinchorro mummies (or parts thereof) were removed from the site[2] Midden refuse, including shell, fish bone and lithic remains, was distributed throughout the deposit, surrounding the mummies. This indicated that the bodies had been interred within an existing midden and the area continued to be used for both burials and the deposition of food remains for some time after the last interment.

Burials located within middens may represent a linkage with past activities or the people associated with the site but they may also represent a connectedness to a particular way of life and to maintain a close association with the living who continue to use that specific place. Inhumations within a specific location that is representative of a group's economy may indicate a ritual link to the deceased that carries forward after death. The midden in

[2] I was involved in this excavation.

such a situation becomes a vector to maintain spiritual linkages between people, place and process, perhaps suggesting a sedentary population.

The taphonomic structure of a midden would be significantly altered when they were used for such purposes. If a body was simply placed on the ground surface (of a midden site) and left to become covered or affected by natural processes (such as animal scavenging), that body would itself become part of the midden stratigraphy. However, if a body was placed on the surface or in a grave and then covered by soil, the act of burial would disrupt the existing stratigraphic profile significantly. Without an actual grave, burial may involve the removal of soil (containing midden material) from another part of the midden and deposit displaced material on top of it possibly reversing the stratigraphy in that particular location. The act of digging a grave to accept a body would bring material from lower strata onto the surface (at the time of the burial) and the soil may be returned to form a new and distinct stratum as the body was covered with soil. Depending on the depth of the grave and the total depth of the midden deposit, burials may result in almost a complete reversal of stratigraphy in some deposits while in others it may result in the juxtaposition of only a few strata.

Marine Resources and Technology

There are three basic forms of fishing gear – harpoons and spears; hooks and line; and nets (Cushing 1988: 2). The basic forms of this equipment are known from at least the Paeleolithic. Techniques appear to have altered little since that time but the technology has evolved significantly.

The following describes the nature of a range of marine based activities and associated artefacts that are either known from the area or inferred to have existed during the prehistoric period. The order of descriptions follows the sea from the shore line outward – shellfish collecting, hunting with spears, fishing with lines and nets, followed lastly by seafaring activities.

Shellfish gathering

Shellfish, some species at least, are one of the easiest marine resources to locate and harvest. Some shellfish species reside within the littoral zone, either buried in the sand (e.g., bivalves) or attached to rocks (e.g., gastropod) and simply require collection as they are exposed at low tide. Such species can be easily collected with nothing more than a bag or basket to carry them in. The evidence of their contribution to a local economy would consist of the shells themselves.

Decisions made during the pursuit of shellfish are simple – take the animal or leave it where it is; there is no need to stalk, pursue, slaughter or butcher it (Anderson 1981: 113). Apart collection, shellfish are merely taken back to the campsite and cooked in their shells or shucked at the point of harvest and the meat taken back, while time-consuming, the returns are constant and require a simple work-plan. Anderson (1981: 112) cited several examples where shell-fishing was a group task which in itself had several advantages. Information could be shared on a minute-by-minute basis and reduce wasted time, particularly when the catch was shared; social interaction was continuous; and, for women, group foraging was advantageous for protection and childcare. As such, shellfish collection is a task that can be done by both males and females of all ages. Women with very young children could take part, leaving their infants within relatively easy reach. Group activities also lower the risk of drowning or injuries where a number of people can keep watch on wave patterns, tidal movements and, perhaps, children who may be accompanying their parents. Children can learn the techniques of shellfish collection solely via observation and mimicry.

Some species, such as oysters or mussels, are sessile as adults while others are mobile, at least to some degree. A number of bivalves and gastropods inhabit areas with sand or mud bottoms. They may be collected by sifting through the sand using fingers or toes or using a digging stick. Other species use strong muscles to attach themselves to the rock faces and can be difficult to remove (e.g., chiton, abalone and limpets). '*Chopes*' were developed for this very purpose. They consist of a chisel/lever made of bone (commonly sea lion rib) or timber with a handle of plant fibre for both grip and protection (see Figures . *Chopes* have been found from the Chinchorro cultural period (7000-3500 BP) (Arriaza 1995a, 1995b) through to the Late (Ceramic) Period (Bird 1943: 265). Bird found modified rib bones at Arica, Pisagua and Taltal. Although he identified them as 'chipping tools' they are clearly what are now known *chopes* (see Bird 1943: 261, 263, 273). *Chopes* are still used by shellfish divers today although they are generally made of metal with rubber handles (pers. obs.).

Many rocky shores species can be collected during low tide but diving is required to collect species that inhabit deeper water (Waselkov 1987: 97). The ability to dive to certain depths can be achieved via experience. Apart from finding the remains of specific species that inhabit deeper water, evidence of diving can also be seen in human skeletal material. Diving in cold water can cause an irritation to the inner ear which may result in a bony growth known as an auditory exostosis (Kennedy 1986)[3]. Auditory exostoses are prevalent in Chinchorro mummies, predominantly in males, indicative of activities associated with exposure to cold water, most likely diving (Arriaza 1995a: 91; Standen et al. 1997: 119; Arriaza et al. 2008: 47).

The evidence of shellfish collection is generally found in middens which may range from a sparse scatter of valves to deep and expansive deposits that may consist of millions of shells spread over many hectares. Recording the species, size and frequency of a collection of shell from midden can be used to interpret foraging and behavioural patterns and environmental change.

[3] – formerly known as 'diver's ear' but now also known as 'surfer's ear'

Through time, the technology related to the efficacy of shellfish collection is not likely to have changed. The use of watercraft may have expanded the available range of shellfish gathering. However, the techniques required to collect them are more dependent on the knowledge related to their location and, perhaps, may have been improved via co-operative efforts. An increase in local populations may have also led to over-exploitation of certain species and this should be visible in the archaeological record.

Spears and harpoons, bows and arrows.

Spears were made shafts of local timber and tipped with a point fashioned from stone, sharpened bone or metal. They ranged from single shaft units to composite harpoons with detachable forepieces. Lighter spears were sometimes tipped with fine, multi-prong points. In the early 20th century, Evans (1906: 21) observed locals at Taltal, central northern Chile, using such spears for hunting small fish as well as sea urchins, octopus and crabs.

Harpoons were generally used for hunting larger prey. In northern Chile, the Chinchorro had a range of fixed tip and detachable head spears and harpoons (Arriaza 1995a). Examples excavated from local sites include harpoons with a [detachable] forepiece with a barbed point that was socketed into a larger diameter main shaft. The harpoons were attached to a strong rope or cord made from cotton or woollen fibre or lengths cut from a sea-lion hide. The intention was that when such a harpoon struck a target, the point would lodge in the prey, detach itself from the shaft and the hunter could use the cord to retrieve it. In larger species, such as shark or sea-lion, the hunter would have had to wait for the animal to die or at least tire before it was fully retrieved.

In 1909 Uhle described a collection of 'throwing sticks' (spear throwers) that came from Chaviña, a burial site in southern Peru. Apart from one specimen crafted out of bone, the throwing sticks were made of wood, between 430 and 550mm long. The hooks, which fitted into a notch at the end of a harpoon to aid with throwing, were made of variety of materials including copper, bone, tooth and wood and attached with cotton or sinew (Uhle 1909: 626). In several cases the hooks were ornately carved. Uhle stated that those from Chaviña were very similar to those he had seen from Nazca and Ica. He also noted that while 18 throwing sticks were retrieved from a burial site located on the coast, none were found at a similar burial ground a 'mile above the site'. Uhle concluded that throwing sticks were 'possibly used for fishing' as they were not found further inland'.

From his excavations in the 1940s at Arica, Pisagua and Taltal, Bird (1943) retrieved a range of paraphernalia relating to harpoons and spears. Several burials contained a range of grave goods and among those he found several harpoons, harpoon heads and points. He found points made from stingray barbs, bone (guanaco or vicuña), copper and flaked stone. A mummy from grave 9 at Quiani had a harpoon forepiece held in its hand. It was a cylindrical length of wood, some 360mm long, it was slotted at one end to take a triangular stone point which was held in place by resin and bound to the shaft along with a bone barb. A length of hand-twisted woollen cord was wrapped around the waist of the mummy and then attached to the forepiece. Several mummies also wore head-dresses adorned with lithic spear points.

At Playa de los Gringos (Arica) in Grave 2 Bird found a quiver containing several harpoon forepieces (1943: 223). The quiver was made of 'rush', measured 235mm x 140mm and contained seven forepieces. They ranged in length from 195mm to 225mm, all were painted with a red pigment and four had conical bases, probably designed to stop the harpoon cord from slipping off. Each forepiece was tipped with a triangular stone point held in place by fine cord whipping. He also located a number of harpoon shafts and forepieces in other graves from Arica, Pisagua and Taltal. The association and frequency of such hunting implements with the deceased was indicative of the significance of marine based hunting to these people. Figure 4.4 is a copy of a photograph taken by Bird of a selection of harpoons and detachable forepieces from Playa de Los Gringos.

At Quebrada de los Burros, Lavallee et al. (2011: 342-345) retrieved over 24,000 lithic pieces from levels N2 to N7, the majority being debitage with a small number of points or parts thereof. Flaked lithic points appear commonly from the earliest periods of occupation to those of the Late Period. There were around twice the number of bifacially flaked pieces than unifacial. The raw materials used for their manufacture included chert, chalcedony and quartz, which were available from sources only a few kilometres from the site.

Bird's excavations at Arica and Punta Pichalo located a number of lithic points. Chalcedony was the dominant material and sourced locally. He noted that narrow, double ended points were more common in the preceramic levels, the later preceramic had stemmed and barbed points and triangular blades, some with a concave base, appeared in the ceramic levels.

Bird collected several harpoon shafts with detachable bone and copper composite points (see Figure 4.4). He suggested that the detachable bone point was the prototype for the copper (or bronze) points (Bird, 1941 notes). The metal points can be attributed to the Late Period.

The Bandelier collection at the AMNH (collected from Caleta Vitor) also contained two copper or bronze spear points. One such point (#B4477) was attached to a length of cord made from sea-lion hide and consisted of two separate pieces. The main shaft of the point is 130 mm long, tapering to a point at each end with a diameter of 6mm at its widest point. A copper barb (20 mm x 3 mm), pointed at both ends, is fixed with cotton whipping to the proximal point. Another point (#B4471) is similar but measures 72 mm x 6 mm with a barb 21 mm x 3.5 mm. Apart from size, the main difference between the two points is that the first is rounded in section while the second is slightly beaten to flatten the sides. Both points have a looped line fixed to the shaft with cotton whipping approximately 15mm from the distal end. This loop could have been used to attach a line to the point. Figures 4.5 is a photograph of these two points.

Apart from the stone points, harpoons and spears are generally made out of perishable material. Items that do survive within the archaeological record are often associated with burials in the form of grave goods. As such, excavations that do not target graves or tombs are less likely to locate the evidence of the artefacts themselves.

Uhle (1909) suggested that bows and arrows were used for hunting fish at Arica. However, Bird stated (1943: 209) that:

> Nothing was found in the excavation to prove the presence of bows and arrows, but some grave goods ... show that they were known at least during the latter part of the pottery period.

Bird found miniature bows and arrows associated with two burials (one from Playa Miller, the other from Playa de los Gringos). Dimensions are stated for only one example (Playa de los Gringos) - the bow was 335mm long with six arrows up to 300mm in length. Both bows were accompanied by six arrows. The arrows had reed shafts, were tipped with thorns and had the remains of feather fletches but none had nocks. He also commented on the presence of small, narrow stemmed lithic points from Punta Pichalo which he suggested were "for shafts no heavier than arrows" (Bird 1943: 276).

Petroglyphs from Rosario, an Inka period site approximately 25 kms from the coast in the Lluta Valley, include the depiction of a hunter using a bow and arrow (pers. obs.). Fauna depicted in this panel include camelids but no obvious marine species.

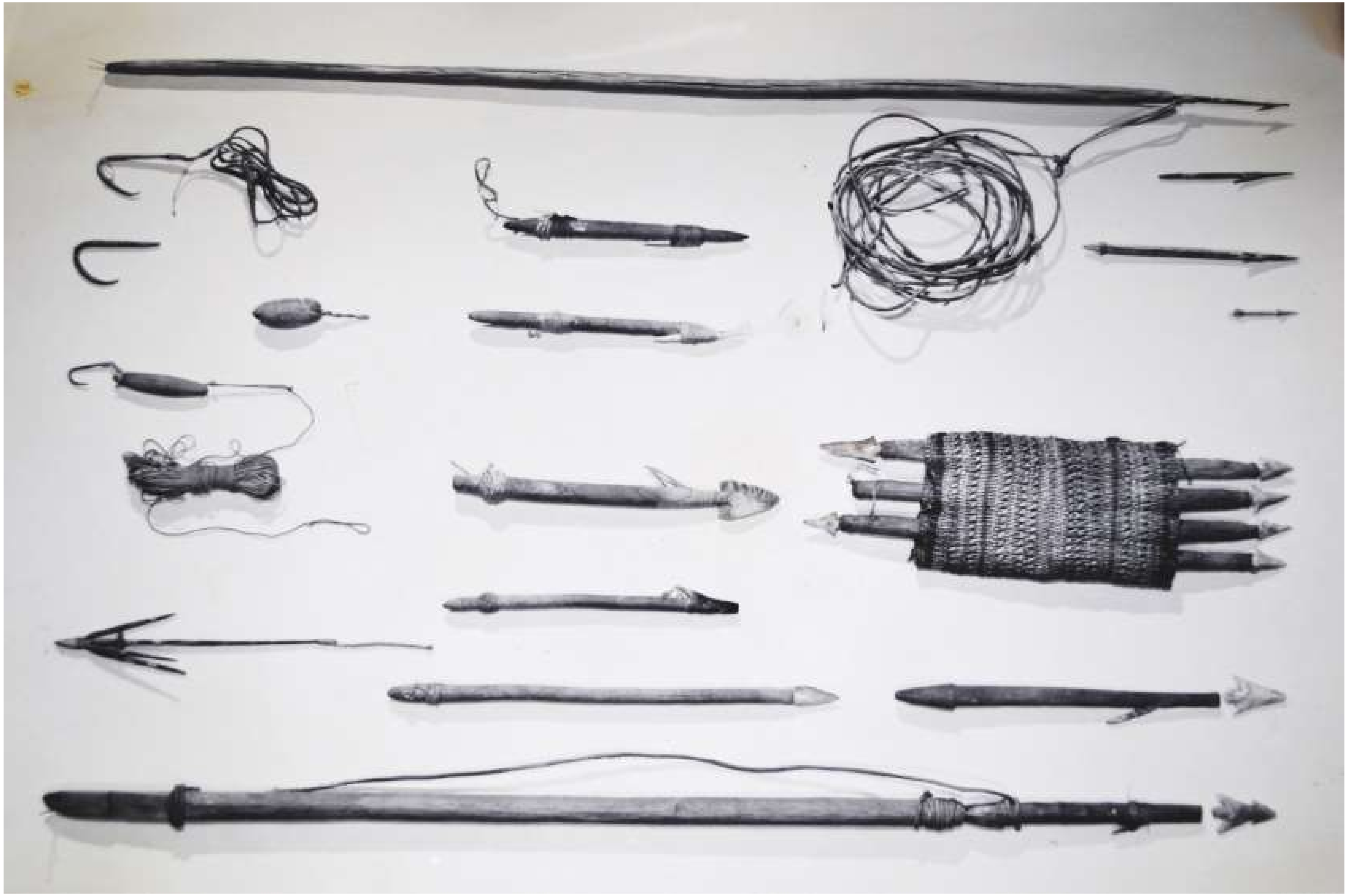


Figure 4.4: Selection of items found by Bird at Playa de los Gringos, Arica, in 1941. Assortment of harpoons, forepieces, quiver, points, lines, lures and hooks. From Bird, 1941 diary and notes – Volume II. **Courtesy AMNH.**

Figure 4.5: Detachable composite copper points, Bandelier Collection, Caleta Vitor. Note sea-lion hide cord on right.
Photo: C. Carter, courtesy AMNH #B4471 (left), #B4477

Hook, line and sinker.

The use of a hook and line is a basic form of angling whereby fish are enticed to take either a baited hook or a hook designed to mimic a fish's natural food (a lure). Once a fish is hooked, it can be brought close enough to the shore or boat to be hauled from the water, speared, clubbed or netted. The most basic kit would comprise a length of line directly attached to a hook. A weight or sinker could be attached to enable the line to be cast further or to take the bait or lure deeper into the water. The size of the prey will be determined by the strength of both hook and line (Salls 1989).

Fishing lines were made from natural fibres including cotton (*Gossypium barbadense*.), a native species found in Peru and northern Chile. The fibres were spun and twisted to form a cord of the desired thickness and length. The evidence of their use has been found in the archaeological record in locations where conditions for good preservation exist (e.g., hyperarid environments) and take the form of complete lines, still attached to sinkers and/or hooks, through to fragments of spun or twisted threads. Spindle whorls were indicative of the spinning of fibres, both for textiles or thread. Bird (1943: 207) found whorls at Playa. He suggested that cotton was favoured for fishing line and that square section spindle whorls made out of whale bone or timber and associated with male burials may have been used for spinning such line. Heavier line was made from cut strips of green sea-lion hide and examples have been found near Arica (Bird 1941). While such line may have been used for attaching to harpoons, one example from Caleta Vitor had a large copper hook attached (AMNH #B4480, Bandelier collection).

Figure 4.6: Bone point, Arica. From Bird Collection
Courtesy AMNH (#5631)

In 1955 Anell compiled a history of fishing techniques and technology from the southern Pacific region. He suggested that the gorge was a pre-cursor to the modern fish hook. Gorges consisted of short, straight shafts of bone or wood with a line attached in the middle. A baited gorge would be swallowed by a fish and the angler would pull on the line causing the gorge to turn sideways and jam in the fish's throat (Anell 1955: 72). He went on to suggest that the gorge was more common in North America than South America (Anell 1955: 82).

Rick et al. (2001) claim that Daisy Cave contains the oldest evidence of hook and line fishing on the coast of North and South America. A range of dates between 12,700 and 8400 BP were obtained from samples of shell and charcoal. Thirty bone bi-points, or parts thereof, (gorges) were found between strata E to F. The lowest level containing one of the bone points was dated to 10,150 BP (Rick et al. 2001: 605).

Bird (1943) located a number of similar bone points at Arica and Punta Pichalo. "Among the items of uncertain use are a group of sharply pointed bone objects ... length five to seven centimeters, averaging 0.5 centimeters in diameter. They taper to sharp points at each end..." (Bird 1943: 263). This description accurately fits that of a gorge. Figure 4.6 is a photograph of one the bone points found by Bird at Arica.

Cactus fish-hooks are known from K4, a site in southern Peru a few kilometres to the north of the Ilo River (deFrance et al. 2009: 237). This site was occupied from the Middle to Late Archaic with an early date of 9290 – 8650 cal BP (charred wood, Beta135387). Other archaeological investigations have found shell fish hooks in numerous preceramic sites in northern Peru (Quilter and Stocker 1983).

In northern Chile, Bird (1941; 1943) collected hundreds of fish hooks from his excavations. At Quiani he found mussel (*choro*) shells hooks in the deepest (preceramic) sections (see Figure 3.2 for examples). These were replaced by thorn or cactus hooks in the later phases. Copper hooks were found in the later, ceramic phase, particularly at Playa Miller near Arica. In 2008 I assisted with the salvage excavation of a Chinchorro (Late Archaic Period) site in Arica and found both shell and cactus within similar units (see Figure 4.7 for examples of these hooks).

Shell hooks are shaped out of a disc cut from a mussel valve (generally *Choromytilus chorus*.). The basic shape is cut or chipped from the blank and the finished form filed smooth with a sharp point. Some examples have a notched shank to prevent the attached line from slipping off. It is not known how the cactus hooks were formed into shape. They may have been formed while the thorn was green or steamed to produce flexibility.

Figure 4.7: Hooks from Arica – cactus on left, single shell hook on right.

Composite hooks are made from stone or bone with a point formed from a sharpened bone lashed to one end (Bird 1943; Lavalleé et al. 2011: 345). Whale bone or basalt was formed (pecked and ground) into a 'cigar' shaped cylinder tapered at both ends, either round or oval in section. Notches were formed around each end to enable a line to be attached and to prevent slippage. Sinkers were also formed in this manner but basalt, not bone, would have been used for this purpose. A point, generally of bone, was fixed to one end with cotton whipping (to form the hook) and looped line to the other, to attach the main line. In some instances, hooks were attached by a line to be loosely suspended below the stone/bone shaft (see Figures 4.4 & 4.8-4.10). Bait could be affixed to a hook but these composite hooks appear more likely to be lures. Basalt is an ideal colour to mimic bait fish such as sardine or anchovy.

At Quebrada de los Burros, Lavallée et al. (2011) located a number of composite hook components including basalt and bone bodies and bone barbs/points. The earliest examples were dated between 8779 - 9427 cal BP (levels N5-N6). Shell (*C. chorus*) hook fragments were found in the upper level (N2) and dated between 6639 - 7506 cal BP.

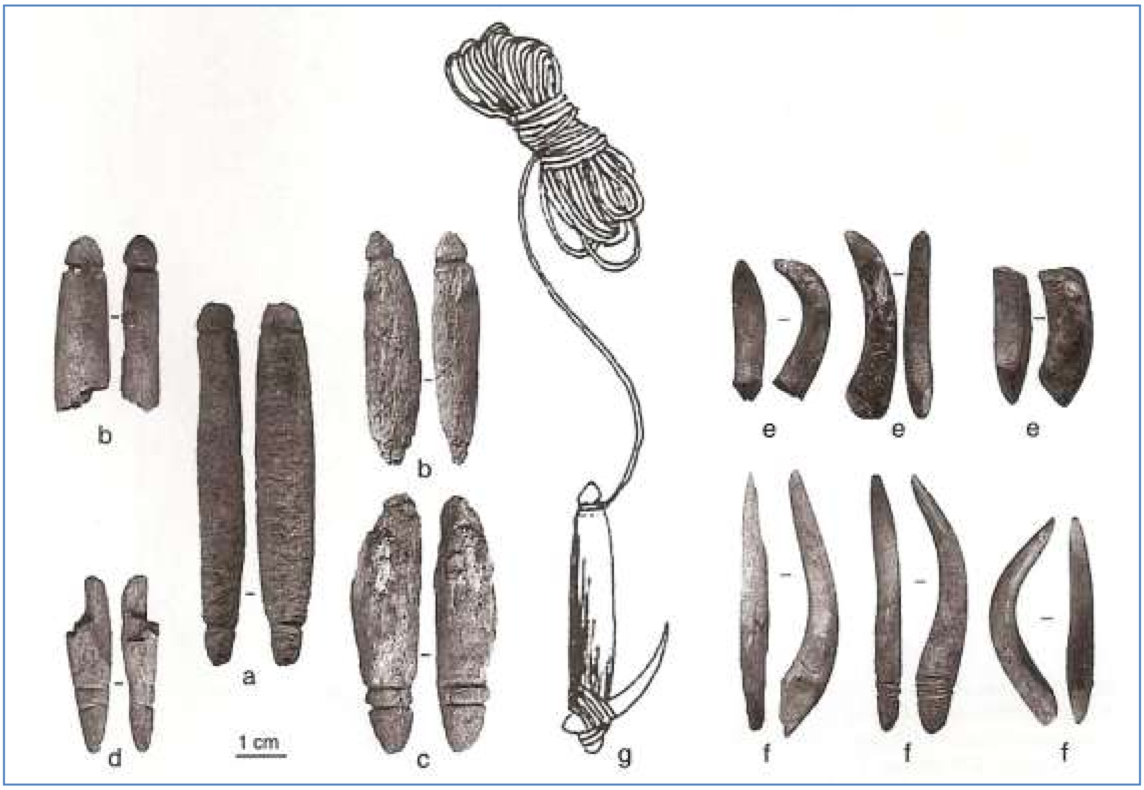


Figure 4.8: Fishing tackle located at Quebrada de Los Burros (from Lavallee et al. 2011)

a-d: Weights and body of composite hooks – bone and stone;
e: barb/point fragments of shell hooks (*C. chorus*);
f: points from composite bone/stone hooks;
g: model of composite hook and line.

Figure 4.8 depicts examples of fishing tackle from Quebrada de Los Burros. These date from the Archaic Period.

Fish hooks were an integral part of the Chinchorro tool-kit and included shell and cactus hooks as well as composite hooks and lures (Arriaza 1995a: 36). Following his excavations at Arica, Bird (1943) proposed that the preceramic period at Arica could be divided into two distinct phases – the Shell Fishhook Phase (Quani I) and the Cactus Fish-hook Phase (Quiani II). Mostny dated these phases to 6200 BP and 5600 BP respectively (Arriaza 1995: 38). Later investigations found that while this sequence may have been applicable at Quiani, other sites in the region (such as Acha 2 and Camarones 17) conflict with Bird's theory in a broader context. Acha 2 is located near Arica but several kilometres inland. The site contained the evidence of a camp consisting of a series of circular huts. Charcoal from a hearth was dated to 8950 BP and a burial dated to 9000 BP (Arriaza 1995: 41). Artefacts from Acha 2 typify a maritime economy and include cactus fish-hooks from the earliest levels.

Occupation of Abtao 1, near Antofagasta, central northern Chile (approximately 700 km south of Arica), has been dated to between 5350 and 3000 BP (Llagostera 1979: 315). Shell hooks were found in the lower levels (5350 - 4000 BP) but between 4000 - 3350 BP bone appeared to replace shell and the latest phase (3350 - 3000 BP) had only bone hooks. Llagostera suggested that a rise in water temperature may have pushed *C. chorus*. (the preferred shell for hook manufacture) southward, as a result of which bone eventually replaced shell for hook manufacture. In relation to the Arica region, Muñoz (2011: 470) argued that the development of the fish-hook was a fundamental factor related to the 'conquest of the sea'. Figures 4.9 and 4.10 are photographs of sinkers and lures found at Caleta Vitor during the 19th century.

Figure 4.9: Selection of sinkers and lures
Bandelier Collection - Caleta Vitor
Courtesy AMNH

Figure 4.10: Line, lure and copper hook
Bandelier Collection – Caleta Vitor
Courtesy AMNH.

Nets

Fishing nets take a variety of forms (Cushing 1988:11). 'Gill' nets are set either drifting along the surface suspended on floats or weighted to sit on the sea-bottom creating a curtain that [hopefully] fish will swim into and become enmeshed. 'Seine' nets are like a gill or drift net but are dragged by both ends toward the shore or onto a boat. Seine nets differ in their configuration so they can be used on the sea surface or dragged along the bottom. 'Cast' nets are generally circular and cast out, intending to cover the fish and a line is used to close the net with fish enclosed. 'Lift' nets are set in the water below an area where fish generally swim – either on the bottom or mid-water. After a desired interval a mechanical device, generally operated by a long lever, lifts the net, attached by a line at each corner, to the surface capturing the fish that are within the catch zone.

The use of nets implies the use of a relatively complex technology. The raw material, primarily cotton, must be secured to manufacture the cord or twine from which the net is woven. The construction of a net is in itself a sophisticated process. There is a need to design the net with its use in mind – either thrown, dragged or set - as well as the size of fish it is intended to catch.

Evidence for nets may consist of the net itself, net floats or net weights. In the late 1940s Junius Bird excavated a number of areas at Huaca Prieta and found a bundled fishing net complete with gourd floats (Hudson 2004: 586). The net itself was not directly dated but was found in a deposit dated to 4780-3225 BP. Local fisherman in northern Peru still occasionally use gourds as net floats.

Marcus et al. (1999: 6569) reported finding the remains of two types of net at Cerro Azul, central Peru. One was a circular cast net and the other a *cortina* or 'curtain' net, both were used primarily for sardines and anchovies but would, of course, capture any fish that strayed into their path. The remains at Cerro Azul date from the Late Intermediate Period.

Scoop nets could be used where fish mass in close proximity to the shore. Marcus (1987) was told by an older fisherman that at times schools of sardines would swarm into the bay at Huarco (Peru) and fishermen standing in waist deep water would simply scoop them out in nets or baskets. Circular cast nets are still in use today in that area but generally used from rock ledges.

The presence of large quantities of the remains of small fish, such as sardines and anchovies, has led to the inference that nets were used well into the past. Quantities of sardine and anchovy remains were located at Daisy Cave and dated to the late Pleistocene and early Holocene periods (Rick et al. 2001). CA-SBA-2057, an open site located on the Californian coast opposite the Channel Islands, has been dated to the early Holocene and contained large quantities of sardine and anchovy (Rick and Erlandson 2000: 621). Ethnohistoric records from that area describe the Chumash exploiting these species with nets. It was inferred that nets were in use at both Daisy Cave and CA-SBA-2057 from the earlier periods of occupation and continued through to the modern period.

A similar inference was drawn with evidence coming from Quebrada Tacahuay in southern Peru (Keefer et al. 1998; deFrance, 2001). The earliest date obtained was 12,860-12,460 cal BP (charcoal, Beta108692A). Sandweiss et al. (1998: 1830) found the remains of cordage that may have been from a net in deposit dated to the early Holocene. However, they inferred that netting fish had its origins far earlier. Layers dated to 12,794-12,515 cal BP (charcoal, BGS1937) contained a quantity of a single species of Sciaenid (*S. deliciosa*) with a mean [head to tail] length of only 170 mm (based on otolith size). As these fish were too small to be easily caught on hook and line, they inferred that nets were used in their capture. Reitz and

Reitz and Sandweiss (2001: 1095) reached a similar conclusion at Ostra Base Camp 1, a mid-Holocene site in central Peru, where they identified a significant number of *lisa* (mullet, *Mugilidae* spp.). Again, this species would have been difficult to catch using a hook and line (see also Harvey Koutts et al (2011) for Bandurria, Peru, where the remains small fish made up a substantial proportion of the assemblage).

Boats

The improvement of watercraft would have provided impetus for major change in a coastal economy. Not only did boats allow ease of movement along the coast, they provided access to an increased array of resources; not only new, deep-water species but also specimens larger than those that they were catching from the shore. Certain fishing techniques, e.g. trolling, can only be practised from boats. Without recourse to a rod and reel, it would be difficult to cast a line from the shore into areas which larger, pelagic species were likely to inhabit.

Indications for the earliest use of watercraft do not necessarily come from direct evidence. The antiquity of the use of water-craft as more than simple floats has been inferred through the arrival of the first inhabitants in islands. Australia and New Guinea have been occupied for at least 50,000 years and the first inhabitants had to negotiate sea crossing up to 70 km wide (Balme 2011; Erlandson 2001). Further evidence indicates that by 30,000 years ago modern humans had the ability to make sea crossings to the islands of Wallacea and to Sahul (Ono et al. 2009: 334). While not universally accepted, O'Connor et al.(2011) suggested evidence from Jerimalai shelter in East Timor indicated that the occupants were catching pelagic species (such as tuna) 42,000 years ago. Catching fish such as these was indicative of a complex marine technology and seafaring skills.

As mentioned, the earliest inferred use of boats in the Americas comes from evidence from the Channel Islands in California. San Miguel Island was at least 7 km off-shore when sites there were occupied over 12,000 years ago (Erlandson and Rick, 2002). Chert sourced on Santa Cruz Island was found on San Miguel Island which indicated that the early inhabitants had the ability to cross relatively broad stretches of water.

In 1932 Lothrop provided a good description of traditional water-craft used along the west coast of South America. In that he described a range of vessels including dug-out canoes, log rafts, reed rafts, seal hide floats, sewn plank canoes and sewn bark canoes. Dugout canoes are still in use in the rivers of South America but did not appear to be used in great number along the Peruvian or Chilean coast – probably because of the lack of trees suitable for their construction. In the south of Chile, the Araucanians used dugout canoes but their use did not extend north beyond Valparaiso.

Balsa rafts were used in the north of Peru and were large enough to be used for coastal trading (Lothrop 1932: 237; Berenguer 2008: 94). In Chile, where timber was scarce, cacti were strapped together for flotation (Lothrop 1932: 237). Tortora reed rafts were the main watercraft used throughout Peru (they are still in use today), although they have been noted in Colombia and northern Chile. Known as *caballitos* (ponies), they were simple bundles of reed lashed together and ridden astride like a surfboard (Lothrop 1932: 238).

Evidence of the use of watercraft in northern Chile during the prehistoric period comes from both direct and indirect evidence. A model of a reed raft found with funerary remains near the mouth of the Rio Loa was dated to around 215 AD (Berenguer 2008: 94). Llagostera (1990) found that a species of deep-water fish, the *congrio* (*Genyopterus* spp.), did not appear in midden deposits at Punta Blanca (130 km south of the Rio Loa) until around 230 AD. He stated that this species was generally found in deep water, not easily captured from the shoreline and inferred that its appearance was an indicator of the use of boats or rafts. Coincidental to the appearance of this fish species was an increase in the abundance and size of shellfish which he also took as an indication of being able to travel to otherwise inaccessible shell beds.

A number of model rafts have been found in coastal cemeteries in southern Peru and northern Chile, with many coming from Arica (Nuñez, 1986: 27). In the early 19th century, Uhle stated that "*se usaban en esta costa balsas de palo, modelos de las cuales son communes en ultimos cementerios de Arica*" [log rafts were used along this coast, models of which are common in late cemeteries at Arica - my translation] (from Llagostera 1990: 39). Bird (1943) also found several model rafts in his excavations at Playa Miller, Quiani and Playa de Los Gringos. These included a model made of twigs bound together, one of bound corn cobs and several more elaborate models, one of which he described as follows:

> The two side pieces of the model balsa are thirty-six centimeters long, by nine centimeters wide, and six centimeters thick, and resemble in all details those of the smaller models. The deck surface is cut flat and is painted with red stripes. On the outer and bottom surfaces at each end deeply cut grooves serve to hold the lashings. (Bird 1943: 227; see Figure 4.11).

Bird also found miniature double ended paddles in association with some of the model rafts. These too were painted red or had blades decorated with red stripes.

The majority of these models correspond to the period 1000 - 1450 AD (Llagostera 1990: 39). Similar rafts are still in use today in northern Chile and southern Peru. They consist of three to five logs lashed together, the central log being the longest (acting as a centre board) with shorter logs lashed to either side ((Llagostera 1990: 39). Known as *chinchorros,* they are primarily used to set nets from the beach (Zaro 2007: 172; pers. obs.).

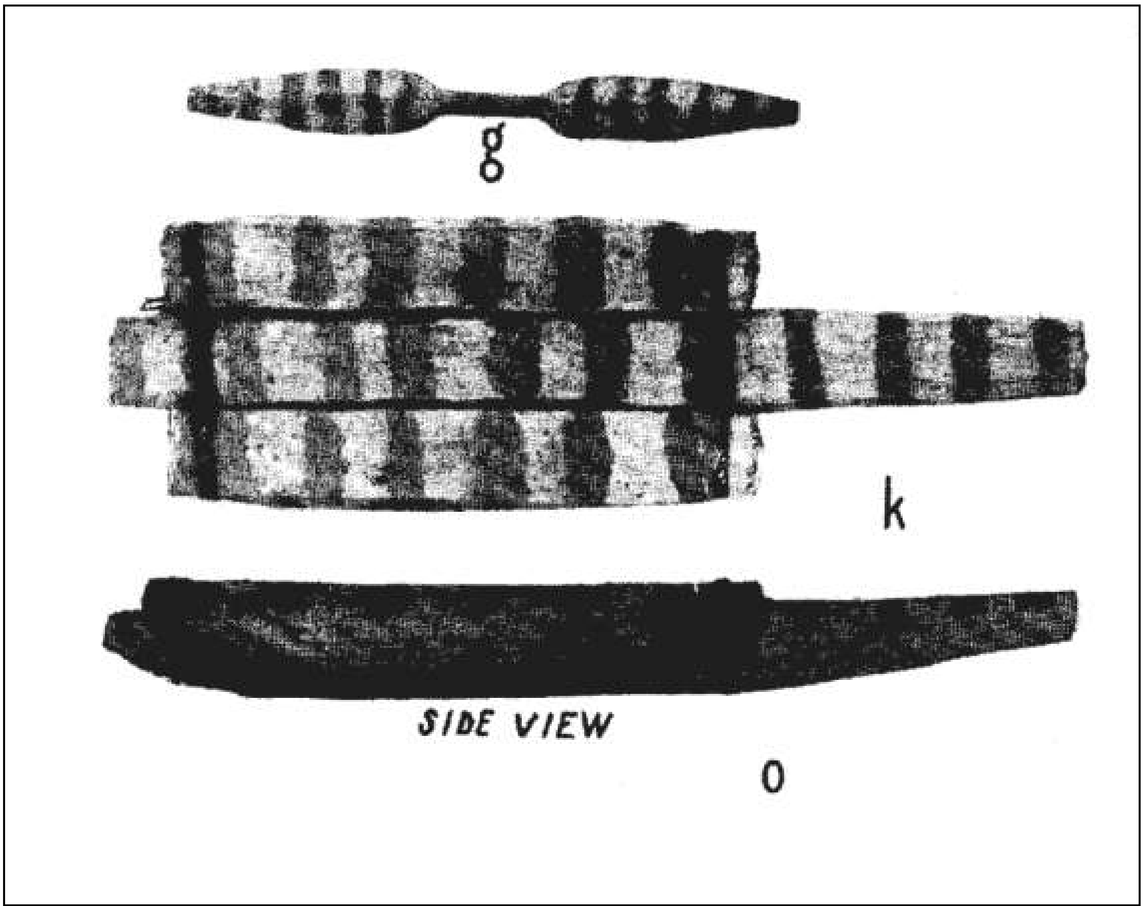


Figure 4.11: Model raft associated with burial at Playa Miller, Arica.
From Bird, 1943: 214

A traditional vessel which appeared to be unique to northern Chile was constructed out of sea-lion hide floats (Lothrop 1932: 241). This type of raft was common between Arica and Coquimbo and it was historically recorded in 1558 (Vivar in Berenguer 2008).

The following provides a detailed description:

> The floats consist of two great pouches, each two or three metres long, with the ends pointed and curved slightly upwards ... Each pouch is made of four or more male seal skins. These skins are allowed to soak in fresh water until they become soft. They are then cut to the required size and sewn together with sinew or with a thread made from the dried and twisted intestines of

> the same amphibian. They leave open part of an upper seam and thereupon proceed to fill the bag with sand until it becomes fully distended. Sometimes they employ reeds instead of sand. Once the bag is full, they allow it to dry in the sun, until the hide becomes hard, stiff and distended. They take out the sand and the bag retains its shape. The hole left to remove the sand is sewn up, and then they coat all the seams with grease or fat from the same animal to keep out the water. Afterwards they make a thick paint of red clay, mixed with grease and oil until it assumes a semi-liquid consistency. With this they paint the bag all over two or three times, thus forming a completely impermeable layer. (Lothrop 1932: 242).

Frezier (1717: 109) not only provided a good description of this type of raft along with an illustration showing the construction techniques (see Figure 4.12). These devises were used up to the 19th century in several ports of northern Chile for fishing, transportation of goods and passengers, and to load saltpeter to transoceanic ships (Paez 1986). Lothrop saw the rotted remains of one of these rafts just north of Coquimbo (central northern Chile) in 1929. While he was there he met two men who were believed to the last to have the skills to make them. Despite paying them an agreed sum, Lothrop's efforts to have them build a raft proved fruitless.

William Carter served as an assistant ship's surgeon from 1829 to 1832 aboard the *HMS Seringapatam* based at Rio de Janeiro (Pitt Rivers Museum archive). One voyage took him along the west coast of South America. His legacy was a series of paintings from his time in the region. One such painting depicts a sailor on an inflatable hide raft. It is annotated 'Balsa de Chili – Arica'. It was described as a raft 'made of bullock hide' (see

Figure 4.13). (Pitt Rivers Museum, #1933.53.23). This may have been a simple error and the raft may have been made with sea lion hides. However, if the notation is correct, it indicates that the local people were able to adapt their boat-building skills and used bullock hides in place of the traditional skins.

The most common evidence of the use of this type of vessel has been found in rock art. In northern Chile there are at least ten sites with examples of a manned sea-lion raft, including several that are over 100 km from the coast (Cabello and Gallardo 2014: 12). They suggested that examples of this manned vessel were one of three iconic rock art motifs from the Formative Period (4000-1500 BP).

The other two iconic motifs were an anthropomorphic figure with a dentate head-dress and a bird with extended wings. Cabello and Gallardo (2014) based much of their findings on Tamentica, a rock art site in inland northern Chile in the Quebrada de Guatacondo. There they reported a total of 445 motifs with fifteen depicting the sea-lion raft. Figure 4.14 contains photographs of several of these figures. Figure in B and D show a person in the act of spearing fish from the raft. Figure D depicts a spear/harpoon attached to a line that would allow the fish to be hauled in after it had been speared.

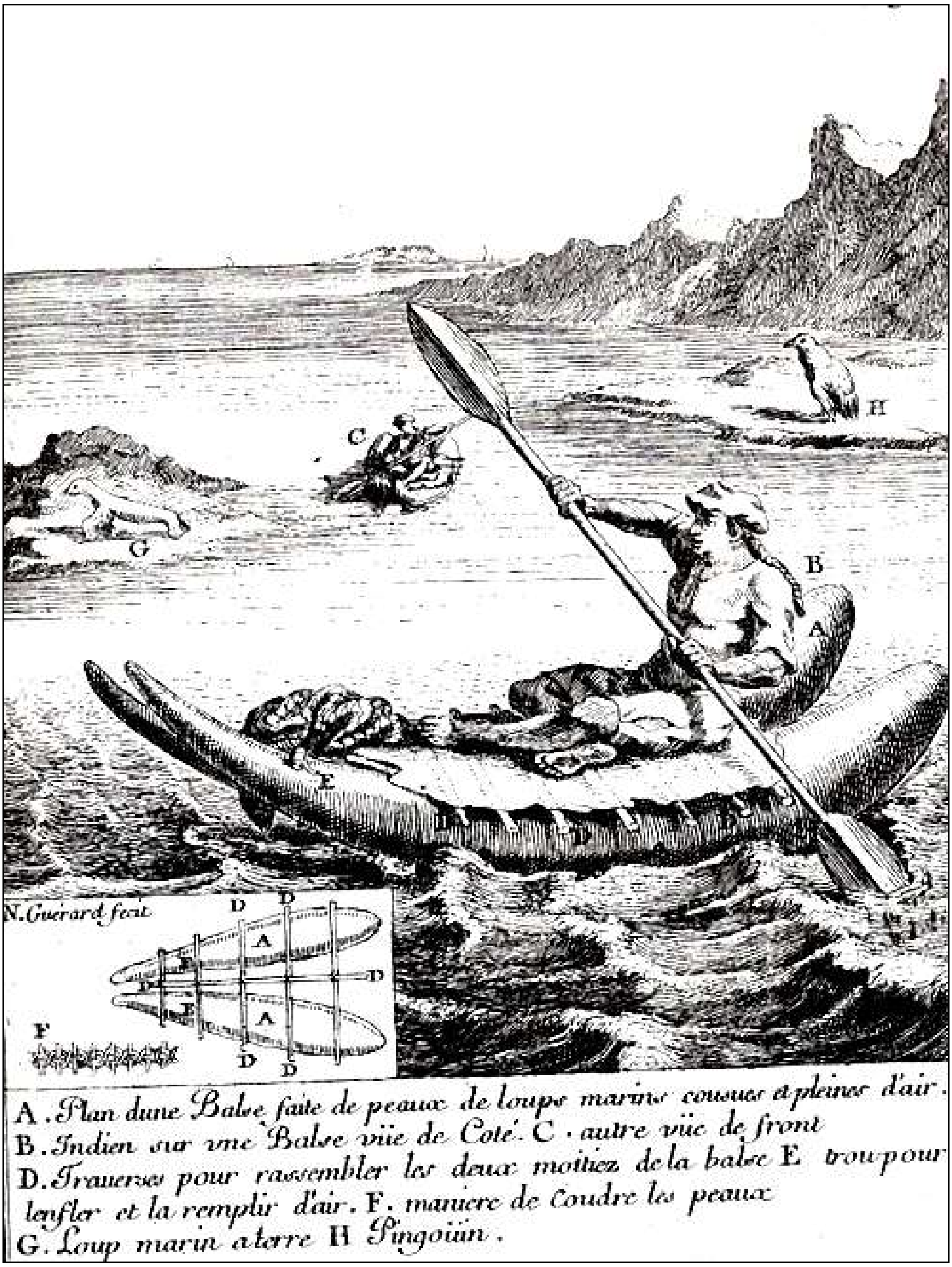


Figure Error! No text of specified style in document.**4.12: 18th century drawing of sea lion hide raft.**
From Frezier, 1717.

Archaeological investigations have recovered partial remains of this type of raft at several sites in northern Chile, including Bajo Molle, Caleta Huelen-23, Caleta Vitor and Abtao-5 (Berenguer 2008: 36). The remains from Caleta Vitor also included a *copuna*, a tube made from a pelican long bone used to inflate the float when required (described by Vivar 1558, from Berenguer 2008). The oldest known remains are those from Abtao-5, found in association with ceramics dated between 400 and 700 AD.

Figure 4.13: 19th century painting of 'bullock hide' raft, Arica.
Courtesy Pitt Rivers Museum, Oxford.

The sea-lion hide raft appeared to have been a common vessel along this section of the coast. The lack of suitable local timber that could have been used in boat construction is likely to be the main reason for this.

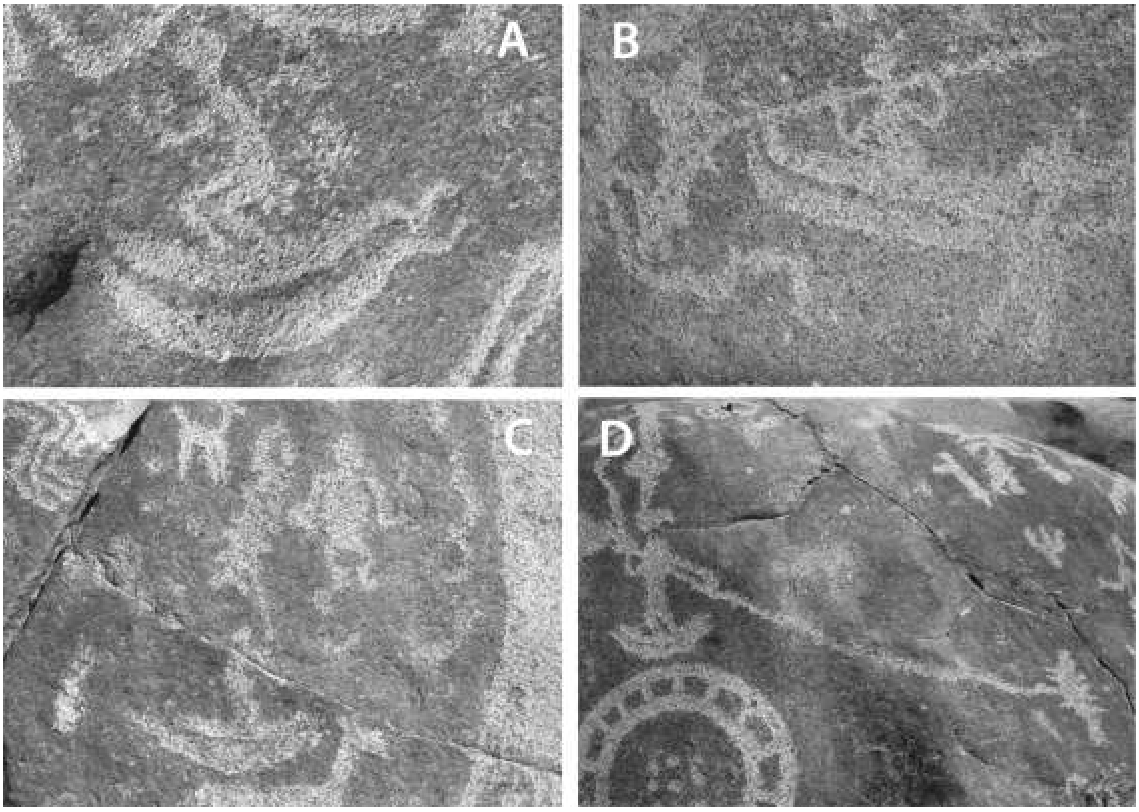


Figure 4.14: Examples of sea-lion raft. Rock art motifs from Tamentica, northern Chile. From Cabello & Gallardo 2014: 19

Management of Resources

The management of a marine based economy is far different than that of an agricultural or pastoral economy that is based on manufacture or the extraction of raw materials. Farmers either own their own tract of land or communally work an area. Manufacturers are based in a particular locale. Miners extract ores from specific places within the ground. These are areas that can be owned and controlled (either individually, communally or via a designated authority). Land that supports an economy has value, with some areas gaining more value than others. This may lead to the need for protection or defences. Whatever the case, many of these factors can be managed or controlled.

A marine based economy is supported by common-pool resources – fish and shellfish are not 'owned' by those fishing an area although 'ownership' may be considered to have occurred once the animal had been harvested. The nature of the ocean and its shorelines is such that it is not necessarily 'owned' by an individual or controlled by a group. Access can be controlled to some degree, particularly on or near-shore activities but once moving off-shore, control is far more difficult, if not impossible, particularly without access to fleets of watercraft.

Terrestrial economies are more often than not based on or over a specific area. Specific areas of land are tilled, crops grown and then harvested. Animals are grazed on plots of land, both controlled and broad-scale. Such commodities can be observed and managed. This is not the case with fisheries. Until aquaculture was developed, marine based commodities could not be observed nor recorded until after harvest. Resource stock flow in a fishery is often uncertain (Dolšak and Ostrom 2003: 9). Furthermore, once a quantity of fish or shellfish has been removed from the resource base, it is impossible to know what impact that has on future returns. A well-developed knowledge base built on years of experience may have allowed fishermen to forecast the nature and possible size of the catch and recruitment/replenishment regimes but the results were never assured.

In the recent past fishery management practices have been developed in many countries in order to prevent over-exploitation and control a sustainable resource. Management of marine resources can include the practice of limiting when (seasonal closures of certain areas); where (creation of marine reserves or defining specific commercial and recreational fishing zones); how (banning of certain techniques or limiting number of devices); what (protecting specific species); how big (introduction of minimum/maximum sizes); and how many (introduction of bag limits) animals can be taken. Such practices can be either proscribed or prescribed.

It has been argued that over-exploitation of marine resources has been detected in the archaeological record including in areas of Oceania, California, Alaska and Peru (Goodwin 1990: 95-96; Mannino and Thomas 2002). Criteria that may indicate over-exploitation within a midden deposit include:

- absolute abundance of preferred species will decrease through time;
- mean shell size will decrease through samples taken from the bottom of a midden to the top;
- mean or modal shell size of the archaeological samples of a species will be significantly smaller than in a non-exploited population;
- less easily procured and processed species will increase in number through a midden (Mannino and Thomas 2002).

To prevent over-exploitation, early management practices may have developed informally by interested parties to protect their own reserves and in response to observed anomalies in the resource base. This may have included a restriction on the removal of juvenile specimens; restricting the number of specimens collected from any one location or simply progressing from one gathering point to another to allow an area to 'rest' and, hopefully, repopulate between collections.

Such management practices are simple and could have been applied in the prehistoric period. However, recognising such a response within the archaeological record may be a difficult task.

* * *

The range and diversity of artefacts associated with a maritime economy clearly demonstrates its complexity. This relates not only to the design and manufacture of individual items but also the strategies that were developed to utilise them. Such strategies relied on the skills of the individual but are also indicative of co-operative efforts and information exchange.

The following chapters focus on the specific results of the archaeological investigation across a number of sites located at Caleta Vitor. This and the preceding chapters provide background for the site descriptions and analysis that follows. Further contextual material will be introduced at relevant points within that discussion.

Chapter Five

> *"... approached from the sea, barren, undulating and broken land is seen, and in its rear ranges of sterile mountains and, farther to the east, the icy peaks of the Andes, towering majestically above all. ... All around is a desert save where a streamlet may run, giving rise to a vegetation."* (Bollaert 1854: 133)

Site Description

Caleta Vitor is located on the coast of northern Chile (18°45'09.94"S 70°20'08.65"W) 29km due south of Arica (see Figure 1, Introduction). The site is located at the mouth of the Quebrada de Vitor[1], a relatively narrow, steep-sided valley running from the Andes in the east to finally cut through the Coastal Cordillera to meet the sea. The *pampa* or plain to the rear (east) of the Coastal Cordillera has altitude of approximately 750 m ASL. The stream bed is generally dry but may flood after heavy rain in the Andes. Several springs (barely seeping water today) are visible on the *quebrada* sides approximately 20 km inland and native grasses grow in their vicinity. The stream bed cuts through an alluvial valley floor with some natural terraces bordering it. Vegetation is mainly limited to the valley floor, adjacent to the stream bed. The coast is generally bounded by high cliffs (700-1000 m ASL) to the north (continuous to Arica) and south of the *caleta* (cove) (continuous to Caleta Camarones). Access on foot along the littoral appears very difficult to the south however there are sections to the north that have a narrow terrace or platform along the cliff base. Figure 5.1 is an aerial photograph of Quebrada Vitor, where it incises the Coastal Cordillera

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[1] This *quebrada* is known as both Quebrada Chaca and Quebrada de Vitor. Quebrada de Vitor has been used herein.

to meet the sea. Note the high, steep cliffs to the north and south of the cove.

Figure 5.1: Aerial view east toward the Quebrada de Vitor and Caleta Vitor
Photo: C. Carter

Surface water is rarely found in the coastal section of the valley. A lagoon is located at the northern end of the beach and contains alluvium washed in by the stream. Dense stands of trees and shrubs flank the lagoon. A 'Google Earth' image dated 2004 showed standing water in a lagoon; in 2010, during the field season, this area was moist and muddy in parts; in July 2012, the lagoon contained water again and the river had breached the sand bar to enter the sea not long previously (see Figured 5.2 and 5.3).

The northern end of the beach contains evidence of copper mining, ore processing and waste dumps. Mining continues today in several locations a few kilometres inland along the flanks of the *quebrada*. Irrigation agriculture is practised along the valley floor with water pumped from subterranean sources.

The beach is approximately 1 km long by 370 m at its widest point. It is bordered to the east by a shallow ignimbrite shelf that is for the most part covered with sand with only a few sections in the lower areas visible. The rear of the beach has been significantly altered through past naval activities and by campers in recent times. Exotic vegetation, including eucalyptus, casuarina and palms, grows along the rear of the beach along with native trees including *algarrobo (Prosopis* spp.*)* and *molle* (*Schinus molle*) Some native reeds and grasses also grow in this area. The shoreline has high energy wave action and waves break relatively close to the shore line from a steeply shelving sea-bed. The wave action is stronger along the northern end of the beach as the southern end is provided some shelter by the headland.

Figure 5.2: View south across the beach of Caleta Vitor.
Photo: C. Carter

Figure 5.3: Second view south across the beach of Caleta Vitor.
Photo: C. Carter

Based on wave formation, this section of the coast appears to be relatively deep close in-shore, with a narrow continental shelf. Bathymetric data[2] show that the beach shelves to a depth of 16m a short distance off-shore while soundings almost to the shoreline immediately west of Cabo Lobo (1 km south of Caleta Vitor) are 69 m BSL and the depth off Punta Pinto, to the north end of the beach, is 57 m BSL only a short distance off-shore.

Figure 5.3 is a photograph along the beach showing the vegetation at the rear of the beach and the lagoon that forms when the watercourse floods. The shelf that appears in the foreground is a dump from the ore processing plant that once operated on the slope above the beach.

[2] From chart no. 22205, 2nd ed. 1997, Arica to Mejillones, Chile; National Geospatial Intelligence Agency, USA.

The rocky shoreline continues from the northern end of the beach to Arica. A few sections of this shoreline can be accessed via pathways zig-zagging their way down the steep slopes but this section is not traversable at sea level along its entire length (Arriaza et al. 2001).

Precipitous cliffs are located at the southern end of the beach and three caves are located 8-15 m east of the shoreline approximately six metres above the ground level. The cliffs continue south for approximately 150m where they abut a narrow terrace backed by steep talus slopes. The terrace in this area is approximately 10 m ASL but is largely covered by talus. Very high cliffs (>800m) overlook this section of the coast.

Figure 5.4: View north-east from southern end of Caleta Vitor.
Photo: C. Carter

The shoreline from the southern end of the beach curves in a south-westerly direction for approximately 1km and provides some shelter from the south-westerly ocean swells. This section of the littoral is made up of scattered boulders which extend out from the shore approximately 40m. While washed by waves at high tide, the area is regularly accessed from the shoreline by amateur shellfish collectors and divers work the waters immediately beyond the rocky shore. As it is partially sheltered from the swells, a short pier has been constructed midway along this section. Local commercial fishermen sometimes off-load their catch at this point and sometimes spend the night in the shelter of the cove.

Wave surge increases near the southern end of the section and kelp beds are partially exposed at low tide. This section is traversable on foot for 850 m before terminating in sheer cliffs. A rocky ledge allows access along the coast for a further 100 m. This rock ledge is about 3-4 m above the HWM and the water immediately beyond the ledge is deep (>10m) and subject to wave surge but too deep for the waves to actually build up and break. Kelp beds grow from the rock-wall below the waterline. This is a favoured area for anglers today due to its close proximity to deep water.

A small cove (inaccessible on foot) is located south of this point and adjacent areas serve as a rookery for Peruvian boobies, Guanay cormorants, Chilean pelican, Inka terns and Humboldt Penguins. Sea lions and otters are also commonly seen in this area. The coastline is inaccessible on foot beyond the cove. The cliffs immediately to the south of this point are very high (>600 m). Based on observations made while flying over this section of the coast, there are very few places, if any, immediately south of the cove where the coast could be accessed other than by boat.

Cliffs continue inland immediately to the east of the caves at the southern end of the beach. They extend for some 150 m and flank a natural ‘theatre’ measuring approximately 190 m x 50 m. This feature is backed by steep slopes to a point 70 m ASL where a low escarpment breaks the slope part way up. A sandy slope sweeps down from this basin toward the rear of the beach. The lower slopes of this area have been significantly altered by earthworks and road construction. The 'theatre' is bordered to the east by the ignimbrite escarpment which forms the perimeter of the basin. This is a sloping area rising from near level on the valley floor to more than 40° at around 150m ASL. The highest peaks are some 800 m above the valley floor.

The valley floor is approximately 600 m wide at the rear of the beach. The soils in this area are sandy light grey to white with a gravelly matrix. The stream bed cuts through the valley floor to a depth ranging from 2 – 4 m. The stream bed ranges in width between 10 – 100 m. While much of the valley floor is under irrigation, with orchards of olive and avocado and crops of peas, beans, tomatoes, chilli and squash, there are stands of native vegetation in some areas. Native trees including *molle* [peppercorn] (*Schinus molle)* and *algarrobo* (*Prosopis* spp.) were noted. The use of mechanical pumps to draw water from wells and for irrigation has resulted in an expansion of the area available for farming. Several families now live in the Quebrada de Vitor with their houses intermittently spaced along the valley floor amongst their fields. Apart from the current farming community and the abandoned mine and mine works at the mouth of the *quebrada*, there is no evidence of Colonial or [non-military] historic occupation within the *quebrada* for some distance inland.

The northern flank of the *quebrada* is very steep and would be unassailable on foot along most of the slopes. The southern flank of the *quebrada* is not as steep as the north but very sandy. Faint traces of a trail (prehistoric in origin) can be seen following a gully and ridgeline out of the *quebrada* a short distance inland from the beach. This trail is marked by a line of stones along some sections. An attempt was made to trace the route of this trail but it was found to be discontinuous on the higher slopes due to landslips. It is likely to head south, parallel to and to the east of the coastal range and a continuation of the trail that connects Arica to Caleta Vitor from the north and also to the east of the coastal range.

While agriculture has been practised along the valley floor for many years, access to the beach has been limited. The land is under the control of the *Armada de Chile* (Chilean Navy). The area was once a naval training base and foundations of buildings are located across the rear of the beach and at the foot of the cliffs to the south. Cannon are located on both the northern and southern ends of the cove. The southern battery is located on a natural terrace that was cut and filled to accommodate the guns. The northern battery is located approximately 80 m ASL on a platform cut into the slope. Access roads were cut into the basal slopes or built up over the rear of the beach. A road was also constructed from the southern end of the beach and across the terrace at the base of the cliff. This required blasting to remove part of the cliff face and a track was cut into the talus slope above the terrace. Bunkers have also been built in some areas and a broad area used as a firing range is located on the southern flank of the valley immediately to the east of the beach. With the removal of the naval facilities in the 1990s, the beach was opened to public access and it has become a popular area for camping and recreational anglers.

Evidence of prehistoric occupation is clearly evident over much of the area flanking Caleta Vitor. Shell, bone, textiles, lithics and ceramics are common and strewn across much of the site. However, construction works and military activities have exposed much more material with burials being disturbed and stratified deposits up to 4 m deep being exposed along some sections of roadway. It appears that the majority of the naval installations were removed and the site graded after the military moved out about ten years ago.

An increased demand for arable land is a developing threat to the archaeological sites. Farmers are encroaching on former military lands and there have been recent discussions to make this land [lawfully] available to them (pers. com. Capitan C. Astorga - *Armada de Chile*). Farming activities in the area would have concealed or destroyed sites close to the stream or on adjacent terraces. Access to similar topographic units inland is limited as local residents are reluctant to allow archaeological surveys in the area.

Littoral Zones

The following provides a description of the Caleta Vitor littoral zone, dividing the area into potential resources sectors. Each sector was then scrutinised to determine skill levels and technology required to harvest resources. Figure 5.15 contains a map of Caleta Vitor marked with each littoral zone. Littoral zones are designated from A to E. The first zone (A) is located on the rocky shore to the north of the main beach and each sector is consecutively numbered to the south until the shore-line consists of sheer cliff and is impassable on foot. Zone descriptions are based on observations made during site visits between 2008 and 2012. Resources may have been exploited to the north and south of those included in this description but have not been included herein as these areas were not inspected.

Zone A – Narrow rocky littoral backed by steep cliffs.

This zone consists of a rocky shoreline which extends north from Punta Thompson (located at the northern end of the beach). Although difficult in places, the shoreline is accessible on foot for some distance (~1km). This area is a high energy shoreline and subjected to constant wave action. Although I have not witnessed any local storms, offshore weather events can generate large swells that impact the coast of northern Chile for extended periods. In August 2010 large swells (up to 7m) battered the Arica coastline for several days and damaged several buildings built close to the shoreline (pers. obs.).

The water rapidly increases in depth immediately off shore. Free-diving immediately offshore would have been dangerous due to turbulence and the water appears too deep for free-diving beyond the wash zone.

The nature of this section of the coastline is such that it may have been favoured by individual or small groups of males. It would have been too dangerous for family groups to forage around the rocks due to the frequent impact of large waves. Figures 5.5 and 5.6 are photographs of two areas of zone A. The rocks in the foreground of Figure 5.5, exposed and washed by the waves, were studded with large numbers of *quiton* and *lapa* when this photograph was taken.

Figure 5.5: - Zone A, view to north.
Photo: C. Carter

Figure 5.6: Zone A, small cove to north of Caleta Vitor
Photo: C. Carter

Zone B – Broad sandy beach with steep shore-line

The beach within this zone shelves rapidly to deep water. It is not considered a 'safe' swimming beach due to its depth, wave action and undercurrents (Capitan C. Astorga, pers. comm.). It is now a favoured spot for anglers who particularly seek *corvina* (*Cilus gilberti*) and *lenguado (Paralichthys microps).*

This is a high energy section of coast, particularly the northern portion of the beach. Due to deep water close in-shore, waves do not break far from shore but rather 'dump' before running a relatively short distance on to the sand. The wave wash zone is relatively steep. The beach is backed by a relatively broad (~350 m) expanse of sand with low dunes forming along its eastern fringe.

Marine avifauna (particularly Pelicaniformes: guanay cormorant (*Phalacrocax bougainvillii*), Peruvain booby (*Sula variegatata*) and brown pelican (*Pelecanus occidentalis*) are often seen feeding close to the beach, just beyond the wave line (pers.obs.). Their prey consists mainly of anchovies and sardines (Clupeidae). These prey species may sometimes swim inshore into the more turbulent, discoloured water to seek shelter from hunting birds and other predators. By doing so, they would bring themselves within the range of people fishing from the shoreline.

At times when the wave surge was minimal, the beach at Caleta Vitor may have been an area where families or groups could have worked together collecting bi-valves without putting younger children in danger. Groups may have also worked together to use nets to catch shoaling fish. The majority of the beach front would have proved difficult as a site for launching watercraft.

Figure 5.7: Zone B, view to north.
Photo: C. Carter.

Figure 5.8: Zone C, view to north-east.
Photo: C. Carter

Zone C – Narrow sandy littoral backed by steep cliff

The southern end of the beach is bounded by sand and loose rock which extends a relatively short distance beyond the tidal zone. The sea bottom beyond the rocks is sandy and becomes shallower to the south. The southernmost section of the beach and this area of rocks are less exposed than the areas to the north and wave size generally abates in this sector. See Figure 5.8.

Some mollusca (including small gastropods and *Fisurella* spp.) were noted in the inter-tidal zone. Species of rock crab (including *Geograpsus lividus*) are commonly encountered on rocks within the inter-tidal zone and sometimes slightly above it. The rocky littoral is also a favoured habitat of lava lizards (most likely *Tropidurus heterolepis*) which feed on invertebrates and algae along the shoreline.

For several days in July 2010, anglers (using handlines) concentrated on an area within this zone and caught large numbers of *lenguado* (*Paralichthys microps)* on the afternoon rising tide (pers. obs.). The anglers were fishing from the rocky shore but casting their baited hooks into areas with a sand bottom. Otters (*Lontra felina*) were often seen swimming within this sector and have been observed feeding on fish and crabs.

This zone was not entirely suitable for family groups to forage safely as waves do sometimes break over the rocks. It would be suitable for individuals who were line fishing or diving as the deeper water is some distance off-shore.

Zone D – rocky littoral backed by low terrace and high, steep cliffs.

This zone is similar to sector 3 although it is more sheltered toward the south and subjected to less wave action. The sea-bottom immediately offshore changes toward the south where it has a lesser depth gradient and becomes more broken with kelp beds evident. The inter-tidal zone is broader than sector 3 and rock-pools form during low tide. It is a more accessible rocky shoreline than sectors 1 or 3. A short pier is located mid-way along this sector. See Figures 5.9 and 5.10.

Small commercial fishing boats often moored overnight close to the shoreline within this sector and fished offshore during the day. Divers (both recreational and commercial) were observed working in this sector on several occasions during the field season. Mollusca harvested by these divers include *lapa* (*Fisurella* spp.), *loco* (*Concholepus concholepus*), *erizo* (Echinoderm - both *Loxechinus albus* and *Tetrapygus niger*), *piure* (*Pyura chilensis*)), octopus (*Octopus vulgaris*) and various fish species including *pintacha* (*Cheilodactylus variegatus*). Large quantities of shell remains scattered along sections of this shoreline adjacent to the pier suggest that *loco* and *herizo* were the most commonly harvested species in recent times.

This zone has a broad range of resources and micro-habitats. Family groups could have foraged around the intertidal rocks and rockpools without unduly endangering children. Individuals could engage in line fishing or diving. This sector is also the most suitable for the launching and landing of watercraft due to a reduced level of wave action.

This area could also be deemed to be a 'live' section of coast. Rock falls have been observed and exposed stratigraphy reveals repeated rocky layers that appear to be the result of minor avalanches. Figure 5.11 is a photograph of an exposed section of midden within this section. Note the alternating layers of scree.

Figure 5.9: Zone D, view to north from scree slope.
Photo: C. Carter

Figure 5.10: Zone D, view to south.
Photo: C. Carter

Figure 5.11: Section of midden exposed in Zone D. Note layers of scree
Photo: C. Carter

Zone E – rocky littoral backed by steep cliff

There is a profound change between zones D and E. The bench running along zone D terminates at a cliff with a narrow rock ledge continuing around the shore-line for approximately 150 m. The rock ledge is located about 4m above the highwater mark overlooking very deep water (>10m). The depth of the water results in less wave action however wave surges do affect the area.

This area may have been favoured by individual or small groups of males as it would be difficult for women with children to forage without placing either themselves or their children in danger of falling from the rock ledge or being washed off the lower rocks. Diving in this area would provide access to shellfish living within the intertidal zone however it is likely that the depth of water in this sector would have limited the available range. Line fishing would have provided access to deep-water, bottom dwelling species. The depth of water immediately off-shore may have provided access to pelagic species, particularly if berley was used to lure fish close to the shore line. Large species, such as shark, may have come within striking distance of fishermen armed with harpoons.

Kelp was observed growing just below the water line and could have been harvested relatively easily, other than at times when the sea was rough. When large swells impact this zone, lengths of kelp often become detached from the rocks and thrown ashore making this a resource that could be harvested from the shore at most times. In many coastal areas today kelp and other seaweeds are commercially harvested (pers. obs.). These products are sold in local markets as a dry bundle. Larger quantities are dried and baled for export by local processors who work within a multi-million dollar industry (Instituto de Fomento Pesquero, Chile).

Figure 5.12: View to east from Zone E across Zone D. Note scree slopes over Zone D. The white stains are recent guano deposits. Photo: C. Carter

Figure 5.13: Zone F, view to south showing sea caves
Photo: C. Carter.

Zone F – rocky littoral backed by steep, high cliff

The southern end of zone F terminates in steep cliffs and a sea-cave and is inaccessible on foot. A small sheltered cove is located approximately 150 m further south, beyond the sea-cave. A rocky point extends northward from the outer edge of this cove. The depth of water within the cove is sufficient to allow naval patrol boats to moor very close to the shore within the cove, in fact a mooring ring is attached to the rocks in this area. The area is flanked by cliffs over 700 m high. The rocky point and lower sections of the cliff are covered in guano deposit. Peruvian booby, guanay cormorant and red-legged cormorant were observed nesting in this area and appear to be the main species contributing to the guano deposit. Inka tern (*Larosterna inca*) were seen nesting within the sea cave. Pelican, Humboldt penguin (*Spheniscus humboldti*) and sea-lions have been observed on the rocky shore within this sector.

This zone is not accessible on foot but was most likely visited by small groups using boats or rafts to target specific resources (eg gathering guano, hunting sea-lion, raiding bird rookeries).

Figure 5.13 is a photograph taken from the southern end of zone E toward zone F. The cleft in the cliff on the left of the photograph contains an Inka tern rookery. A large cave is located just out of sight behind the cleft with the entrance to another cave to its right. Note the guano discolouring the cliff face and rocks. Also note the kelp growing on rocks immediately below the HWM. Figure 5.15 shows a juvenile Peruvian booby, obviously a contributor to the build-up of guano.

Figure 5.14: Juvenile Peruvian booby and guano deposits within Zone F
Photo: C. Carter

* * *

Habitat complexity correlates with high species diversity (Reitz and Wing 2008: 110). Despite its barren appearance, Caleta Vitor is made up of a varied and a relatively complex habitat. From the vegetation along the stream bed, the lagoon backing the beach, a sandy shoreline flanked to the north and south by a rocky littoral and is, in turn, bordered by areas of very deep water as well as a shallow, rocky inter-tidal zone along its southern zone. The species richness is thus expected to be far higher at Caleta Vitor than the areas immediately north and south of the *quebrada* making it a preferred locale for settlement, particularly due to the presence of water.

Survey Results

The archaeological sites at Caleta Vitor are expansive and cover an area of at least 350,000 sqm. Surface surveys were conducted to define concentrations or delimit areas within specific topographic units. The surveys of Caleta Vitor took place over several visits from 2008 to 2010. The survey area included the accessible shoreline around Caleta Vitor and continued inland along the floor of the *quebrada* for approximately 1km. A survey from the shoreline to the Pan-American Highway (20 km inland) was planned but local opposition prevented access to properties in that area.

The aim of the initial surveys was to establish the location and extent of archaeological material based on evidence visible on the ground surface, or sub-surface material visible as a result of disturbance or road-works. Once the location, nature and extent of archaeological material was recorded, the entire site was divided into individual sectors. The area surveyed was eventually divided into seven sectors delimited by either topographic features or arbitrary boundaries. Each sector was given the prefix 'CV' and numbered from one to eight. A hand-held GPS was used to record sector boundaries and locations of specific materials. It is highly likely that sectors contain overlapping archaeological features but for the sake of simplicity and efficiency, sector boundaries remain as part of an arbitrary landscape created by the recorder.

Figure 5.16 is a photograph taken from the northern flank of the *quebrada* showing the location of the archaeological sectors. CV7 does not appear in the photograph and is located above and behind the position from where the photograph was taken.

Figure 5.15: Base map of Caleta Vitor showing littoral zones (in red) and sector locations. Base Map: Google Earth, adapted by C. Carter

Figure 5.16: View to south across Caleta Vitor showing sector locations CV1-CV6.
Photo: C. Carter July 2012

The following contains a brief description of each sector:

CV1

This sector is located on the basal slopes of the southern flank of the valley approximately 350 m east of the current coastline. The slope ranges from gentle at the base to very steep (> 30°) along its upper boundary. It is bounded on the west by an ignimbrite escarpment overlooking CV2. The site covers an area of approximately 55,000 sqm[3] and is delimited elsewhere by archaeological material visible on the ground surface, including lithics, shell and bone. The ground surface is covered with coarse light grey sand with a scattering of gravel and stones that have rolled down from the cliffs above the slopes. The ground surface in some areas, particularly along the western

[3] Sector areas were measured using a Garmin Etrex GPS. The defined boundary of the sector was walked and areas calculated automatically.

flank, was particularly hard where salts (sodium and potassium nitrates, gypsum) in the soils had hardened after becoming damp.

High cliffs (>700 m) to the south overlook this sector. Access to the cliff tops may be possible via a shallow gully line running directly up the slope. Attempts were made to climb this slope but they failed as the ascent became too dangerous.

Figure 5.17: View to the north from upper area of CV1. CV2 is to the left of the rocks that border the escarpment. The mounds of CV3 are immediately to the left (west) of the road that passes through the middle of the photograph. CV4 includes the area containing the trees to the left of the photograph. Photo: C.Carter

The surface of this sector has been badly disturbed. Several bunkers are located adjacent to the escarpment on the western edge of the sector. There is evidence to suggest that these bunkers were created as gun emplacements. Pits occur across the site and may have also been excavated for military purposes. It has also been suggested that some may have been caused by explosives. A ‘geoglyph’ in the shape of an army tank outlined by stones is located on the slope, a further suggestion that this slope was used for target practice. Bullets are commonly found scattered across this section of the site. Vehicular tracks have also damaged parts of the ground surface.

Recreational 4WD vehicles and trail bikes have been observed in the area and the military have also used it for exercises in the recent past.

Prehistoric occupational debris can be seen across the entire sector. This includes shell, bone and lithic fragments. Sea lion, whale and human bone were noted. Lithic material is almost entirely made up of white chert flakes. Fragments of bifacial points were recorded but whole artefacts are rarely found on the surface. Two grind stones (lower parts) were also recorded. No ceramics or woven cotton textiles were recorded in this sector.

Concentrations of shell and bone were located in the vicinity of disturbed areas where previous excavation (non-archaeological) had uncovered *in situ* midden material. Stratified deposit over one metre deep was revealed in some areas of disturbance.

Several concentrated scatters of human bone were encountered during this survey. Human burials appear to have been disturbed by both military activities and looters[4]. One group of remains was located in a heavily disturbed area mid-way up the sector at an altitude of 68 m ASL [5]. Evidence of other burials was located further up the slope, at an altitude of 115m ASL (Chapter Seven contains a more details description of these burials).

The archaeological deposit within CV1 is likely to spill onto the river terrace. Shell, bone and lithic artefacts were noted in the lower section. However, for the purposes of this investigation, this sector was limited to the sloping areas south of the terrace. The terrace is utilised by local residents and was not surveyed in detail. Figure 5.17 is a photograph of this sector taken from the higher area with a view to the north.

[4] Looting has been a problem in the broader area for a very long period of time (see Aufderheide and Santoro, 1999: 24). In recent times Caleta Vitor has become popular with campers and anglers. Visitors have been observed walking over the site looking for 'interesting' items. On two occasions artefacts located during our survey where removed while the site was unattended. Several visitors asked if we had found 'gold'. Mummies were also found to be removed from their graves, some redeposited, others not.

[5] As measured by Garmin Etrex GPS.

CV2

CV2 is contained within a sloping, theatre-like basin on the southern flank of the valley immediately east of the current coastline. The site is located at the base of a steep, sandy slope with loose stones (up to 400 mm) scattered across the surface. Its eastern and southern perimeters are formed by an ignimbrite scarp. This sector covers an area of approximately 10,200 sqm. Loose sandy soils cover much of it, apart from those areas that have been altered in the more recent past. Figure 5.18 is a photograph of this sector.

Military installations, including artillery and concrete bunkers have exposed sections of stratified archaeological deposit over 2 m deep. A large portion of the slope had been mechanically cut and filled to form a base to install the cannon and provide access to the bunkers. The cut is approximately 2 m deep with a similar amount of fill deposited over the lower section. An access road runs along the northern border of this sector and has also cut into the lower section of the deposit again revealing stratified deposit. Figure 5.19 provides a good example of the archaeological deposit in this sector along with the type and extent of disturbance caused by military installations.

Artefactual material visible on the surface and within exposures includes shell, bone (including human remains), lithics, plant remains, ceramic and textiles. Burials and burial pits have been exposed through recent human action as well as by earth tremors.

Exposed stratified deposit is continuous across the sector – from the escarpment to the east to the cliffs to the west. The deposit within CV2 is likely to continue northward into CV4 however, the access road arbitrarily defines the northern boundary of this sector.

Figure 5.18: View to south toward CV2 from CV4
Photo: C. Carter

Figure 5.19: View to south-west across CV2.
Photo: C. Carter

CV3

This sector is not a natural feature and consists of a series of three, or possibly four, artificial mounds to the north of CV1 and to the east of the beach flat (CV4). The mounds are constructed from layers of reed and grasses, with some soil, and range between 2 m and 5 m high and up to 20 m in diameter. The mounds are in a line aligned roughly north-south along the termination of the floodplain. Figure 5.20 is a photograph of this sector.

Archaeological material is visible on the surface and includes shell, bone (including human remains) and lithics. The scatter of artefacts extends to the east onto the floodplain. Stratified deposit has been exposed through excavations (non-archaeological) in several locations around the mounds. These exposures indicate that what appears to be the natural ground level at the mound base is actually stratified archaeological deposit containing shell, bone and lithics.

Evidence of a number of burials has been recorded within the mounds. In 2008 part of a cranium was exposed and the team made attempts to cover and disguise its presence. In the following year a pit was found where this cranium was previously exposed. The cranium was most likely part of a textile wrapped mummy and removed by looters. Human bone from three other probable burials was located on the slopes of these mounds during the 2010 survey.

Visitors to the site have also been observed fossicking through the visible archaeological material of this area and dig up suspected artefacts. The main access road passes to the east of the mounds and the obvious nature of the archaeological remains attracts such visitors.

Figure 5.20: View to east toward CV3 from CV4. The mounds located centrally are artificial – marked with red arrows. Photo: C. Carter

CV4

This sector is a large expansive area immediately to the west of CV3 extending over 200,000 sqm from the high water mark to the western edge of the floodplain. It is flanked to the north by a lagoon and by CV2 (road) to the south. The area is covered with a layer of sand and low dunes. A lagoon has formed where the stream abuts the sea and a sandbank has formed to hold back water other than when the river is in flood. While damp in parts, the lagoon did not contain water during the 2010 field season but did so in 2012. A dense stand of shrubs surround the lagoon. Exotic trees including *Casuarina* spp. and *Eucalyptus* spp. are growing in the southern part of this sector. Grasses grow over much of the rear dune. Figure 5.21 is a photograph with a view across this sector.

This area has been disturbed by military activities which included the construction of several buildings (now demolished), a helicopter landing pad and access roads. The remains of a mineral processing plant are located at the base of the cliffs at the northern end of the beach. A waste dump from the plant covers an area immediately to the north of the lagoon. The rear of the beach and the wooded areas are popular with campers and disturbance continues. Those accessing the beach have created a number of vehicular tracks across this sector. As such, it is difficult to determine where the ground surface remains undisturbed.

Archaeological material is visible within surface exposures across the entire sector and includes shell, bone (non-human), lithics, ceramic and textile.

Figure 5.21: View from CV1 north across CV4. The mounds of CV3 are visible on the right of the photograph. CV7 is located adjacent to the track rising up the far slope. Note the vehicular tracks and remains of buildings in the mid-foreground (within CV4). Photo: C.Carter

Linear features over the flat area above the high water mark appear to have been made by grading the site, most likely when the navy left the area. Many artefacts (mainly ceramic fragments) have been deposited in rows along the edges of these lines.

An area along the eastern edge of CV3 appears has been graded in part and contains the remains (footings and floor) of modern buildings. Pits have also been excavated in several areas, perhaps for quarrying purposes. Apart from stratified midden deposit revealed in disturbed areas, survey also located the remains of 21 wooden posts, barely visible at ground level, within CV4 immediately below the mounds of CV3.

CV5

This sector is made up of a three caves/overhangs at the base of cliffs overlooking the ocean immediately to the south of the beach. The caves contain figures painted with red ochre with some archaeological deposit on the cave floor. Much of the art has been damaged by vandals and the cave has been polluted by recent use (the floor of the shelter is littered with faecal matter and toilet tissue). One small overhang is located approximately 30 m above the current ground level and is inaccessible without climbing equipment. Painted figures are visible within this overhang. Discernible images include humans, camelids, sea-lions and fish outlined in red/orange and white ochres. The cliffline of CV5 almost blocks passage along the shore from the beach to the southern rocky shore. There is evidence that sections of this cliff have been removed by blasting as drill cores identify where charges were placed during this process. Remains of road base indicate that the road once continued further around the cliff face.

The photograph in Figure 5.22 shows the caves in the cliff face.

Figure 5.22: View south toward CV5. Caves marked with red arrows.
Photo: C. Carter

CV6

This sector contains deep, broad midden deposit located approximately 20m from the rocky shoreline and almost continuous between CV5 and the southern end of the cove (limit of access on foot). This sector covers an area of approximately 15,000 sqm. The area is overlooked by high cliffs (>800 m) with a steep talus slope immediately above a low marine terrace sweeping around the shoreline. A track has been cut along part of this section of the coast and has exposed midden deposits exceeding four metres in depth in several locations. The talus slope is active with regular rock-falls observed. Debris from rockfalls covers the upper portion of this sector. In some areas only the exposed face of midden is accessible. As such it is not possible to determine the north/south dimensions of the deposit.

The only relatively clear surface area is located below a large rock outcrop that has protected an area of about 350 sqm. This area contains an exposed scatter of shell, bone and ceramics. The outcrop forms a shallow overhang. The base of two stone walls extend out from the base of the overhang and may have once formed part of a larger structure. Another structural feature was located about 50 m west of the outcrop. The cut made during road construction has exposed a number of large stones that appear to have been placed in a line to form the base of a structure or possibly a large fireplace.

Material visible within the midden includes shell, bone (including human remains), plant remains, lithics, ceramic and textile. Maize cobs are common across the disturbed surface of the midden, as are the remains of sea lions and fragments of whale bone. Several human burials were also noted in this area. The exposed deposit shows distinct layers of rockfall debris at varying intervals. Two panels of rock art were located at the base of the cliff at its junction with the talus slope. Each panel contained images of camelids executed in red/orange pigment. Figures 5.23, 5.24 and 5.25 contain photographs of this sector.

Figure 5.23: View to south-west along CV6.
Photo: C. Carter

Figure 5.24: Central section of CV6, view to east. Note modern disturbance in foreground and road cutting running from the pit down toward the shoreline. Photo: C. Carter

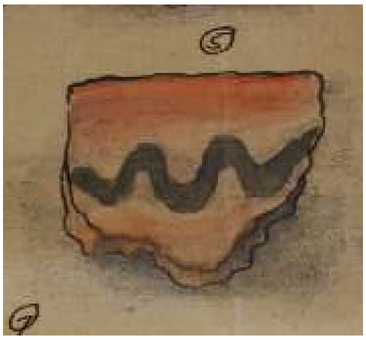
Figure 5.25: Central section of CV6. View showing midden deposit exposed by road cutting. Photo: C. Carter

CV7

This sector contains a shallow deposit (<1 m) of shell and bone and is located on the northern slope of the valley above a lateral gully approximately 300 m inland and 60 m ASL with views south along the beach and valley mouth. Archaeological material was exposed by roadworks and consists of a shallow deposit of shell, lithics and bone with a potential spread of at least 300 sqm. Human remains were also noted in the vicinity of the midden at the head of the adjacent shallow gully

Figure 5.26 is a photograph of this sector. Midden was exposed as a result of the road construction. Further disturbance to this area included the levelling of an area above the road for the installation of artillery.

Figure 5.26: View to south-east across CV7. Note exposure from road cutting. Gun emplacement is located above the road within levelled area at top of photograph. Photo: C. Carter



Chapter Six

> *"Thanks to the general dryness of the climate, and consequently favourable conditions for the preservation of fragile relics, the records of a vanished people are frequently found in so fresh a state as to add greatly to the interest of their collection."* (Evans 1906: 19)

Excavation

The purpose of my excavations was to retrieve archaeological material from stratigraphically intact deposit through as broad a temporal range as possible. With this aim in mind, trenches were generally restricted in area to 0.5 sqm (1000 mm x 500 mm). Individual trenches were spread across each sector of the site in an attempt to obtain data from as broad a range of settlement periods as possible. Selection was based on the results of the surface survey. The location of each trench was determined by its position within the sector and, where possible, trenches were located adjacent to areas that had been disturbed by earthworks (generally attributed to naval activities). This reduced the extent of disturbance and often enabled excavation to be carried out into a vertical. Both CV/1 and CV4 covered a large area and it was decided to excavate two trenches in these sectors to ascertain continuity or variation within the area. CV6 extended along a narrow section of the coastline. The variation in exposed midden profile resulted in two trenches being excavated in this sector. Trench location and altitude were recorded using a hand-held GPS.

Target data were acquired from midden deposit containing shell, bone and plant remains along with cultural material including (but not restricted to) lithics, ceramics, textiles, metal and wooden objects. Burials were not targeted but the remains of at least eight individuals were encountered during the excavations.

A total of twelve trenches were excavated across six of the eight designated sectors. A total area of 5.5 sqm was opened. Excavations were undertaken by hand following defined stratigraphic units in most cases. Such units were generally defined by changes in soil colour, density, texture and/or composition. Stratigraphic units included continuous layers across the trench through to small, discrete lenses. Units were consecutively numbered from the uppermost level (1) as they were exposed. Profiles shown in this report do not show discrete units that may have been removed completely during the excavation.

Trenches CV4/2, CV4/3, CV4/6 and CV6/2 did not display clear stratigraphy and were excavated in arbitrary 100mm or 50mm spits. Excavated material was sieved through a 1.7 mm screen. An unsieved soil sample of approximately 0.5 litres was taken from each stratum and bagged if required for future analysis. Natural stone and coarse gravel was removed from the sieves by hand and discarded. Obvious artefactual material was removed and bagged along with visible fragile items such as ceramic, textile and bone. All material remaining in the sieve was bagged for sorting which was completed off site. Table 6.1 summarises the extent of each trench. Samples from each trench were selected for radiocarbon dating. Table 6.4 at the end of this chapter contains a summary of samples, dates and details. Figure 6.1 contains a map showing trench locations.

Trench No	Number of units	Size (M)	Depth at Base	Basal Stratum
CV1/2	17	1.0x0.5	1.2	Bedrock
CV1/3	26	1.0x0.5	1.8	Bedrock
CV2/1	58	1.0x0.5	3.2	Deposit continues
CV3/1	31	1.0x0.5	1.8	Bedrock
CV4/1	19	1.0x0.5	0.8	Deposit continues
CV4/2[1]	5 (arbitrary)	1.0x0.5	0.5	Deposit continues
CV4/3	2 (arbitrary)	0.75x0.75	0.15	Deposit continues
CV4/6	10 (arbitrary)	1.0x0.5	1.0	Deposit continues
CV6/1	16	1.0x0.5	1.2	Deposit continues
CV6/2	5 (arbitrary)	1.0x0.5	0.5	Bedrock
CV6/3	6	1.0x0.5	0.6	Deposit continues
CV7/1	11	0.5x0.5	0.8	Sterile sand and loose rock

Table 6.1: Trench Summary

[1] CV4/2 and CV4/3 were test pits to ascertain the function of timber posts found in this sector. These two trenches both contained burials. Excavation did not continue beyond the skeletal remains

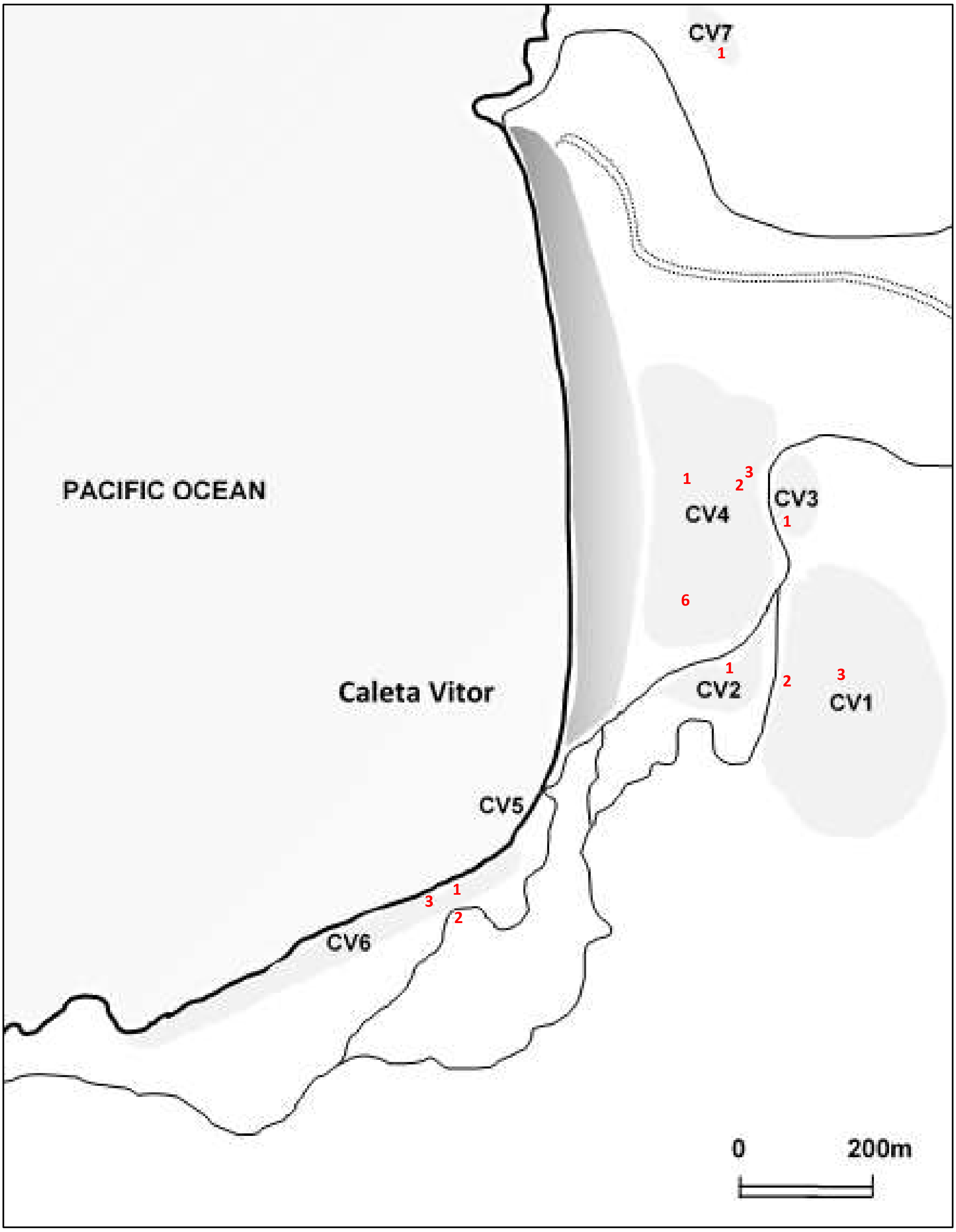


Figure: 6.1: Map of Caleta Vitor showing approximate trench locations within each sector (numbered in red). Drawn: C. Carter

Key to trench profiles

Light grey sand

Brown sandy soils (shades vary)

Humic soils (shades vary)

Reed mix

Vegetation/organic material

Ash

Shell concetrations

Gravels

Rock

Calcretion

CV1[2]

This sector consists of a broad area midden covering approximately 55,000 sqm. Disturbance most probably related to military activities revealed deep, stratified deposit in many areas. The areas selected for excavation were partially exposed as a result of this disturbance allowing archaeological excavation adjacent to an exposed face. CV1/2 was located mid-way up the lower slope and 15m east of the steep scarp which bounds the sector to the west (CV2). CV1/3 was also located mid-way up the lower slope, approximately 100m east of CV1/2. Figure 6.2 shows the location of the trenches in relation to the topography of the landscape. Evidence of occupation spreads well above the location of the trenches on to the steeply sloping area. CV2 was located within the collapsed 'theatre' (right of photograph) where an ignimbrite flow was forced up as it came against the harder rock of the coastal range.

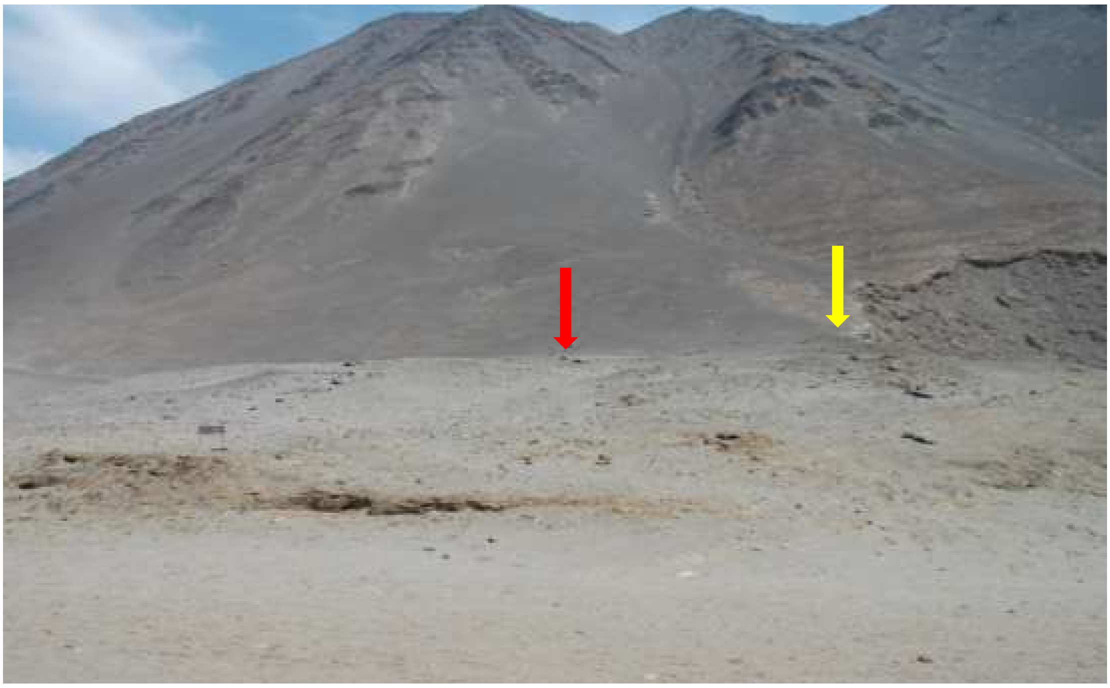


Figure 6.2: View south across CV1 showing trench locations.
Arrows mark trenches – Yellow - CV1/2 Red – CV1/3.
Photo: C. Carter

[2] Trench numbering: potential trench locations were identified and numbered during the surface survey. Not all identified locations were eventually selected for excavation; hence loci such as CV1/1 and CV4/4 (*inter alia*) were not excavated.

CV1/2

Location: 18°45.373'S 70°20'0.29"W Altitude: 27m ASL

Size: 1 000 x 500 mm

Description: Located on the edge of a pit which was possibly utilised as a bunker during military exercises. A total of 17 units were excavated to a depth of 1170 mm below natural ground level at the deepest point. The base was defined by bedrock (ignimbrite). Units were generally well defined, often separated by calcrete layers[3] which ranged from a thin crust up to 50 mm in thickness. Organic remains including shell and fish bone were common along with plant remains, predominantly consisting of reed, some of which may have been used as matting. Other identified bone included sea lion vertebrae and ribs.

Several layers showed evidence of burning with obvious charcoal lenses. No ceramic material was located in this trench. Short lengths of spun thread were found consistently throughout the trench although no woven material was found.

[3] Sands left exposed harden over time due to the reaction of natural salts and moisture (fog or dew).

Figure 6.3: Photograph of excavated trench - CV1/2.
West wall. Photo: C. Carter

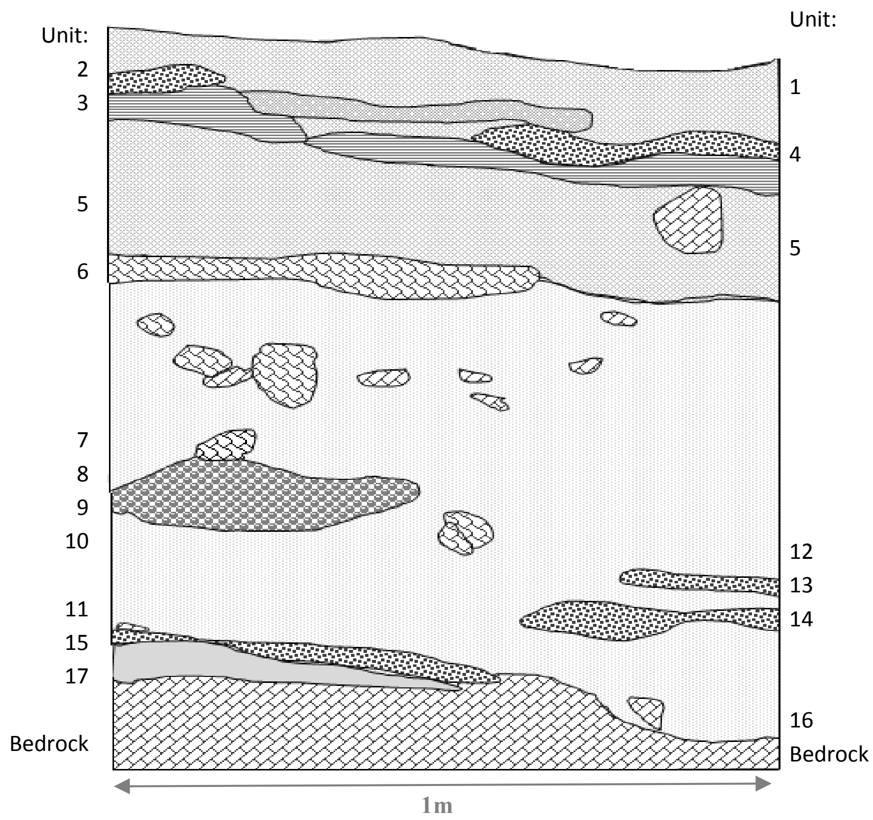


Figure 6.4: Trench profile - CV1/2.
West wall. Drawn: C. Carter

CV1/3

Location: 18°45'37.3"S 70°20'01.3"W   Altitude: 35m ASL

Size: 1 000 x 500 mm

Description: Located on the edge of a pit which was possibly utilised as a bunker during military exercises. A total of 26 units were excavated to a depth of 1800 mm below natural ground level at the deepest point. The base was defined by bedrock.

The upper six units were loosely packed and contained alternating layers of sandy material mixed with ash and organic material (shell, bone and plant remains) with some thin calcretions marking unit boundaries.

CV1/3 contained an anomaly at unit 10. Maize cobs were located in a cavity located beneath a calcrete layer (unit 9). This was regarded as anomalous as this section of the site was considered to be pre-ceramic and therefore should not have contained maize – an introduced agricultural crop. However, along with the maize, two rodent skeletons (recent) were located in a nest of feather and fur. The nest was intrusive and excavated (by the rodents) into the prehistoric deposit. The maize was likely to have been brought up by the animals from the field below.

Evidence of at least two human burials was located in this trench. Disarticulated human bone including a right radius, ulna and scapula were located in the north-east corner of the trench within unit 8 (420 mm below NGL). Loose sections of reed matting become visible toward the base of Unit 9 continuing into the rear (south) wall of the trench. Unit 10 revealed more of the matting along with an individual human femur. Unit 11 (840 mm below NGL) revealed the edge of an intact reed bundle with human bone visible within it. Unit 12 was excavated to a depth of 990 mm below NGL and the trench stepped northward. The reed wrapped human remains were left *in situ* and later reburied along with the loose, individual human bones. It is possible that the individual, loose bones were from an earlier burial that was disturbed (and disarticulated) when the bundled remains were interred.

Lower units were interspersed with hard, uneven calcrete layers that contained little or no organic or cultural material. Unit 19 consisted of a large (450 mm diameter) clump of consolidated soils and gravel (1650 mm below NGL). The basal layers contained some lithic artefacts and shell fragments.

No ceramics were located in this trench. Fragments of spun thread were found consistently through the trench although no woven material was found.

Figure 6.5: Composite photograph of excavated trench - CV1/2.
West wall. Photo: C. Carter

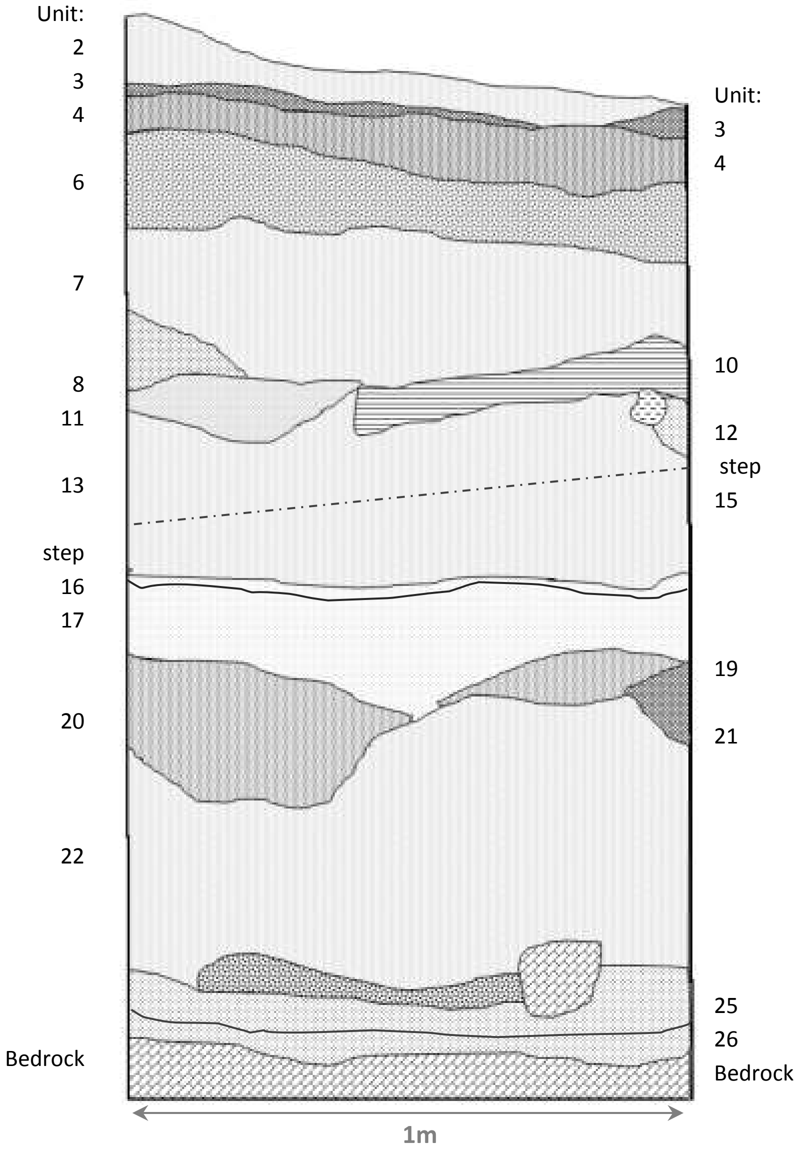


Figure 6.6: Trench profile - CV1/3.
South wall. Drawn: C. Carter

CV2

This site is contained within the 190 m wide naturally formed 'theatre' beneath an ignimbrite deposit at the base of cliffs on the southern flank of the *quebrada* approximately 200 m from the ocean. The surface area of this sector is approximately 10,200 sqm. The majority of this sector has been badly disturbed by earthworks related to road building and the installation of artillery. A large volume of material was previously removed from the central area of this sector to level an area for construction purposes. The lower portion of the sector was cut during the construction of the road that passes around the base of the slope and continues to the shoreline. The northern boundary between CV2 and CV4 was arbitrarily defined by the road.

Disturbance has exposed between one and two metres of stratified deposit along approximately 100 m of this sector. The area chosen for excavation was selected centrally within the sector with an exposed face that would allow easy excavation to a depth of over two metres. Human remains and burial chambers have been exposed by previous mechanical cuts through this sector.

Figure 6.7: View to east across CV2 showing approximate location of trench CV2/1

CV2/1

Location: 18°45'27.2"S 70°20'05.4"W Altitude: 19m ASL

Size: 1 000 x 500 mm

Description: This area of the deposit has exposed archaeological material up to 2 m deep. The area that was selected for excavation was adjacent to one bunker in the mid-section of the sector. One reason that this area was selected was that no burials were obvious in the immediate vicinity. The trench was excavated to a depth of 3.2 m through 58 identifiable stratigraphic units. The excavation was halted at this level due to safety concerns although cultural deposit appears to continue.

The upper units of this trench were distinctly layered with occupational debris including shell, bone, textile, lithics, bone (fish and mammal), feather, plant material (seed, reed and woody plant pieces) and charcoal lenses. Identifiable seed included *algarrobo*, *molle*, squash and cotton. No maize was identified in this trench. Camelid dung was found in unit 8.

The trench was stepped (to the north) at unit 25 to follow the slope of the section. Ceramic sherds were noted in upper levels and the lowest fragment was found in Unit 27. Figure 6.8 is a photograph of CV2/1 at the completion of the excavation. The ceramic/preceramic divide is marked with a yellow line. Through these chapters CV2/1 is commonly divided into CV2/1C (denoting the Ceramic Period – units 1-27) and CV2/1PC (denoting the Preceramic Period – units 28-58).

Unit 30 revealed two whale ribs lying side by side aligned approximately east-west. They appeared to continue to the east into the wall of the trench. In order to determine if the bones were part of a larger cache, the trench was extended to the east but the bones did not extend beyond the trench walls by more than a few millimetres. However, the trench extension did expose a burial chamber and a textile wrapped mummy bundle.

The grave containing the mummy had been previously disturbed and the mummy reburied – either intentionally or via natural means. A bow and six arrows were found in a group, placed upright alongside the bundle. Another burial chamber was located immediately to the east of the mummy. This chamber may have once contained a body but had since been refilled with loose material. An array of grave goods was located in the second chamber and included textile bags and wooden implements as well as fragments of sub-adult crania from at least two individuals. The human remains exposed during this excavation were reburied after the trench was completed.

Units containing occupational debris continued until the excavation was halted at unit 58. At that point excavation was not only difficult but also dangerous and shoring would have been necessary to continue. The lowest units contained shells (encrusted and fragile), fish bone and lithic artefacts.

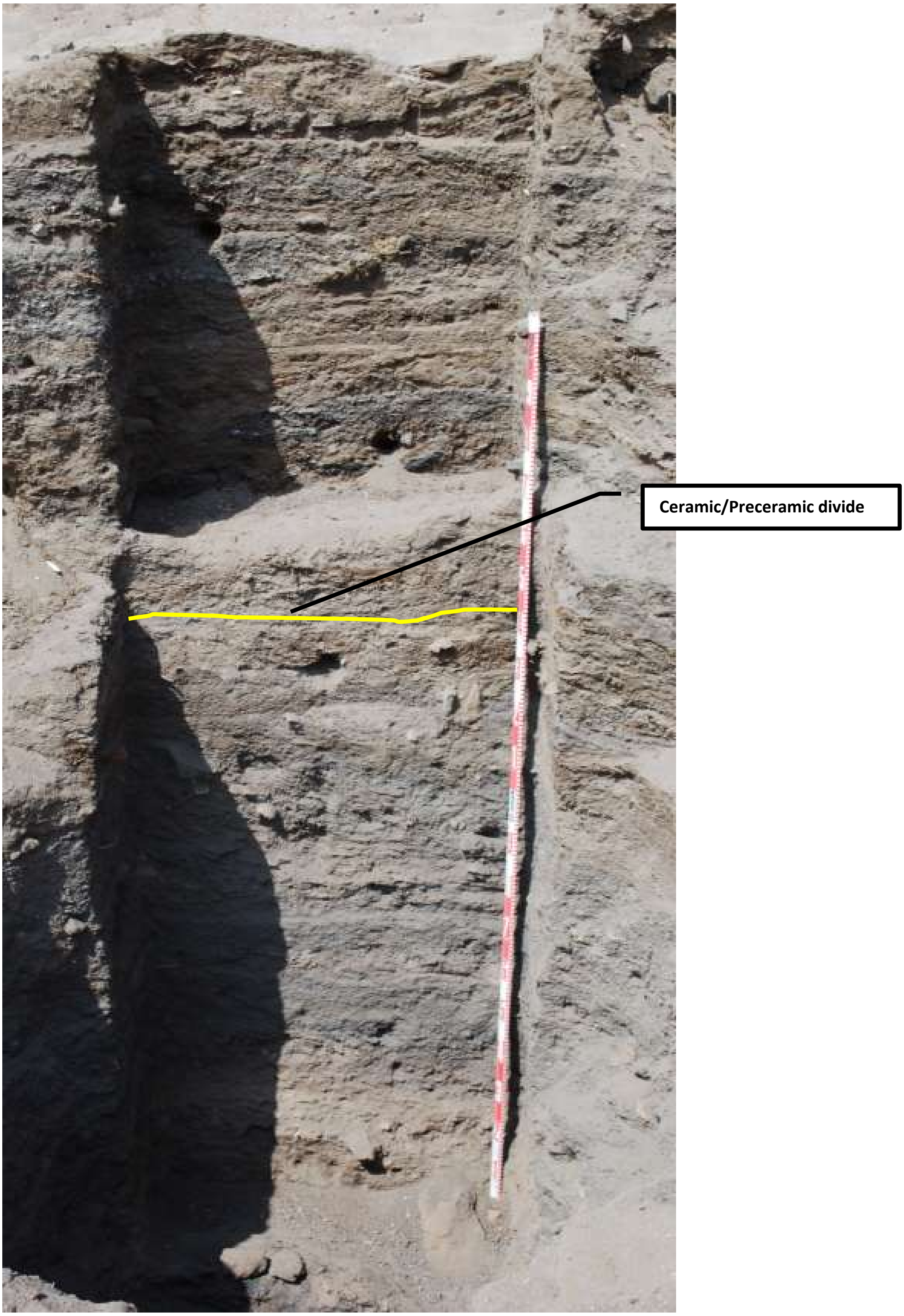


Figure 6.8: Photograph of excavated trench - CV2/1
Photo: C. Carter

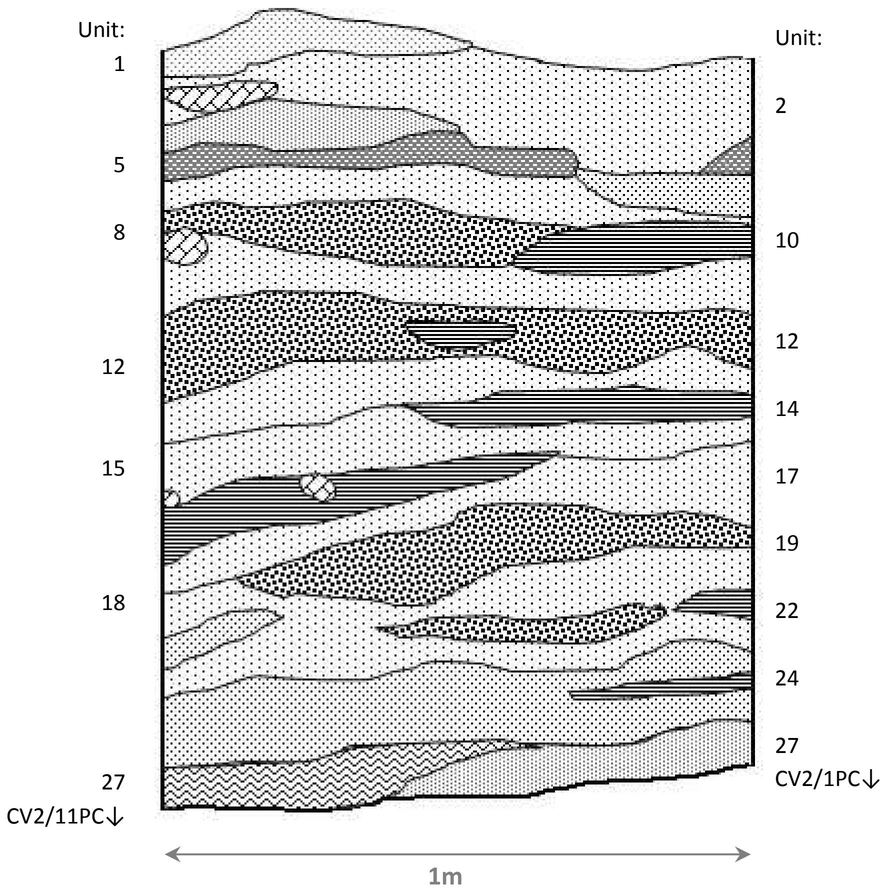


Figure 6.9: Trench profile of CV2/1C – Upper (Ceramic) units

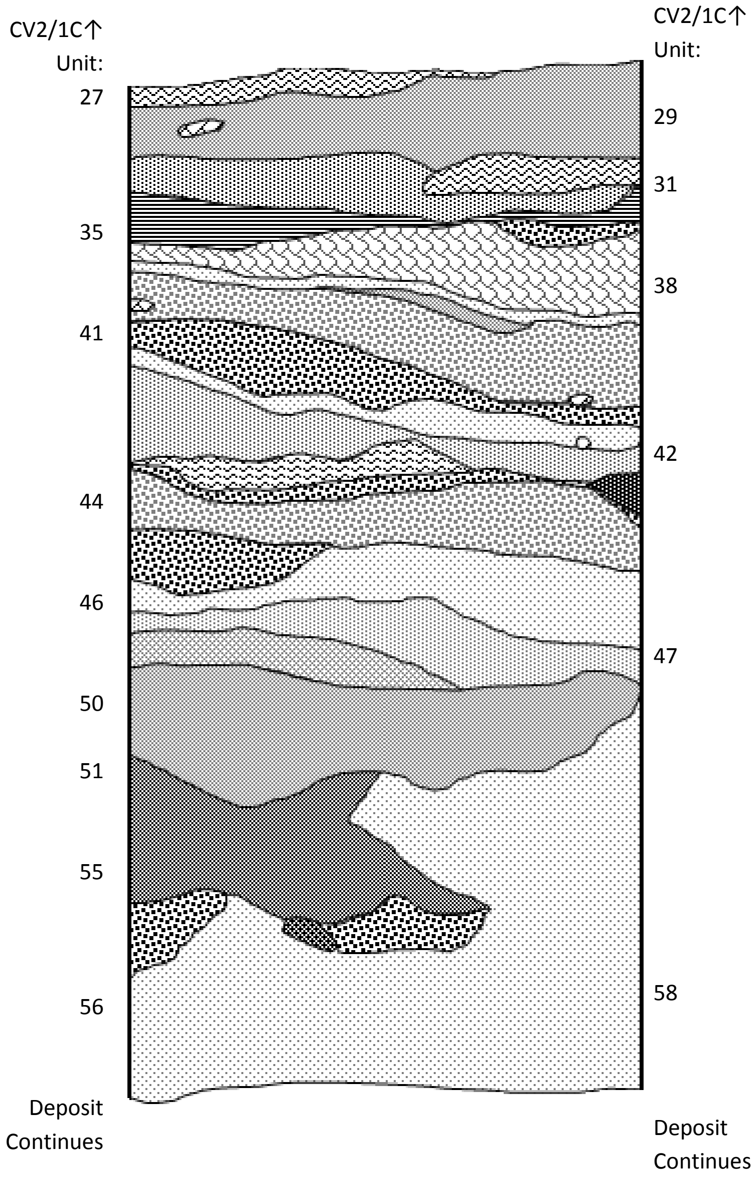


Figure 6.10: Trench profile of CV2/1PC – Lower (Preceramic) units

CV3

This sector contains of a series of artificial mounds (at least three, possibly four) which cover an area of approximately 9000 sqm. Much of the ground surface has been disturbed. Previous earthworks had exposed a section of one mound and this area was selected for excavation – to examine both the construction of the mound and to analyse midden content. Figure 6.11 is a photograph of this sector viewed from CV4. The foreground is likely to have been levelled during the military occupation of the area.

Figure 6.11: View east across CV4 to mounds of CV3. Red arrow marks location of trench. Photo: C. Carter

CV3/1

Location: 18°45'19.8"S 70°20'02.0"W   Altitude: 13m ASL

Size: 1 000 x 500 mm

Description: This area was selected for excavation as it had been previously disturbed with a vertical cut adjacent to a pit. A total of 31 units were excavated, finishing over 1.8 m below the upper surface of the mound.

The first (upper) nine units formed parted of the mound itself, the lower units continued below the mound base through midden deposit. The upper units revealed that the mound was constructed with alternating layers of native grasses and reed laid in alternating, opposing directions. Only a few isolated shells and fish bones were located within these layers of vegetation. Unit 6 contained several stones (100-150 mm diameter) that appear to have been placed in a line (bearing 96°mag). Unit 7 was situated at the base of the mound and at approximately the same level as the areas surrounding the mounds.

Midden deposit continued below the base of the mound with distinct strata visible with some ash lenses. Unit 25 consisted of a 100 mm [approximate] layer of apparently sterile fine grey sand, similar to that found on the beach surface. It was initially thought that this was the lowest level of occupation. Continued excavation through the sandy layer revealed lithic artefacts, shell and fish bone. Excavation continued for another 400 mm to reach bedrock at 1420 mm below the base of the mound. The bedrock appears to be a continuation of the basal layer of CV1 at the base of the slope as it levelled out across CV3.

Figure 6.12: Photograph of excavated trench – CV3/1.
East wall. Photo: C. Carter

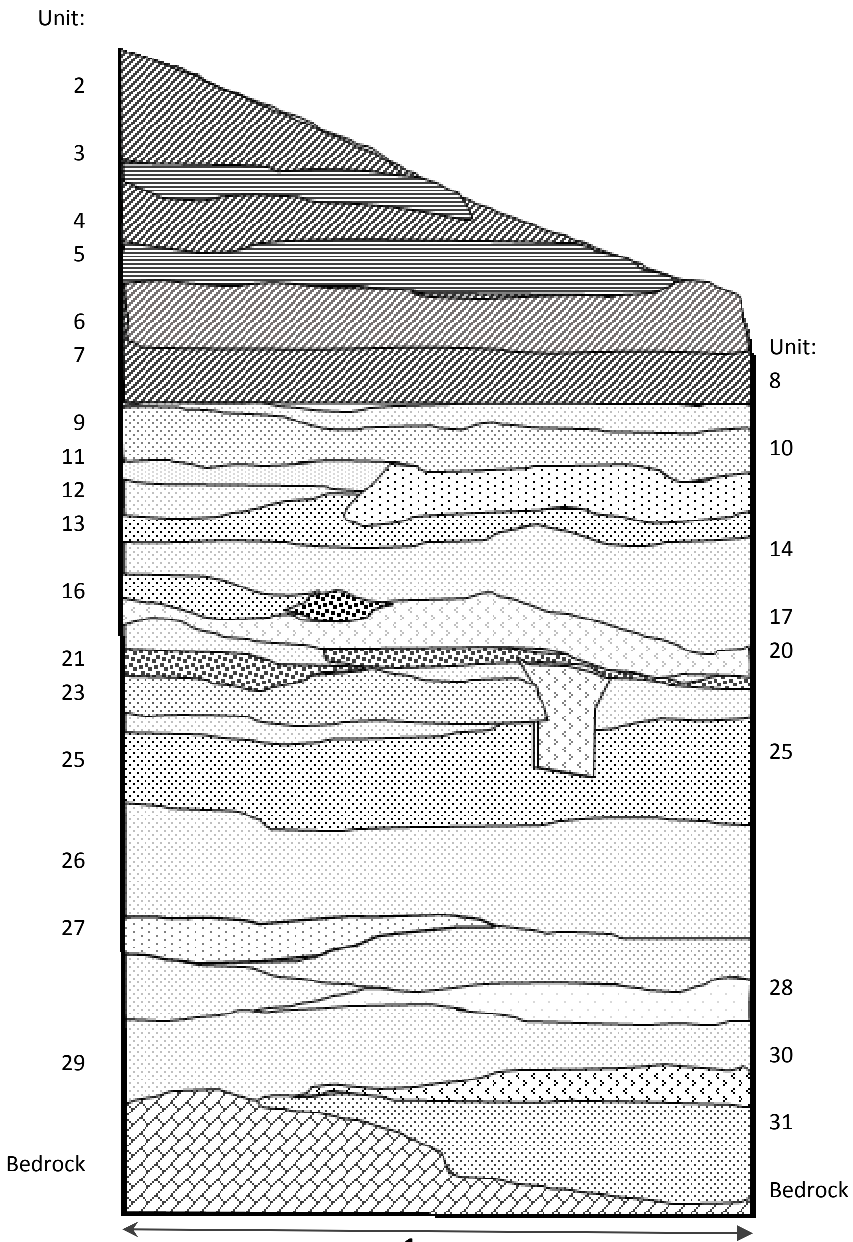


Figure 6.13: Trench profile - CV3/1
East wall. Drawn: C. Carter

CV4

This sector covers a broad area (at least 220,000 sqm) to the rear of the beach at Caleta Vitor. While the area is generally flat, there are several areas where low (~1-1.5m), windblown dunes have built up. CV4 is bordered to the north by the lagoon at the mouth of the watercourse. The remains of a copper mining enterprise obscure the area to the north of the lagoon. CV4 has been disturbed in several areas by the construction of buildings associated with the naval base. The area also has several stands of exotic trees (eucalypts and palms) which are favoured as camp-sites. Camping and vehicular traffic have both contributed to disturbance of varying degrees across this sector. Artefacts and faunal remains were noted scattered over a significant proportion of CV4.

Four trenches were excavated within this sector. CV4/1 was selected as it was adjacent to a disturbed area below the mounds of CV3 where dense midden deposit had been revealed. CV4/6 was located midway between CV4/1 and the highwater level and approximately 150m north of the road that divided CV2 from CV4.

The tops of twenty timber posts were recorded over the flat area below and to the west of the mounds and to the east of CV4/1. Their locations were mapped as it was thought that they may have related to either a building frame, fence or corral. No distinct alignment or pattern was noted (see figure 6.15). One post was selected for excavation in an attempt to determine what purpose they may have served. A volunteer member of the team randomly selected one post out of the twenty. The post was found to mark a burial. In order to determine if other posts marked burials, another was randomly selected for excavation. CV4/3 was located approximately 4 m to the north-east of CV4/2. It too marked a burial.

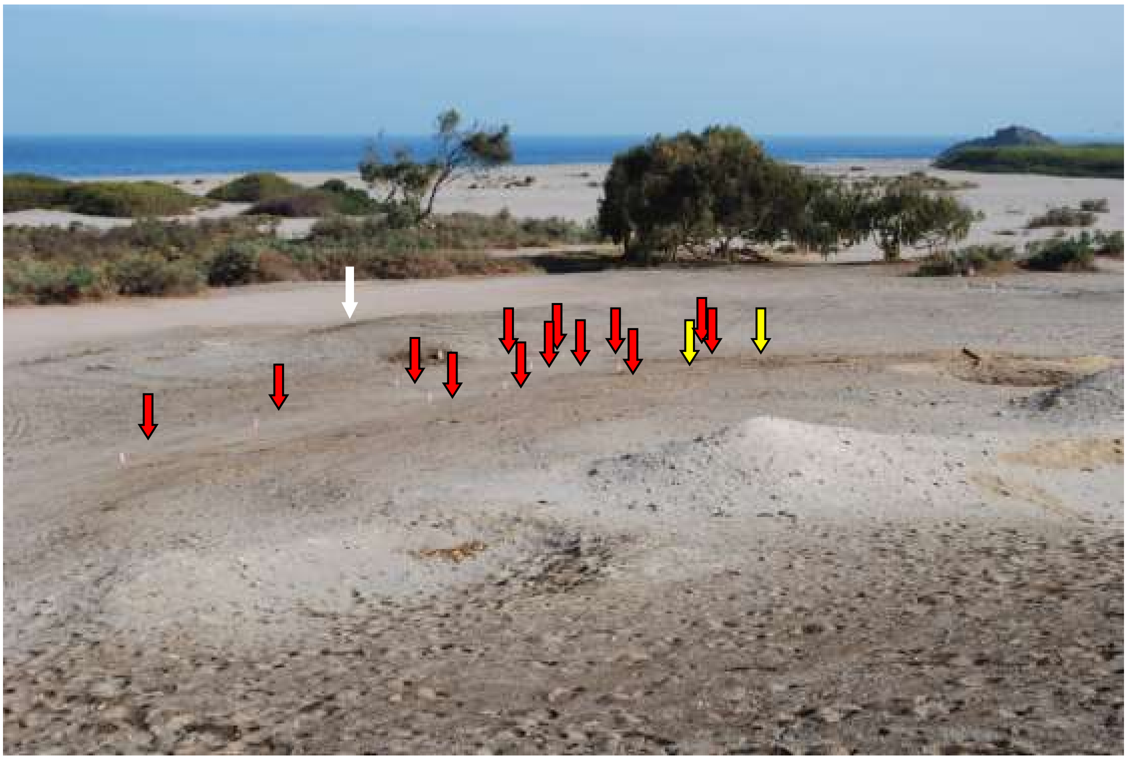


Figure 6.14: View to north-west over the central area of CV4. The white arrow indicates the location of CV4/1. The red arrows indicate the remains of timber posts. The yellow arrows indicate posts that were excavated. Photo: C. Carter

CV4/1

Location: 18°45'19.8"S 70°20'04.3"W Altitude: 8m ASL

Size: 1 000 x 500mm

Description: Located adjacent to a pit excavated for the installation of a [modern] sump and drain. A very dense midden (containing fish bone, shell, lithics, textiles and ceramic sherds) was exposed by this work but was of sufficient stratigraphic integrity to warrant excavation. A total of 19 strata were excavated, finishing at a depth of 800 mm below the ground surface. This trench contained an irregular deposit of grass and reed in the upper layers interspersed with fine sandy gravels which became more coarse in the lower levels. Layers of reed were not level and may have been mounded. Shell and fish bone were dispersed throughout the trench along with fragments of ceramics. Quantities of seeds were found in the majority of levels and included *algarrobo, molle*, maize, cotton, squash and numerous small black seeds (most likely Solanaceae spp. – C. Latorré, pers. comm.). Camelid dung was located in 15 out of 19 units.

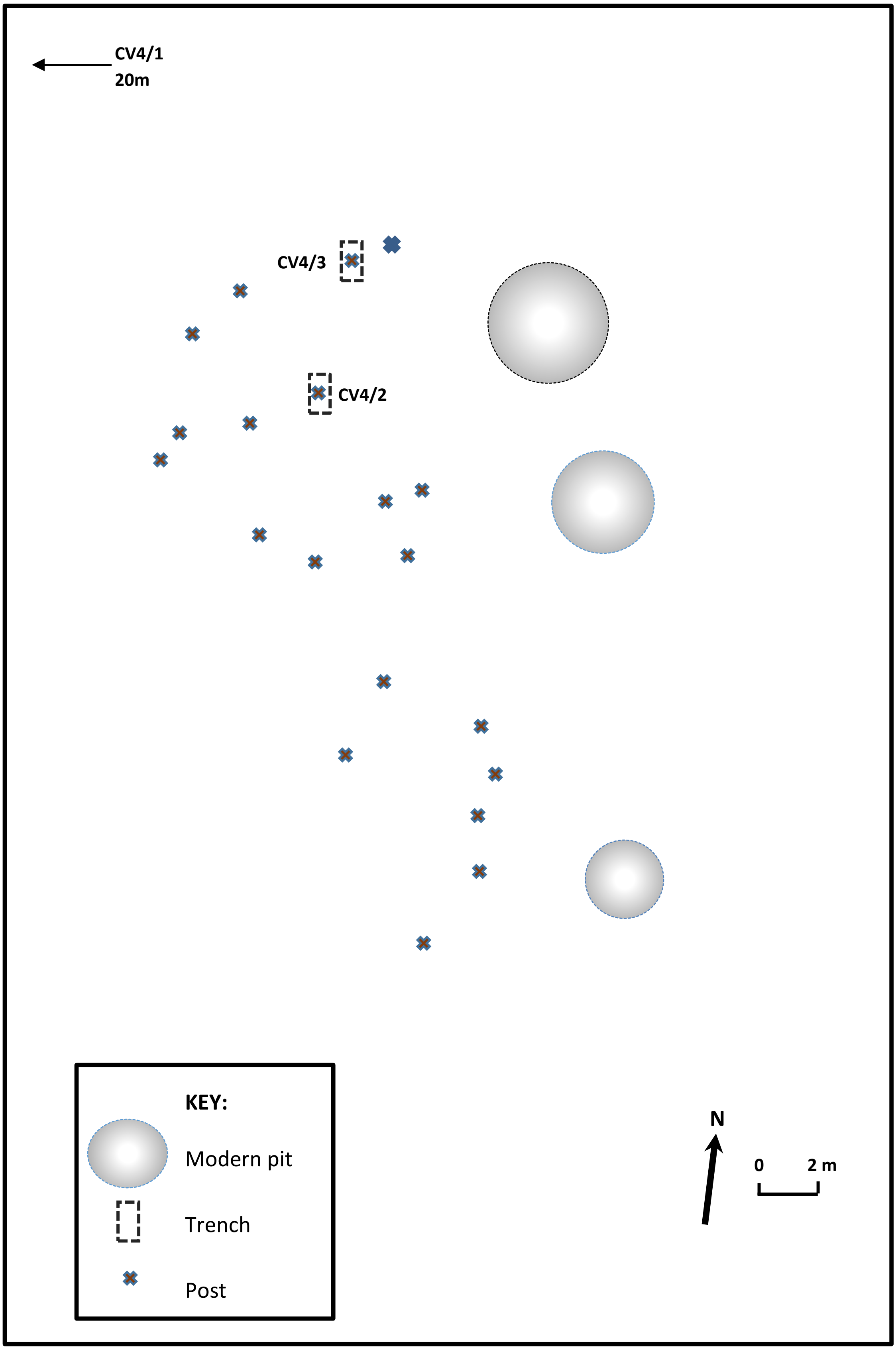


Figure 6.15: Plan showing distribution of post remains within CV4 west of the mounds of CV3. Drawn: C. Carter

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Figure 6.16: Photograph of excavated trench - CV4/1
East wall. Photo: C. Carter

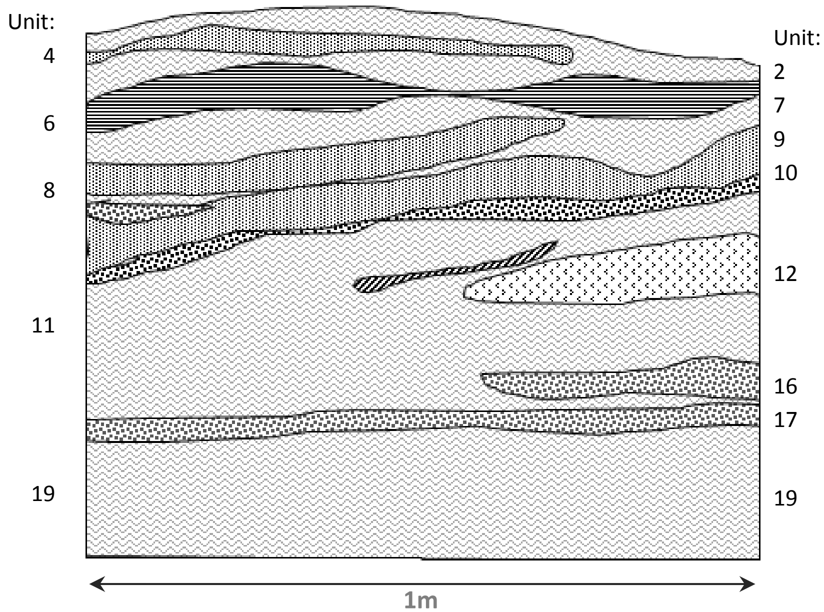


Figure 6.17: Trench profile - CV4/1.
East wall. Drawn: C. Carter

CV4/2

Location: 18°45'19.8"S 70°20'03.8"W Altitude: 10m ASL

Size: 1 000 x 500 mm

This trench was excavated in arbitrary 100 mm spits with the exposed timber post located in the centre of the 500 mm x 500 mm trench. The deposit of light sandy soil contained several chert flakes and shell fragments to a depth of 300 mm where reed matting became visible with obvious mounding in the stratigraphy. Human skeletal remains were exposed immediately below the reed matting, 450 mm below NGL and the trench was extended to 1000 mm x 500 mm. Another timber post was located lying horizontally across the grave slightly above but to the side of the body but well below the ground surface. This post was not fully exposed so its function could not be determined. Further descriptions of this burial appear in Chapter 7.

Figure 6.18: Photograph of excavated trench - CV4/2
Photo: C. Carter

CV4/3

Location: 18°45’19.9”S 70°20’03.5”W Altitude: 10m ASL

Size: 750 x 750 mm

A timber post was located centrally in this trench. The first spit consisted of a thin layer of sand over brown stained soil containing organic matter. The head of a left tibia and condyles of a femur were exposed less than 60 mm below NGL. Reed matting was associated with the burial, but had decomposed to some degree. Excavation continued to further expose the skeleton to a depth of 180 mm below NGL. The bones were severely damaged, most likely because they were just below the ground surface. Vehicle tracks were visible across this area and as the burial had little covering of soil, vehicular traffic probably caused compression damage. No samples were taken from this skeleton for radiocarbon dating. Further descriptions of this burial appear in Chapter 7.

Figure 6.19: Photograph of skeletal remains - CV4/3
Photo: C. Carter.

CV4/6

Location: 18°45'24.0"S 70°20'07.8"W Altitude: 6m ASL

Size: 1 000 x 500 mm

Description: This trench is located within an expansive area of the site with occupational debris obvious in many areas. Much of this sector appears to have been mechanically graded and vehicular tracks criss-cross the area. Concentrated midden deposit was not obvious. However, shell, bone and ceramics were sparsely scattered across the surface. The selection of this trench was directed toward an area that appeared to have less superficial disturbance and may have contained stratigraphically intact deposit.

The soils within this trench were stained brown by organic matter and contained indistinct strata. As such, the excavation was carried out in arbitrary 100 mm spits. Excavation ceased at a depth of 1.0 m although cultural deposit appears to continue below. Apart from the surface layers, soils within this trench were damp and, unlike the other sectors, there was some surface vegetation with root penetration extending at least 600 mm below ground level. Larger shells had begun to calcify in the lower sections (below unit 7). Ceramic fragments were located in all but one of the units. A few stones were distributed through the trench with no obvious layering.

Figure 6.20: View to south-west over CV4. Red arrow indicates location of CV4/6
Photo: C. Carter.

Figure 6.21: Photograph of excavated trench (to west) – CV4/6
Photo: C. Carter

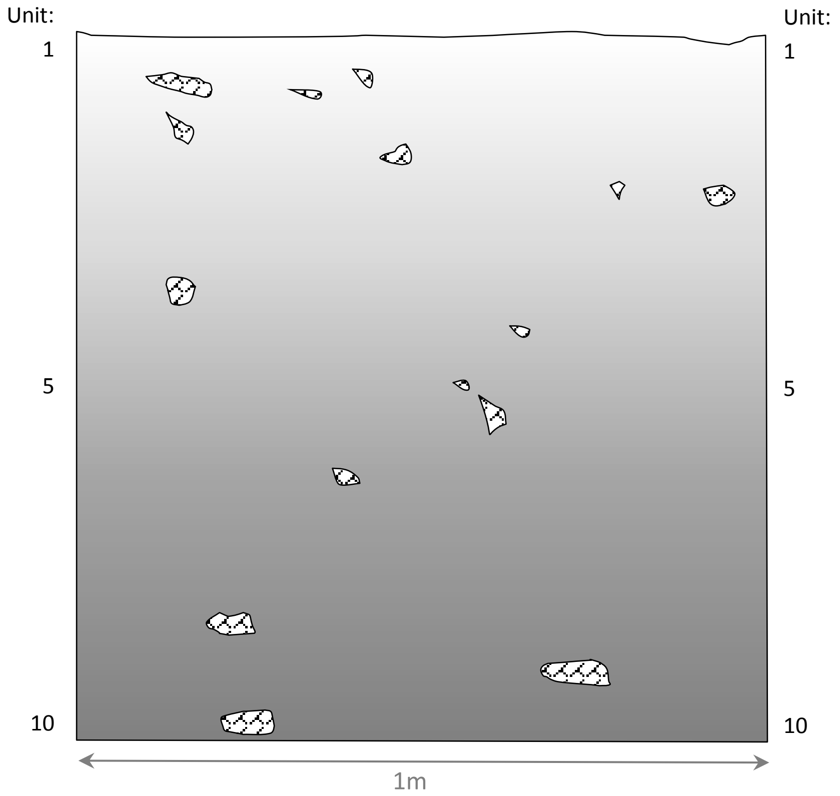


Figure 6.22: Profile of CV4/6. West wall.
Drawn: C. Carter

CV5

This sector contains a series of caves facing the ocean located near the base of the southern cliffs and was not excavated. Surface evidence indicates that there may be some shallow occupational deposit over the cave floors. However increased public visitation has resulted in the caves being used as toilets. The cave floors are littered with faecal matter and toilet tissue. It was considered unsafe to excavate in this area. Parietal art containing zoomorphic, geometric and abstract figures were found on a number of panels in each of the caves. The figures were executed in white and red/orange pigments. A more detailed description of the art is included in Chapter Seven.

Figure 6.23: Interior of cave – CV5
Photo: C. Carter

CV6

This is a broad area midden located at the base of a talus slope below the cliffs flanking the southern coastline of Caleta Vitor. This sector covers at least 15,000 sqm but is likely to be much larger as the boundaries of this sector are obscured by the base of a talus slope. There is only a narrow band of rocky shoreline (~5-15 m wide) between the base of the cliffs and the sea along the entire length of this sector. A broad swathe of this sector had been disturbed where a track has been cut across the base of the slope. Much of this track is now covered by scree and its destination unclear.

Stratified deposit ranging from 0.5 m to over 4 m deep was exposed during the construction of the track. The trench CV6/1 was located below a rocky outcrop which contains a rock shelter. This area was selected as a visible deposit almost 2m in depth had been exposed by roadworks. This allowed for ease of excavation and minimal further disturbance. CV6/2 was located within the rock shelter approximately 20m above CV6/1. CV6/3 was located approximately 40 m west of CV6/1 and associated with another deep section of exposed deposit and just west of the protection provided by the rock overhang.

Human burials were noted about 50 m to the west and scattered human bone was found on the track below the excavated areas. No human remains were located during the excavation of this sector.

This sector is at the base of a talus slope below 600-700 m high cliffs. Excavations within this sector were curtailed by falling rock which made working conditions unsafe. Military exercises on the *pampa* to the east of Caleta Vitor included repeated artillery fire. The sound of this cannon fire echoed along the valley and around the cliffs and on several occasions the sound-wave dislodged rocks which fell on to the site while the excavations were underway. After two near misses, it was decided to abandon the excavations.

Figure 6.24: View to south-west across CV6.
Red arrow – CV6/1, yellow arrow – CV6/3. CV6/2 in rockshelter above CV6/1
Photo: C. Carter

CV6/1

Location: 18°45'39.7"S 70°20'22.7"W Altitude: 12m ASL

Size: 1 000 x 500 mm

Description: This trench was located along the cut edge of a moderately sloping terrace below a rock outcrop at the base of very high cliffs. Loose sandy soil covered the area along with numerous small rocks (<300 mm). Scatters of shell and bone were spread across the area.

This trench was excavated to a depth of 1.2 m through 16 units. The first unit (140 mm deep) contained evidence of post-Colonial occupation including glass, ceramics and a peach stone along with a bifacial point. Dense layers of vegetal material including reed, cane and maize stalks and cobs were found in the upper levels of the trench (above unit 11). Ceramics were located in all but the lowest unit. The basal layer contained decomposing, calcified shell.

Figure 6.25: Photograph of excavated trench – CV6/1
Photo: C. Carter

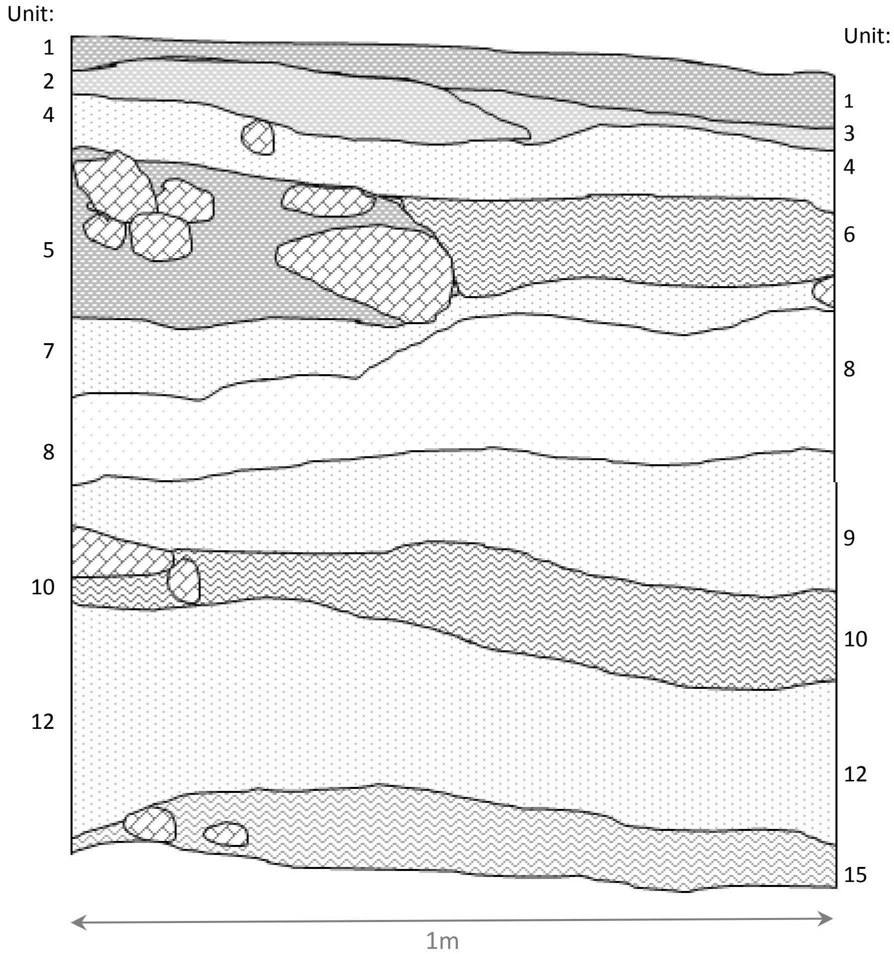


Figure 6.26: Trench profile - CV6/1 south wall
Drawn: C. Carter

CV6/2

Location: 18°45'39.9"S 70°20'22.8'W Altitude: 16m ASL

Size: 1 000 x 500 mm

Description: This trench was located beneath the overhang of a large rock outcrop and against the rear (southern) wall. Vegetation and animal dung suggest that this area was used to corral livestock (most likely llama). Two lines of stone had been laid projecting out from the outcrop and were likely to have formed the base of a wall either to contain livestock or to hold soil to build up the level of the floor of the shelter. Figure 6.27 contains a plan showing the outline of the shelter and the stone wall lines.

The surface was very hard and had to be broken with a pick. Sieving of material from unit 1 was not possible and visual inspection did not reveal any items of interest, apart from a cigarette butt and a hypodermic needle. Soils were mixed with vegetation and animal dung beneath the hard surface layer. Stratigraphy was indistinct and the excavation was carried out in arbitrary 100mm spits. Sloping bedrock cut across the base of the trench at a depth of 400mm.

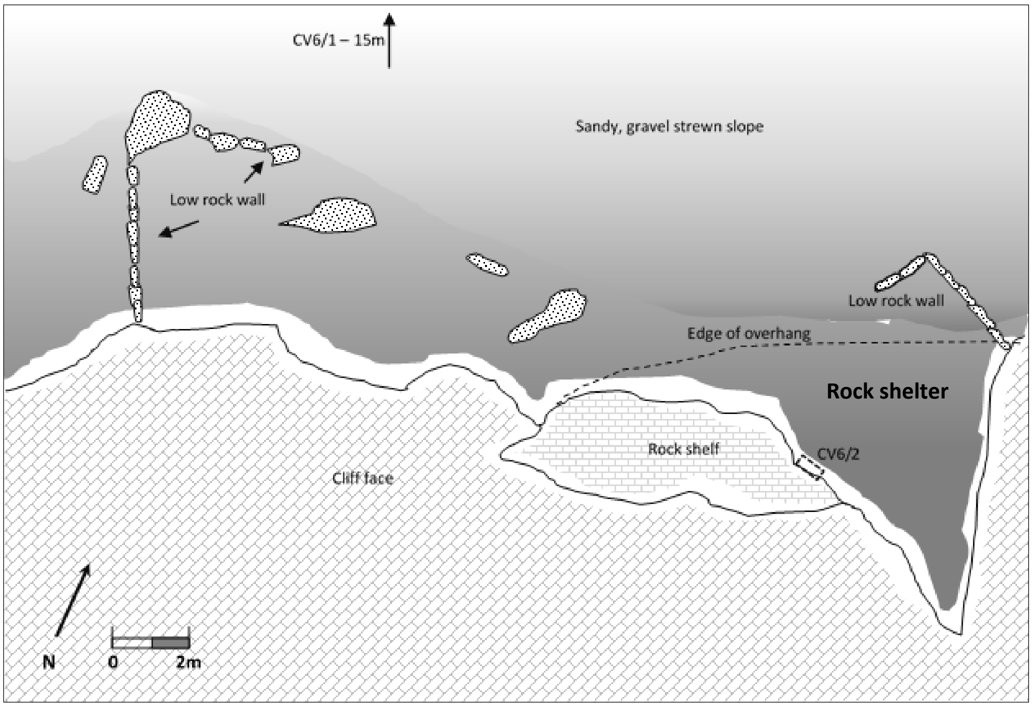


Figure 6.27: Plan of rock-shelter in CV6 and location of trench CV6/2.
Drawn: C. Carter

Figure 6.28: Photograph of excavated trench - CV6/2
Photo: C. Carter

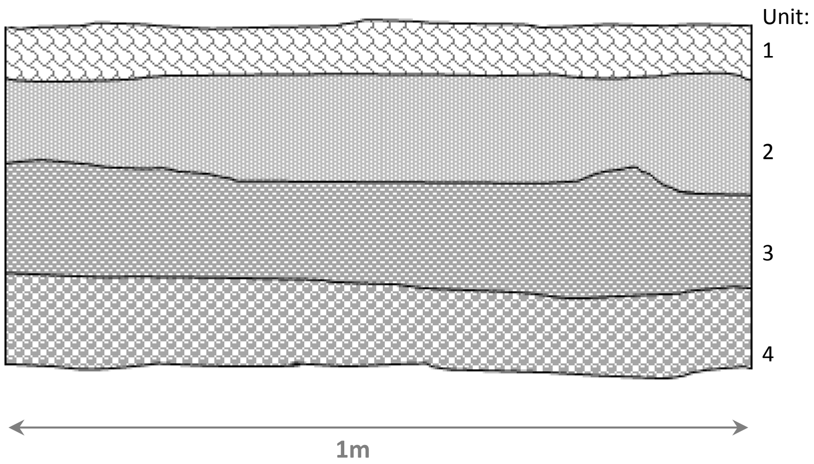


Figure 6.29: Trench profile - CV6/2 – north wall.
Drawn: C. Carter

CV6/3

Location: 18°45’39.7”S 70°20’22.6’W Altitude: 12m ASL

Size: 1 000 x 500 mm

Description: This trench was located outside of the protection of the rocky outcrop, approximately 40 m to the west of CV6/1. The ground surface above the trench was strewn with rocks ranging from 50 mm to 500 mm in diameter. This area slopes moderately upward for 20 m before becoming very steep until it meets the base of the cliff, some 50 m further south. Figure 6.30 is a photograph of the excavated trench – this photograph was taken after the excavation had been terminated and some collapse of the trench wall had occurred (right of photo). As mentioned, the excavation was not finished as planned due to safety concerns.

The stratigraphy of the deposit exposed on either side of this trench indicated intensive occupation with fire pits and possible structures nearby. Occupational material was very mixed and may have been disturbed following initial deposition.

Figure 6.30: Photograph of excavated trench - CV6/3. South wall.
Photo: C. Carter

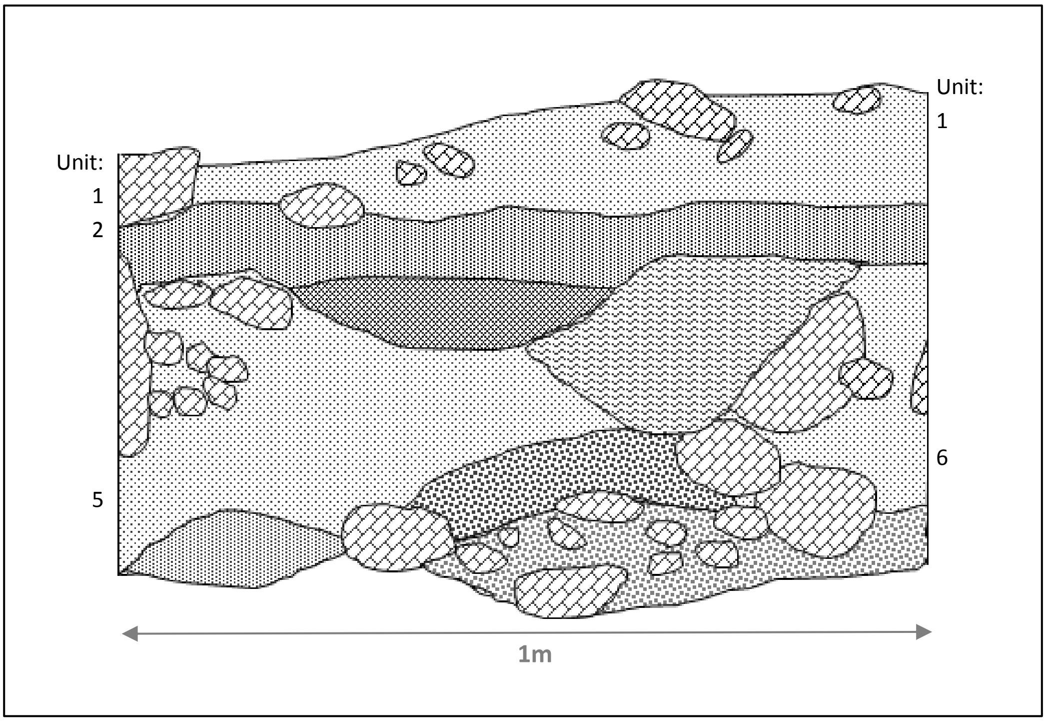


Figure 6.31: Trench profile - CV6/3. South wall.
Drawn: C. Carter

CV7

A shallow midden deposit was located high on the northern flank of the *quebrada* and relatively limited in area (approximately 300 sqm). The area of the deposit may be far larger, its full extent concealed by a layer of loose sand.

Midden deposit within this sector was exposed during the construction of a track leading to an artillery installation. This trench was excavated to test the age, depth and use of this part of the site.

CV7/1

Location: 18°44'53.0"S 70°20'07.1"W Altitude: 57m ASL
Size: 500 x 500 mm

Description: This trench was excavated to a depth of 0.8 m through 11 units. The trench was located in a badly disturbed area below a gun emplacement. This area of the site was cut during road construction.

Low densities of shell, bone, lithics and fibre were found throughout the trench. Burials were noted nearby (see Chapter Eight). The base of the trench consisted of a hard calcrete layer amongst several individual rocks.

Figure 6.32: View to south-east across CV7. Trench location marked with red arrow. Photo: C. Carter

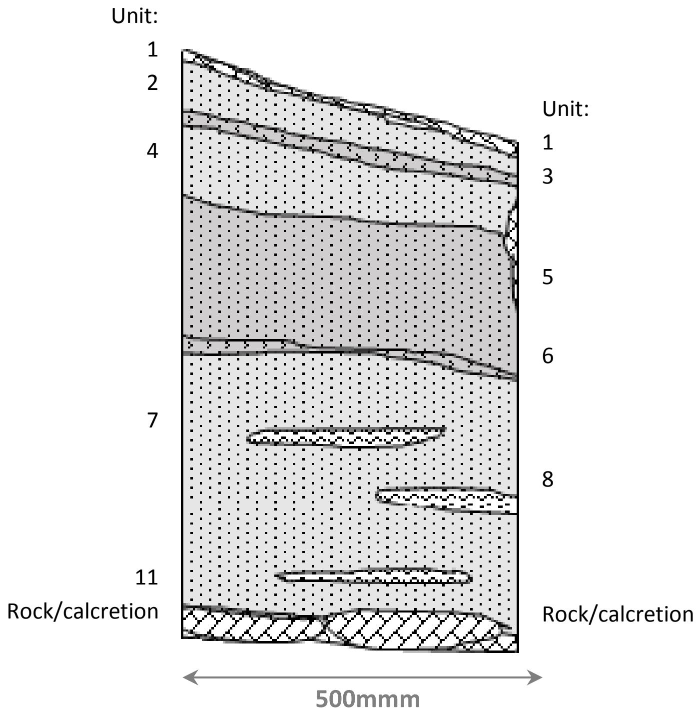


Figure 6.33: Trench profile - CV7/1 – south wall. Drawn: C. Carter

Summary of Excavation Results

Material retrieved via excavation was bagged on site and transported to Arica for sorting. Sorting was carried out in two stages. At each stage, categories separated from the original bag were re-bagged and labelled with the category along with trench and spit number. The first stage was to separate faunal, floral and cultural material from the gravels and other debris. This stage divided the material into the following categories:

- Bones
- Shells
- Plant remains
- Lithics
- Ceramics
- Fur and feathers
- Textiles – separating woven cloth and spun fibres
- Coprolites (human)
- Dung (non-human)
- Metal objects
- Special finds – eg fish hooks, sinkers/lures, bone points, wooden items, decorative items.

The second stage refined each category and divided the assemblage in the following subcategories:

- Bones – fish bone was separated from mammal and avifauna and further divided into vertebrae, dentition, otoliths and general (or indeterminate);
- Shells - divided into individual genera or species (where possible) and indeterminate fragments.
- Lithics – sorted into size categories and by raw material. Implements and parts thereof were recorded individually.

- The remaining categories were weighed but not examined in detail for this portion of the project.

The following table summarises the total amounts (weight in grams) of the major categories of material retrieved from the excavated trenches:

Trench No.	Fish Bone	Other Bone	Shells	Lithics	Ceramic Sherds
CV1/2	626.6	1291.0	3106.3	1211.7	-
CV1/3	2380.1	1256.6	6994.8	986.9	-
CV2/1	4506.4	1351.6	21410.2	2306.6	413.6
CV3/1	1207.4	835.8	12262.4	809.5	-
CV4/1	3657.6	320.4	16966.4	330.9	3133.3
CV4/6	764.5	507.1	1257.8	514.3	2853.4
CV6/1	2031.1	3211.0	19535.4	2168.9	3839.9
CV6/2	198.3	5.5	1054.0	228.6	456.2
CV6/3	1555.8	2688.3	13434.1	861.6	1500.8
CV7/1	141.4	10.5	639.0	36.8	-
Total	17069.6	11477.9	96660.4	9458.8	12197.2

Table 6.2: Summary of material from excavated trenches at Caleta Vitor Weight (grams) of major categories.

The table below summarises the radiocarbon dates obtained from samples collected during the excavations at Caleta Vitor.

Lab No.	Sample ID	Material	δ13C,‰	14C age yrs BP	±	Age (cal 2 sigma)
UGAMS10519	CV4/6/1	seed	-24.7	420	20	330-500
UGAMS10522	CV6/1/8	maize	-10.7	530	25	500-543
UGAMS10517	CV4/1/1	seeds	-25.7	610	25	529-631
UGAMS10518	CV4/1/19	maize	-10.7	630	30	535-646
UGAMS10523	CV6/1/16	maize	-11	660	25	551-650
UGAMS10520	CV4/6/10	cotton seed	-23.5	1820	25	1570-1810
UGAMS10511	CV2/1/11	cotton seed	-25.8	1930	30	1723-1880
UGAMS10510	CV2/1/1	algarrobo pod	-26.8	2120	25	1931-2129
UGAMS10507	CV1/3/1	algarrobo pod	-25.3	2470	25	2484-2697
UGAMS10512	CV2/1/31	cotton seed	-22.7	2490	25	2354-2702
ANU31013-9185	CV2/1/20	charcoal	-23	2525	35	2363-2713
UGAMS10505	CV1/2/6	algarrobo pod	-24.2	3100	25	3263-3360
UGAMS10513	CV2/1/39	cotton seed	-21.9	3230	25	3346-3458
UGAMS10514	CV2/1/43	calyx	-28.4	3240	25	3346-3474
UGAMS10515	CV2/1/58	charcoal	-29.1	3820	30	3989-4243
UGAMS10524	CV7/1/6	calyx	-28.3	3880	25	4094-4408
UGAMS10506	CV1/2/13	calyx	-26.6	4030	30	4437-4525
ANU31017-9188	CV7/1/10	cane	-21.2	4400	35	4839-5039
ANU31018-9189	CV1/3/9	Cane	-20.9	5110	35	5664-5910
UGAMS10509	CV1/3/25	calyx	-25.2	5770	30	6411-6631
UGAMS10508	CV1/3/14	calyx	-27.7	5860	30	6496-6717
ANU31014-9186	CV3/1/30	charcoal	-26.1	8075	40	8662-9023
ANU31016-9187	CV3/1/31	cane	-21.7	8420	40	9271-9487

Table 6.3: Radiocarbon dates, in chronological order, obtained from Caleta Vitor samples

The following chapters of this part of the thesis contain descriptions and analyses of the various categories and subcategories of material retrieved through excavation. Some material recorded during the surface survey is also included in this section. Chapter Seven describes items relating to the material culture of the occupants of Caleta Vitor and Chapter Eight relates to burial practices. Chapters Nine and Ten deal with faunal and floral remains that made up the bulk of their diet and/or trade goods.

Chapter Seven

In observing these types of culture we should pay attention particularly to their succession in time; for their importance as stylistic strata which succeeded and covered each other (and, for the greater part, covered a coextensive area), is far beyond that which they may possess as local types. (Uhle 1902: 754)

Material Culture

With occupation at Caleta Vitor dating back over 9000 years, considerable cultural change should be evident in the material culture of the site. Included earlier, the history of the broader region describes how the early hunter/gatherer populations adopted new rituals and practices as they moved toward an agricultural economy. Through this period, technological advances included the manufacture and use of ceramics, textiles and metal goods along with an increasing complexity in political and social structures.

Some of these changes may have occurred slowly, perhaps over many generations (e.g. burial practices). However, technological advances, such as the advent of ceramic manufacture and metallurgy, may have been the result in abrupt and significant change. Table 7.1 lists the recognised time-line for this region and includes some of the technological advances associated with cultural shifts.

This chapter contains a description of the material culture of Caleta Vitor as determined via surface survey and excavation. The intention here is to demonstrate the range and extent of cultural change that is evident through the entire period of occupation (>9000 years). This can then be used to ascertain if, and to what extent, the local economy was influenced by such material culture changes, and when those changes may have occurred.

Time period (cal. BP)	Period	Phases	Cultural/Technological Markers
13,000–7,500	Early Archaic	Acha, early Chinchorro	Extended burials Fishing gear
7,500–6,000	Middle Archaic	Chinchorro	Artificial mummification
6,000–4,000	Late Archaic	Late Chinchorro	
4,000-1,500	Formative	Azapa phase (4,000-2,500 Alto Ramírez (2,500-1,500)	Early ceramics Simple textiles Agriculture Flexed burials Trade goods
1,500-900	Middle Horizon (Tiwanaku polities expansion)	Cabuza Maitas Chiribaya San Miguel	Metallurgy Complex textiles Decorated ceramics Mummy bundles Highland products
900-600	Late Intermediate	Gentilar	
600-500	Late (Inka Empire)		Inka style ceramics/textiles

Table 7.1: Regional time-line showing cultural and technological shifts.

* * *

Lithic Artefacts

Apart from shell and bone fragments, lithic items (flakes, points, cores and flaked pieces) are the most common cultural indicators visible on the ground surface at Caleta Vitor. White chert and chalcedony flakes and fragments are obvious on the grey sands, particularly across the broad, bare expanses of CV1 and CV3. Thousands of lithic items are visible on the ground surface over much of the site.

A total of 9.458 kgs was recorded and consisted of 19,188 individual lithic items. Lithic artefacts were retrieved from 172 out of 198 excavated units (86.8%).

Only a basic analysis of the lithic material was undertaken. At the primary sorting stage, lithic items were separated from other material and bagged for each stratigraphic unit. Weights were recorded for each unit. Each individual item was inspected and size class and raw material recorded. Implements and parts thereof were bagged individually.

The most common raw material was chert (96.7%, n=18,569) followed by basalt (3.2%, n=619). Chert items were generally white but ranged from opaque through to translucent and almost clear with some gradations of colour. Chert is locally available with nodules eroding from the upper walls of the *quebrada* a few kilometres inland (pers. obs.). Basalt can be obtained locally, particularly along the coast line.

There were only three examples of raw material other than chert and basalt. The first was the proximal portion of a broken, stemmed bifacially flaked point (from CV1/2/14) which was rosy/brown quartzite. The second artefact was a flake with no retouch but had signs of use-wear across a broad distal margin (probable scraper), made from a light green quartzite (from CV1/2/14). A figurine carved out of a green stone was found in CV6/1/9. This item was partially encrusted with soil and was not washed. It is possibly a green quartzite, similar material to the utilised flake from CV1/2/14. The sources of these raw materials are not known.

The absence of obsidian in the assemblage is worthy of comment. Such artefacts are recorded within coastal sites in southern Peru (e.g. Quebrada Jaguay, Quebrada de los Burros) (Sandweiss et al. 1998; Beresford-Jones et al. 2015). I have also found obsidian artefacts in the Lluta Valley in sites relatively close to the coast (pers. obs.). Obsidian is found in the vicinity of volcanoes and suggests that either the material was traded from highland groups or collected when coastal groups ventured in that direction. Volcanoes are located along the main ranges of the Andes directly to the east of Caleta Vitor. The absence of this material in the Caleta Vitor assemblage is anomalous and suggests that local lithic workshops favoured local materials and had no desire for such exotic material.

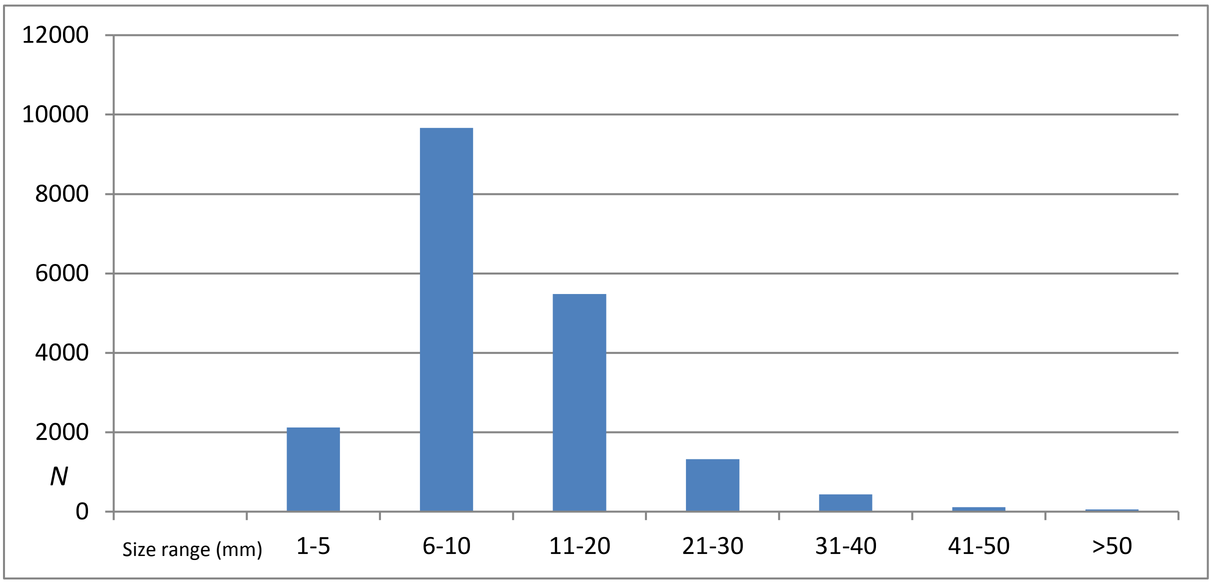


Figure 7.1: Graph showing size range (in mm) of lithic items found at Caleta Vitor.

In excess of 99% of the assemblage (assemblage total = 19,188) consisted of flakes, flaked pieces or core fragments. Out of the total, 61.4% (n=11,783/19,188) were flakes that measured 10mm or less in length (see Figure 7.1). While detailed analysis of each individual flake was not undertaken, this portion of the assemblage predominantly consisted of debitage created during the knapping process. The majority appear to be retouch flakes generated during the production of unifacially and bifacially flaked points.

Only fifty-two (0.003% of total) implements (or parts thereof) were recorded. This number included points (harpoon, spear or arrow), utilised flakes, sinkers or lures, and one ornamental piece (figurine/pendant). Thirty-nine flaked items showed evidence of either unifacial or bifacial retouch on their lateral margins. However, out of the 39, only three were whole, the remainder were fragments only. Given the number of small flakes and broken items, this suggested that the manufacture of lithic points was carried out on the site and that the broken points recorded were the result of breakages that occurred during the manufacturing process and not during use.

Thirty-nine points (or parts thereof) were retrieved from excavations at Caleta Vitor, the majority (33/39 - 84.6%) were bifacially flaked, with a range of retouch - from coarse to finely denticulated lateral margins. Bifacially flaked pieces were distributed across a range of periods with seven being found in trenches dating from the Archaic Period, eleven in Formative trenches and fifteen from Late Period trenches. Of the six unifacially retouched pieces, five were from the Late Period and one from the Formative.

Bird (1943) found a number of lithic items in his excavations at Arica and Punta Pichalo. His methodology did not allow the collection of small items (<5mm) nor, it appears, did he intend to collect such material. As such, he reported on 'chipped' stone tools and spear points. He refers to the dominant raw material as 'chalcedony' which is a form of chert. He also found several implements made of bone that he referred to as 'chipping implements', that is tools that were used for removing flakes from the lateral margins to manufacture unifacial or bifacially flaked points.

Bird's (1943) assemblage from Punta Pichalo included a number of lithic points from the pre-ceramic through to the ceramic levels (Bird, 1943: 259). While there were some point types that continued through both pre-ceramic and ceramic phases, he noted that double-ended points were more common in the pre-ceramic layers and that a stemmed and barbed type of point (possibly for arrows) was concentrated in the late pre-ceramic layers. Triangular blades and points became more dominant in the ceramic period. The majority of these had concave bases with varying degrees of curvature.

The majority of lithic artefacts found by Bird at Quiani (Arica) were located on the ground surface (Bird 1943: 234). Bird recovered a number (>150) of what he described as 'rough chopping tools' struck from 'oval cobblestones with unilateral flaking', coming from the lowest levels through to the surface. He found over 1700 'unworked' chalcedony flakes and over 160 double-ended points with finely serrated edges varying in length from 50mm to 70mm. One mummy from the AMNH that originally came from Caleta Vitor in 1894. It had white chert knife placed on its lap (Bird 1943: 250). This knife was 170mm long and had a handle made from a piece of woollen cloth and bound with hair cord. Figure 7.2 is a photograph of this knife.

Figure 7.2: - Chert knife found at Caleta Vitor, 1894. Courtesy AMNH. Cat. No. B4499. Photo: C. Carter

Another mummy from Bird's collection was a child. It was interred with a string tied around its head with nine lithic points attached. These points were uniform in size and style, duplicating those found on harpoon forepieces (Bird 1943: 251). Both of these mummies were interred with artefacts from the Colonial period (e.g. glass beads, brass thimble, a Spanish document dated 1578). Such information was useful in that it provided a temporal framework to demonstrate the traditional use of certain types of artefacts and rituals over an extended period, ie, from the prehistoric into the Colonial periods. Furthermore, there is no record of any Colonial settlement at or near Caleta Vitor (Bird 1943: 251). The presence of Colonial imports suggests contact with Europeans further along the coast, accompanied with a desire to maintain local traditions.

Sandweiss (2008: 151) reported on the lithic assemblage at Quebrada Jaguay (ca 13,000 – 11,400 cal BP), where 'abundant' lithic remains were found within house remains. The raw material for the majority of lithic items was found locally but there were several flaked from obsidian which was sourced to Alca, some 165km inland. He also made the comment that there were 'almost no finished tools.' He concluded that the remains located suggested that the site was used for 'shelter, food preparation and consumption, and tool making for use elsewhere.'

There were insufficient implements found at Caleta Vitor, either complete or incomplete, to make any comprehensive comments relating to typological variation. Four stemmed points (see Table 7.2) show some variation but display similarities with the morphology of points found by Bird (1943) at Playa Miller, Quiani and Punta Pichalo (see Bird 1943: 207-270).

Trench/Unit	Photograph	Dimensions (mm)
CV2/1/3		36.6x18.4x4.5
CV2/1/14		21.7x16.9x3.0
CV6/1/7		37.4x31.2x8.5
CV6/3/4		30.0x14.5x4.5

Table 7.2: - Stemmed points from Caleta Vitor.

Three particular lithic points require comment. Both are sections of broken, bifacially flaked points with coarse (1-3mm) denticulated margins – one was found on the ground surface of CV2, one came from CV2/1/43 (Formative Period) and one from CV6/1/9 (Late Period). The AMNH holds material collected by Oswald Evans in the early 20th century, including several of his note books. In an entry dated 1904, Evans drew a number of lithic points that he found at Taltal, northern Chile (see Table 7.3). Two of the points that he described were denticulated in a similar fashion to those found at Caleta Vitor. Table 7.3 contains photographs of these items. Bird (1943) described a number of lithic points from Arica and included numerous photographs in this publication. He did not describe any points with this coarse style of denticulation.

Trench/Unit	Photograph	Comment
		Found at Taltal, drawn by Oswald Evans in 1904. Notebook courtesy AMNH.
CV2/1 surface		
CV6/1/9		28.2x18.2x10.6mm
CV2/1/43		18.1x12.7x3.4mm Burnt

Table 7.3: - Points with coarse denticulation.

Several other points were found with finely denticulated margins. One was a white chert stemmed bifacial point from CV2/1/3. This was likely an arrow head and measured 36.6 x 18.4 x 4.5mm. This point had very fine denticulations (<0.5mm) along both lateral margins. The other two were both small white chert bifacial points (most likely arrow tips) with similarly fine denticulation. One (from CV2/1/2) was broken and only the tip remained, the other (from CV2/1/47) was whole, broad across the proximal margin and measured 24 x 12.6 x 3.2mm.

Figure 7.3: - Basalt flake from CV1/3/20.
Photo: C. Carter

A basalt flake struck from a small oval cobble, with use-wear along the distal margin was found in CV1/3/20 (see Figure 7.3). This may be an example that may be categorised as a 'rough chopping tool' as defined by Bird (1943: 247).

Three whole flakes exhibited evidence of use-wear (one each from CV1/2/14, CV1/3/20 & CV3/1/31) and may have been for domestic use (cutting or scraping).

While no evidence of domestic structures has been found at Caleta Vitor, the lithic assemblage is similar to Quebrada Jaguay. It suggests that the sites were multifunctional, where, along with domestic activities such as food preparation and consumption, knapping or tool maintenance occurred but the finished products were used or stored elsewhere. It may be that the complete points were used until they could no longer be sharpened, and were discarded where they were used. The best source of such points may well be within the cemetery, where they may be found as grave goods.

Ground Basalt Artefacts

Nine whole or parts of basalt sinkers or lures were located. Six of the nine were located in CV2/1 in levels 43 to 52 which date from the early Formative period. Of the nine, three were whole (CV6/1/10, CV2/1/44 and CV2/1/45) although one of the three was broken into two pieces. Two had grooves at one end (both from CV2/1/45), one was tapered (CV2/1/45), one was ground flat on one side (CV2/1/43) and two had both sides ground flat (CV2/1/45; CV2/1/52). CV6/1/10 was a 'tear-drop' shape and broader than all others. Table 7.4 depicts six examples of ground basalt sinkers.

Bird (1943) described similar items he found at Playa Miller and Quiani as sinkers. At Quiani he found several items in various stages of their manufacture (Bird 1943: 239). Firstly the sinker was roughly shaped by flaking a basalt cobble, then pecked into shape and ultimately ground to a 'cigar' shaped final form. He found some with grooves around the end and some were ground flat on one or both sides. He concluded these variations seemed to "have no particular significance" (Bird 1943: 209). At Quebrada de los Burros, Lavallée et al. (1999 & 2011) found similar, ground basalt items. They described them as sinkers and/or parts of composite hooks or lures.

Trench/Unit	Photograph	Comment/Dimensions
CV2/1/18		Broken 83.9x16.45x9.3
CV2/1/45		106.7x17.1x10.8
CV2/1/45		Part only, grooved around tip. 33.3x15.6x11.3
CV2/1/52		Part only 56.9x19.7x10.6
CV4/6/4		Part only 59.2x16.0x9.8
CV6/1/10		Coarse finish, not ground smooth 68.9x33.8x30.1

Table 7.4: Ground basalt sinkers/lures/net weights.

The function of the grooves made at each end of the item from CV2/1/45 may have been to prevent the bound line from slipping from the body of the implement. Examples from the Museo de San Miguel de Azapa (Arica) suggest that this is the case. Given a sufficient number of these implements, variation in design and inherent features (such as grooving) may indeed prove significant. Variation through time and/or space may indicate practical improvements or the adoption of particular styles or techniques and are thus cultural markers.

Along with the sinkers, a ground basalt disc was found in CV2/1/24 (19.7mm diameter x 10.7mm thick). It appeared to have been pecked roughly into shape and then ground smooth around the circumference and ground flat on opposing sides. Its function is not clear.

While there is insufficient material to make any definitive comments, the range of lithic items found at Caleta Vitor indicates that a local source provided sufficient raw material. Apart from only two or three items, there is no evidence of material being imported into the site in any quantity. The types of lithic artefacts found fall within those present at sites including Arica (Playa Miller & Quiani) and Pisagua (Punta Pichalo). This is suggestive of a continuity of the lithic tradition along this section of the coast. The variations that are evident in assemblages from this region would appear to be more stylistic than functional.

While there were only three examples, the coarsely denticulated points are worthy of comment. They are an unusual design but the two specimens from excavated contexts display a relatively broad age range - from the Formative Period (CV2/1/43) to the Late Period (CV6/1/9). The specimen from the Oswald collection also suggests that this style spread over a broad geographic range – from at least Taltal (central northern Chile) to Caleta Vitor, a distance of some 600kms.

Ceramics

While not as prolific as lithics, shell and bone, ceramic sherds are a common sight on the ground surface in certain areas of Caleta Vitor.

In this region, the presence of ceramic artefacts marks the arrival of the Formative Period (beginning around 3500 BP).

Apart from several sherds found along the junctions of the neighbouring sectors (CV2 and CV4), no ceramics were observed on the ground surface of either CV1 or CV7 (Archaic trenches).

No whole, intact items were found and very few painted or decorated ceramic sherds were retrieved from the excavations. Numerous polychrome sherds were found scattered across CV4, CV2 and CV6. Sherds were not common on the ground surface of CV3. Those within CV2 and CV6 were observed in disturbed areas, often *in situ* within exposed, stratified deposits. Much of CV4 appears to have been graded in the more recent past (possibly by the Navy after they stopped using the site) and ceramic sherds were commonly found along graded 'wind rows' at the rear of the beach. Figure 7.4 is a photograph showing some examples from that sector. Without whole, intact items, there is some uncertainty when attempting to place such pieces within any particular phase of occupation. However, based on colour and pattern these pieces may come from the Middle Horizon or Late Intermediate - the San Miguel and/or Gentilar Phase (see Daulesberg 1972: 166 & 168; Rivera 2008: 971-972).

Figure 7.4: Examples of decorated ceramic sherds – CV4 surface finds, Caleta Vitor. Photo: C. Carter

A fragment of a shallow plate that was identified as being from the Late Period (Inka) was found on the surface of CV2 in the vicinity of CV2/1. This piece was a part of a shallow dish decorated with a moulded zoomorphic head (see Figure 7.5). This is typical plate style from the Inka Period and known as a *pucu* (see Bingham 1915: 266). Similar items have been found at Molle Pampa, an Inka Period village in the Lluta Valley (pers.obs.).

Figure 7.5: CV2 Surface find, Caleta Vitor - Fragment of *pucu* (Inka Period)
Photo: C. Carter.

A total of 11.861 kg of ceramic sherds were recovered from excavations. Sherds were sorted and brushed but not washed and a total weight for each excavation unit was recorded. Detailed analysis was not undertaken at this time. For this portion of the investigation, the presence of ceramics indicates the introduction of new materials and technologies and suggests a period of cultural change.

No ceramics were found at Caleta Vitor in those trenches attributed solely to the Archaic Period (CV1 and CV7). The date ranges for the excavation at

CV2/1 are 4243-1931 cal BP. The earliest ceramic sherd comes from CV2/1/27. CV2/1/31 was dated 2702-2354 cal BP and CV2/1/20 dated 2713-2363 cal BP – the Formative Period.

Rivera (2008: 963) suggests that, as the Chinchorro tradition declined, a Highland Andean Tradition appeared in northern Chile, extending as far as the coast. While there was a continuation of some Chinchorro practices for several centuries, features from the circum-Titicaca and Altiplano area appear along the coast and these include, inter alia, the first ceramics. The general timeframe for the periods of this introduction was ca. 4000 BP.

No ceramic material was located in either CV1/2 or CV1/3. The later dates obtained from these trenches are from the early Formative Period (CV1/2/6 - 3263-336 cal BP; CV1/3/1 – 2484-2697 cal BP). One could have expected to find ceramic material within the upper units of these trenches.

As mentioned, CV2/1 contained the earliest dated ceramic remains with a total of 413.6 gms coming from 10 of the upper 27 units. The upper units of CV2/1 also date from the Formative Period (CV2/1/1 - 1931-2129 cal BP). The overall mean weight per unit (upper units only) was 31.8 gms per unit. The mean from the upper 13 units was 31.0 gms and the mean from the lower units was 33.6 gms indicating little variation in the ceramics deposited over this period and a consistency in occupation intensity.

CV4/6 contained a total of 2853 gms of ceramic sherds and was dated between 1570-1810 cal BP (CV4/6/10 – Middle Horizon) and 330-500 cal BP (CV4/6/1 – Late Period). Ceramics were found in nine out of the ten excavated units – CV4/6/8 contained none at all. CV4/6/10 contained 26.8 gms and, apart from CV4/6/8, there was a considerable increase in the later units with CV4/6/3 containing 734.3 gms. The mean weight per unit for CV4/6/1-5 was 464.63 gms and the mean weight for the lower units was 132.6 gms.

CV6/1 contained 3839.6 gms of ceramic sherds and was dated between 551-650 cal BP (CV6/1/16 – Late Intermediate) and at least 500-543 cal BP (CV6/1/8 – Late Period). This trench consisted of 16 units and only one, CV6/1/10, did not contain any ceramics. CV6/1/7 contained 1530.2 gms of ceramic sherds. The overall mean weight per unit was 256 gms, but there was a considerable variation between the upper and lower units. The mean weight per unit for CV6/1/1-7 was 363 gms and the mean weight for the lower units was 184 gms. The increased quantity of ceramics appearing in the upper units may be the result of an increased intensity of occupation concomitant with the arrival of the Inka during the Late Period.

CV4/1 contained 3133.3 gms of ceramics and was dated to between 529-631 cal BP (CV4/1/1) and 535-646 cal BP (CV4/1/19). Both the highest and lowest trenches date from the cusp of the Late Intermediate and Late Periods. However, like CV6/1, there is a significant variation of mean weight per unit in the upper and lower units. The overall mean per unit was 164.9 gms. The upper units mean weight was 246.4 gms and lowers units mean weight was 74.4 gms. Again, this indicates that there may been an increased intensity of occupation at the beginning of the Late Period.

More recently, research using neutron activated analysis (NAA) was undertaken to determine the source of clays used for the manufacture of ceramics at Caleta Vitor (Bland et al. submitted). The results indicate that local clays were the primary source although compositional analysis indicated that there were other clay sources including the valleys around Arica. Results also indicated that the use of local and imported clays were in use over the past 2000 years with little or no change between the samples from the periods where two major cultural groups, the Tiwanaku and Inka, would have impacted on those living at Caleta Vitor. This suggests that there was a local autonomy that was not greatly affected by the influence of the major external groups.

While limited, the evidence indicates that ceramics arrived in Caleta Vitor a little later than in the more intensively occupied valleys such as Azapa and Lluta near Arica. The evidence is also sufficient enough to demonstrate influence, if not dominance, of the larger Andean states and indicated that, unless it was simply an increase in discard rates, there was an increase in the intensity of occupation with the arrival of the Inka.

Textiles

Fibres and/or threads were found in 91 of the excavation units at Caleta Vitor (including textile items or fragments of cloth). Detailed analysis of individual fibres or threads was not undertaken, and only presence was recorded for each unit. No fibres or threads were found in CV3/1, the units from the Early Archaic period. However, threads were common the Middle to Late Archaic units of CV1/2 and CV1/3. Within the trench CV2/1, CV2/1/37 was the deepest unit containing threads and this is likely to have been during the mid-Formative Period (later Azapa phase). The first cotton seeds and bolls appeared in CV2/1/39 (3458-3346 cal BP), and occurred frequently in the trench from this point onward.

A number of textile fragments and threads were found in the CV6 trenches. Only two relatively intact items were located during the excavation. A small textile 'bag' was found in CV6/1/9 (Late Period). The bag consisted of a piece of woven cloth which was gathered at the corners to form a pocket and then bound with string (the binding cord left impressions around the tied area but was not present) (see Figure 7.6). The bag was not opened completely so its dimensions were not determined. It contained a 'ball' of white/light grey powder. While the contents were not tested it is likely that this was lime that was used as a catalyst when chewing coca leaf. Without this powder, the active ingredients in the coca leaf will not react and produce the desired effect.

The second item was the strap of either a bag or pocket of a sling. It consisted of a woven, brown and yellow (faded) rectangular piece that measured 137 mm x 33 mm, with an intricately woven cord attached to both ends and spliced into the rectangular piece. It appears to have been a composite mix of camelid wool with some cotton (see figure 7.7). Bird (1943: 231) describes a sling that he found at Playa de los Gringos (Arica) in very similar terms – 'with round braided cords of two shades of wool, solid woven center and a loop finger grip.'

A looted grave was located adjacent to CV2/1. Apart from fragments of human bone, several textile items were located in the burial chamber. Two hats and five bags were located in this assemblage. See Table 7.5 for details relating to these bags.

Two hats shaped like a truncated cone, similar to a fez, were found at Caleta Vitor associated with looted burials in CV2 (adjacent to CV2/1). Both were damaged but one was sufficiently intact to determine its form and pattern. Figure 7.8 is a photograph of these items. They are constructed in a fashion similar to a coiled basket, with camelid fibre wound around the core used to build up the coil. Coloured yarns were used to produce geometric patterns. Cords were attached to each side and would have been used to tie the hat to the head.

A pre-Hispanic cemetery was located in the Quebrada Chaca (Vitor) about 23 km from the coast. In 1959 a number of tombs (from a total of 21) were excavated and four hats of this style were found (Horta 2011: 558). These tombs have been attributed to the Late/Inka Period. Similar tombs have not been located at Caleta Vitor where burials were in simple, excavated chambers.

Figure 7.6: Textile 'bag' containing white powder - CV6/1/9
Photo: C. Carter

Figure 7.7: Pocket of 'Sling' - CV6/1/7
Photo: C. Carter

Figure 7.8: Hats, '*chucus*', from CV2
Photo: C. Carter

Bird (1943: 251) suggested that these hats were peculiar to northern Chile. A similar hat was found on one of the mummies sent by Bandelier from Caleta Vitor to the AMNH in 1894 (Bird 1943: 251). He described the hat as being 'like a common flower pot' and it had feathers from pelicans and parrots tied in a bunch and attached to a small hole in the top centre of the hat. The feathers were not arranged to stand up but drooped down over the edge of the hat. It was made as a coiled basket with either llama or human hair forming the core of the coil. Black, white, red, tan and khaki dyed yarns were used to decorate the coil and produce a pattern. The mummy wearing this hat also had a Spanish document – a Proclamation of Indulgences dated 1578 – wrapped within a mummy bundle, thus dating the use of the hat to the latter part of the 16th century. Bird (1943: 250) also stated that he was aware of several examples of this style of hat from this area. He knew of another at the AMNH from Pica and the Peabody Museum had one collected by Blake in the 19th century. There are several examples in Museo de San Miguel de Azapa, Arica (pers. obs.; see Horta 2011 for numbers and other locations).

Bag No.	Photograph	Comment/ Dimensions
1		Camelid fibre. Trapezoidal in shape, brown body with cream vertical stitching. Contains white powder. Single piece of fabric folded over and stitched along the sides. 86 wefts over 190mm, 13 warp threads to 10mm. Poor condition – insect holes. 190 x 175
2		Camelid/cotton fibre. Frayed across based, strap missing. Red dominant weft in 40mm bands, with alternating 10mm black bands. Dark warps. Two repeated geometric patterns on red bands – embroidered with white, yellow and cream stitching. 250 x 240
3		Camelid wool. Coarse bag woven with mid-brown and dark brown vertical stripes (wefts). Warps light brown. Folded and stitched on each side – gathered at the neck, drawstring not present. 120 x 110
4		Camelid wool. Small finely woven brown bag. Faded but stripes visible in weave. Thin red line (3 weft threads wide) decorating the bag along with a single small (2mm) copper bead. Loop handle consists of a single 3 ply string. 95 x 85
5		Camelid wool. Brown dominant weft with red, green and yellow stripes. Embroidered repeating pattern – green on red decorated with yellow, red and green stitching. 180 x 170

Table 7.5: Textile bags from disturbed grave - CV2.

Shaped like a 'fez', these hats are known as *chucus* and were indicative of *Aymara* or *Colla* (i.e., highland) identity in the Norte Grande region of Chile, particularly during the Late/Inka Period (Horta 2011: 551; see also Dauelsberg 1972: 171).

The introduction of more elaborate textiles was an indicator of external cultural influences. During the Archaic Period the Chinchorro wove simple fabrics using reeds (*tortora* and *junquillo*) and camelid fibre for use as funerary wraps, loin clothes and wraps (Aufderheide 1993; Standen 1997: 144; Muñoz 2008: 475; Arriaza et al. 2008: 54). Vegetal fibres including cotton were also utilised by the Chinchorro for fishing lines and nets (Arriaza 1995: 5). Daulesberg (1974) found fringed textiles woven from wool and fishing lines made from cotton at Quiani dating from the Archaic Period.

Pre-ceramic sites of northern Peru had evidence of cultigens and artefacts including twined textiles and cotton nets (Pozorski & Pozorski 2008: 607). A Late Pre-ceramic agricultural community at Caral (dated 4600 – 3800 cal BP) had evidence of a variety of cultigens, but 'especially' cotton (Pozorski & Pozorski 2008: 609). Moseley (1975) went as far as to suggest that cotton played a significant role in the rise of the Andean Civilisation and he developed what became known as the 'Maritime Hypothesis', recognising the importance of cotton on coastal Peruvian sites. It is now accepted that cotton becomes more abundant, widespread and a focus in local economies in northern Peru from ca. 5000 BP onward (Pearsall 2008: 116).

During the late Chinchorro/Early Formative period (ca. 3500 BP) in northern Chile, textiles become more complex (Rivera 1991: 15). This included the introduction of the belt-loom; the use of wool together with cotton; and new techniques that produced geometric designs. Tapestry and 'lost-warp' techniques can be seen in the Alto Ramírez phase of the Formative Period (2500 – 1500 BP) (Rivera 1991: 21). The Alto Ramirez

Phase burials also contain mummies wrapped in textiles that display a range of techniques, including twining and braiding with geometric designs, anthropomorphic figures and depictions of trophy heads. Textile production during the Middle Horizon (Tiwanaku) Period displayed further advances in techniques that produced polychrome designs as well as a proliferation of textiles for separate purposes – ceremonial, ritual and domestic (Rivera 1991: 29).

The bags located in CV2 clearly demonstrate an advanced level of textile production. These items may have been manufactured elsewhere but their presence demonstrated influence from outside the region. This statement is supported by the presence of the *chucu* which are indicative of highland influences from the Inka Period. The presence of coca leaf in one bag also demonstrated contact with inland cultures as that plant was grown in the highlands.

The use of fibres from both animal and vegetal sources suggests domestication in both spheres. Either llama or alpaca were the source of the wool, and while there is evidence of camelid faecal pellets at Caleta Vitor, no camelid bone was located, neither in the trenches nor during the surface survey. This contrasts with Molle Pampa, a Late Intermediate/Inka Period site in the Lluta Valley 16km from the coast (Petruzzelli 2012: 74). Camelid bones are commonly seen on the ground surface at that site (pers.obs.). It could be argued that if camelids were present at Caleta Vitor as part of trade caravans, they would not have been commonly utilised as a source of meat as their value would lie elsewhere.

Cotton appears earlier than wool, at least for use in twining fishing line. Its original source would have been from wild plants growing along the floor of the *quebrada*. Domesticated varieties may have been introduced during the Formative Period or spun cotton may have been imported as a finished product. The presence of a spindle whorl (without thread) within a grave at

CV2 suggests that some threads were locally produced, at least during the later periods.

The complex textile items and more refined ceramics from the later periods clearly demonstrate introduced technologies. The sources were most likely highland cultures, either directly via trade caravans or indirectly via settlements in the adjacent valleys (Azapa and/or Camarones), or from the valleys in the Precordillera.

Bone

Bone was used to manufacture a range of implements including *chopes*, spear and arrow points, fishing lures and in composite hooks. Six bone points (or parts thereof) were found ranging from CV4/6/5-7 and CV6/3/2-3, 9 (all Late Period units). Bird (1943) found similar bone points at Quiani and Punta Pichalo. He was unsure as to their use but suggested they may have been used to tip fishing spears or were gorges – an early form of hook. Table 7.6 contains photographs of the points from Caleta Vitor.

Three bone points of a different design were located in CV6/1, one each from units 3, 8 and 13. These differed in shape to those previously mentioned. The points are cut from bone and worked to provide a flat surface on one end to allow a close fit when bound onto a shaft (see Table 7.7). Their shape suggested that they were components (most likely barbs) used in the manufacture of composite fish hooks/lures - where the barb was lashed to a ground basalt body (see Figure 4.8 for an example). Alternatively they may have been barbs for harpoons tipped with lithic points (see Figures 3.6 & 4.4 for examples).

As mentioned in Chapters Three and Four, the Chinchorro used modified sea lion rib bones as chisels to prise molluscs from rocks – these implements were known as *chopes*. Three *chopes* were found at Caleta Vitor and were dated from the Formative through to the Late Periods (see Figure 7.9).

Trench/Unit	Photograph	Dimensions (LxWxT in mm)
CV4/6/5		54.4x12.3x4.1
CV6/3/2		Tip broken off 51.1x9.4x3.7
CV6/3/3		Broken 17.2x9.8x2.9
CV6/3/3		Broken 16.1x8.6x3.7

Table 7.6: Examples of barbed bone points, Caleta Vitor

Trench/Unit	Photograph	Dimensions (LxWxT in mm)
CV1/3/25		Bone lure/composite hook 81.6x13.1x9.5
CV6/1/8		Worked bone – ?part composite hook or barb 77.0x18.2x5.3
CV6/1/13		Worked bone – ?part composite hook or barb 36.2x7.9x4.6
CV6/3/3		Worked bone – ?part composite hook, barb 65.4x7.0x5.1

Table 7.7: Examples of bone barbs, Caleta Vitor

Figure 7.9: Examples of chisels – *chopes* - made from sea-lion rib.
Upper – Found in association with burial CV4/2/4 –Formative Period
Centre - with bound hand grip. Surface find CV3 – Formative Period
Lower – from excavation CV6/1/9 – Late Period.
Photos: C. Carter

Shell

Molluscs were a major resource for the inhabitants at Caleta Vitor. Shellfish made up a significant portion of the diet, however the shells themselves were used for practical purposes. Large valves were useful as containers, more robust species could be fashioned into decorative pieces, particularly beads, and fish hooks were rasped out of certain species of mussel (*choro*) shell. Several examples of shell being used other than as a food resource were located in the excavations at Caleta Vitor.

Evidence for the use of shell valves would be minimal if the pieces had not been modified in some way, or, as in the case of containers, if residue from their contents was not present. To simply use a bivalve shell as an implement such as a scoop or a spoon would not necessarily leave evidence that could be discerned without detailed examination. Likewise, to use a naturally sharp edged valve as a scraper or knife would leave similarly scant evidence.

Shells used as containers were found in two units, CV6/2/4 and CV4/1/16 (both dated to the Late Period). In both instances, traces of red ochre were found inside valve fragments (see Figure 7.10). The use of shell to manufacture fish hooks is discussed in the section 'Fish Hooks' which follows.

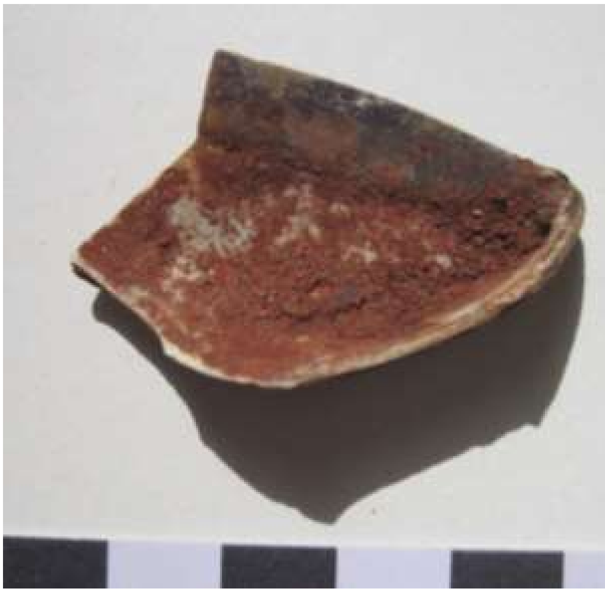


Figure 7.10: CV6/2/4 - Mussel valve containing red pigment
Photo: C. Carter

The most commonly found shell artefacts were decorative beads. These were generally white in colour, between 3-6mm in diameter, 1-2mm thick with a hole between 1-2mm bored through the centre. Many hundreds were noted during the surface survey, particularly in CV2 where concentrations were found in association with looted burial chambers. These were most likely bead necklaces that were damaged as mummies were disturbed. This type of bead was found strung around the neck of a burial found in CV4/3 (Formative Period).

A total of sixteen beads were found during excavation. Only one bead was found in a trench dated to the Archaic Period (CV1/2/9). The remainder were found in trenches dating from the Late Period (five from CV4 and ten from CV6). While a positive identification has not been made, the most likely shell species used in bead manufacture was *loco*. How the beads were shaped or bored has not been determined. However, the fine bore and smooth finish suggest a high degree of skill and a well-developed technology. Table 7.8 contains photographs of a sample of beads recovered during excavations.

A ground shell (*choro*) disc which was 11.7mm in diameter and 1mm thick was found in CV4/6/1. This disc did not have a central hole bored through it. Due to its relatively small size, it was probably not to be made into a fish hook and was more likely to be used as a decorative piece, used as an inlay or further enhanced for use on a necklet.

Trench/Unit	Photograph	Dimensions (mm)/comment
CV2		Selection of surface finds
CV1/2/9		8.1x1.5 2.7 diam. hole. ?*choro*
CV4/1/18		(L) 3.1x2.1 1.3 diam hole (C) 2.9x1.3 1.5 diam hole (R) 3.6x1.5 1.5 diam hole (part)
CV6/1/3		(L) 3.6x1.6 1.4 diam hole (R) 3.4x1.1 1.3 diam hole
CV4/6/1		11.7x1.0 *choro*

Table 7.8: Examples of shell beads from Caleta Vitor (ground shell).
Photos: C. Carter

Fish Hooks

A total of nine hooks (of parts thereof) were located at Caleta Vitor. Of those seven were shaped from cactus spine, one was cut from mussel shell (*C. chorus, choro*) and one was copper. Nine unshaped cactus spines were also found. These modified spines may have been intended for use as hooks but were also used as needles with an 'eye' cut into the proximal end. It is not known how the spines were shaped but these items appear to maintain their strength even after being buried for several thousand years. The spines may have been shaped while they were green and pliable or techniques that may have been involved boiling or otherwise treating them.

Prehistoric fish-hooks are common in archaeological assemblages in this region. Bird (1943) found numerous shell and thorn hooks from the Arica excavations – sufficient for him to suggest that the earlier settlers used shell hooks which were later replaced by hooks made out of cactus thorn – a clear indicator of technological change. Later investigations found that this was not a common pattern and that other sites had both shell and thorn hooks used at the same time, or reversed in order, that is with thorn hooks being replaced by shell hooks.

At Caleta Vitor, cactus hooks were found in trenches dating from the Archaic Period (CV1/3) and the Formative (CV2/1PC). Unshaped cactus spines were found in CV6/1 and the only shell hook came from CV3/1/19 (Archaic Period). Table 7.9 contains examples of hooks found at Caleta Vitor. These hooks would have been used primarily for bait fishing. Some may have been attached by a short length of line to drag behind a lure.

Trench/Unit	Photograph	Dimensions
CV1/3/13		Cactus hook. Shaft missing 22.2mm wide
CV1/3/21		Cactus hook. Shaft missing
CV2/1/46		Cactus hook. 27.5x14.2x1.6
CV3/1/19		Mussel shell hook, part only. 19.9x5.5x1.5.
CV6 surface		Copper hook, 32.3x18.4x3.6 diam

Table 7.9: Examples of fish hooks from Caleta Vitor.

A major technological advance in this area was the introduction of metals which occurred as early as the Alto Ramirez phase of the Formative Period (Rivera 2008: 966). Bird (1943: 214) found copper hooks at Playa Miller (Arica) from the Intermediate to the Late Period. He only found one copper hook at Punta Pichalo and that was from the upper level of the excavation (Bird 1943: 266). One copper hook was found at Caleta Vitor on the ground surface within CV6 (see Table 7.9). Copper is currently mined along the flanks of Quebrada de Vitor. Traces of copper ore were commonly encountered on the ground surface and within the excavations at Caleta Vitor.

Wood

Only two wooden artefacts were found in the excavated trenches. One wooden item was found in CV6/1/7 (Late Period). This was a fragment measuring 58mm x 38mm (see Figure 7.11). It had been cut and carved but badly damaged. It may have been the base of a container that had been carved out of solid piece of wood, once divided into separate chambers. Wooden items, particularly snuff trays, were common from the Alto Ramírez (Formative) through the Tiwanaku phase of the Middle Horizon (Rivera 1991: 21; 2008: 964). Snuff trays were generally shallow and were often elaborately decorated with carvings and/or shell inlays (including bead inlays). They were used to hold snuff for inhalation through bone tubes.

Figure 7.11: - CV6/1/7 – fragment of worked wood.
Photo: C. Carter

Foccaci (1959) excavated a number of tombs located in the Quebrada Vitor in the vicinity of the Panamerican Highway in the Valle de Chaca. He found several wooden boxes associated with the burials. Sections had been carved into the surface of the item from CV6/1/7and it may have been a snuff tray.

The second item found in the excavation was wooden point, possibly an arrow tip. It measured 93mm long with a 6.9mm diameter. It was sharpened at the distal end with the remains of some binding around the proximal end (see Figure 7.12).

Figure 7.12: CV6/3/6 – wooden point.
Photo: C. Carter

The wooden point in Figure 7.12 was similar in form to arrow points located in a burial in CV2 adjacent to CV2/1 (see Figure 7.13). A bow and five arrows were located in a disturbed grave (no body present) that had filled with loose sand, debris and several artefacts. They were located grouped together standing upright against the grave wall – this may have been their original position, placed within the grave standing between the grave wall and the mummy bundle. The bow was only 510mm long and the arrows were tipped with carved wooden tips, not likely to be effective projectiles against any prey that had either feathers or hide (see Figure 7.13).

Figure 7.13: CV2 – miniature bow and arrows.
Photo: C. Carter

Table 7.10 provides a description and dimensions of these items. This bow and arrow set may well have been a miniature replica of three types of weapon. Bird (1943: 212) found a bow and arrows associated with a burial at La Lisera (Arica). He did not provide dimensions for these items but he described them as 'a miniature bow; six arrows, with thorn tips and two feathers on each.' This burial also contained, *inter alia*, a miniature harpoon forepiece, miniature 'water jar', miniature *kero* cup and a miniature log raft.

A wooden harpoon forepiece was found on the surface of CV2. This item was 136.1mm long with a diameter varying between 12-14mm. A conical shaped proximal end had a diameter of 18.5mm and was 40.3mm long. The distal end was socketed to take a [stemmed] point. Figure 7.13 is a photograph of this item. The conical shaped end fits into a socketed harpoon shaft, most likely with a cord attached to the forepiece. A stemmed stone point, possibly along with a bone barb, would have been fixed to the socketed end. Bird (1943) found a number of similar forepieces at Arica (see Figure 4.4 for examples).

Item	Dimension/Description
Bow	Slightly curved, carved/scraped timber shaft, 510mm long, 13.6mm diam at thickest point, 8.1mm diam at thinnest. Cotton string attached at both ends. Both shaft and string stained with red ochre.
Arrow	2 piece wooden shaft, socketed to take wooden tip. Split at distal end to take feather fletches which were bound with string. Tip fitted into proximal end and bound with string. Total length 437mm, shaft 325mm x 10.5mm, tip 117mm x 6.5mm. Majority of shaft stained with red ochre, area adjacent fletch not stained.
Arrow	2 piece wooden shaft, socketed to take wooden tip. Split at distal end to take feather fletches which were bound with string. Tip fitted into proximal end and bound with string. Total length 444mm, shaft 326mm x 9.5mm, tip 117mm x 5.5mm. Majority of shaft stained with red ochre, area adjacent fletch not stained.
Arrow	2 piece wooden shaft, socketed to take wooden tip. Split at distal end to take feather fletches which were bound with string. Shaft 324mm x 7.5mm. Majority of shaft stained with red ochre, area adjacent fletch not stained
Arrow	Wooden shaft, socketed to take wooden tip but tip missing. No fletches present. Shaft 325mm x 9.5mm, Majority of shaft stained with red ochre, area adjacent fletch not stained
Arrow	2 piece, intact. Wooden shaft, socketed to take wooden tip. Split at distal end to take feather fletches which were bound with string. Shaft 324mm x 7.4mm. Majority of shaft stained with red ochre, area adjacent fletch not stained Tip separate, 118mm x 4.7mm.

Table 7.10: Description of bow and arrows found in CV2

Figure 7.14: CV2 – wooden harpoon forepiece.
Photo: C. Carter

No analysis has been undertaken to determine the species of wood used for the construction of the wooden items found at Caleta Vitor. A number of trees including *Schinus molle* and *Algarrobo* spp. grow along the watercourse at the base of Quebrada de Vitor. Seeds and pods from these species were found during the excavation. An *algarrobo* pod from CV1/2/6 was dated to 3263-3360 cal BP. Seeds from the *molle* were found as early as CV1/3/4 which is likely to date at least as early as CV1/2/6 and *molle* seed was abundant during the Late Period (CV6/1 & 3). This indicated that wood was available locally. Timber from these trees may have been utilised for the manufacture of harpoon shafts and heads.

Miscellaneous Items

There were few other items that warrant detailed discussion. The most perplexing of those are four items that consist of short lengths of strings attached to an object – having no obvious function or purpose. Table 7.11 contains images and description of these items. They are similar in that each has a string attached. The range of materials tied to these strings is broad – from a small maize cob, a broken gastropod to amorphous stones. The gastropod was attached to a length of string that was in turn tied to another, different piece of string. They are not all sinkers that could be used for fishing – the maize cob would float and the gastropod shell would not be heavy enough to work efficiently, nor were the attached lines strong enough to be used for fishing. The stones were too light and the strings not strong enough to work effectively as *bolas*. Their function is unclear. It has been suggested that they may have been toys, something to keep children amused (Santoro, pers. comm.).

Trench/Unit	Photograph	Comment
CV4/1/12		Broken gastropod, *Tegula atra*, with string attached tied around column of shell valve. Length of string made up of two separate pieces tied together - one piece cotton, the other camelid wool.
CV6/1/2		Small maize cob tied to short length spun cotton string.
CV6/1/9		Small fragment of basalt (unworked) tied to a short length of thin spun cotton string.
CV6/3/3		Small fragment of basalt (unworked) tied to a short length of thin vegetal fibre string.

Table 7.11: Miscellaneous items – function unknown

Rock Art

Painted figures were located in five separate loci at Caleta Vitor, however all panels are situated to the south of the beach within caves, under overhangs or on rock panels at the base of cliffs. A range of anthropomorphic, zoomorphic and abstract figures were recorded, painted in red/orange or white pigment.

Due to the dynamic nature of the landscape, it is likely that the survey did not locate all the painted figures in this area and, in cases, alterations to the landscape (e.g. landslides, road construction) may have destroyed or obliterated some panels.

It is possible that geoglyphs may be found in the Quebrada de Vitor. Geoglyphs are known in the region (e.g. the Rosario site in the Lluta Valley and in the vicinity of Codpa (Quebrada Chaca) inland from Caleta Vitor (pers. obs.). This survey was limited to the area along the coastline and did not venture inland due to issues with access.

The following describes examples of parietal art located at Caleta Vitor.

CV5/1-2

This sector of the site contains a series of caves at the base of the cliffs along with several shallow overhangs. Archaeological deposit is apparent in each of the caves and includes shell, bone and vegetal remains. Three of the caves and a shallow overhang contain painted figures. In general, the images are in poor condition. A number have been deliberately damaged and overwritten with chalk, others have been scratched or rubbed. Many have been obscured. However, in some cases, this may have been due to natural weathering processes. The caves themselves are used by visitors to Caleta Vitor as toilets and are strewn with faecal matter and toilet tissue. In fact, one cave was not inspected due to its condition – the northern-most cave is worse than the others due to its ease of access.

In 2010 a survey of the art sites at Caleta Vitor was undertaken by staff from the Universidad de Tarapacá (Sepúlveda 2010). They recorded 99 figures over 14 panels. The majority (64%) were painted in red, with 19% in orange, 5% a combination of red/orange and 12% in cream/white or highlighted with a light colour. Most of the figures were unidentifiable (58%), 17% were animals and 5% human figures. Of the animals, two were fish, one an unidentified quadruped and the remainder were camelids.

Figures 7.15-7.19 contain examples of the painted figures. Figures 7.15 and 7.16 are photographs of figures in CV5/2 that may represent sea-lions or small species of cetaceans. Figures 7.17 and 7.18 are also from CV5/2. Note the damage to the panel – chalk has been used to deface the images. It also appears that the rock face has been scratched deliberately.

One figure in Figure 7.17, while partially obscured with chalk, was a human wearing a plumed head-dress. Examples of this type of head-dress are displayed at the Museo de San Miguel de Azapa (Arica). These head-dresses are adorned with the feathers of rhea (*Rhea pennata*), a ratite that is generally found in the highlands, particularly the Altiplano. Like an ostrich, rhea have decorative plumes. The Bandelier collection at the AMNH also contain items adorned with rhea plumes (Cat. Nos. B4430 and B4432). These were buried with mummies retrieved from Caleta Vitor.

Figure 7.15: CV5/2 – painted figure, possibly a sea lion
Photo: D. Valenzuela

Figure 7.16: CV5/2 –painted figure of sea-lion or small cetacean
Photo: D. Valenzuela

Figure 7.17: CV5/2 – painted figures, quadrupeds and human wearing headdress. Note recent deliberate damage. Photo: C. Carter.

Figure 7.18: CV5/3 – painted figures, quadrupeds. Photo: C. Carter.

CV5/3

This locus was not inspected closely as it located approximately 30m above the current ground level and was inaccessible without climbing equipment. As such the exact dimensions of the overhang are not known. From the ground there appears to be a small shelf, perhaps 5m x 2m, which is sheltered by an overhang. Figures painted on a vertical slab can be seen from the ground. On the left side (north) of the panel there are three stylised quadrupeds, possibly guanaco or llama, painted in white pigment and several, undefined, figures in a red pigment. The white figures appear to overlay the red figures on the right hand (south) side of the panel. To the left there are another series of figures in red pigment. One figure is clearly a quadruped, possibly a camelid while the others (at least eight) are not clear.

This section of the cliff was altered when a track was constructed around the base of the cliff. Drill core holes indicate that a quantity of rock was blasted from the cliff to make way for the track. It is not possible to determine the original nature of this section. The form of the cliff may have once provided easier access to the shelter of CV5/3. Figure 7.18 is a photograph of CV5/3 taken with a zoom lens.

CV6

This locus contains several red figures painted on the vertical surface at the base of the cliff at where the talus slope meets the cliff face. The figures appear to be camelids – either guanaco or llama. There are at least three camelids painted on this panel. However, several other obscure red figures are also present (see Figure 7.19). A coating of dust has obscured the form of these figures.

The location of these figures suggest that the talus slope has been at its present level or slightly lower for some time (since the time of painting). While there may be a ledge covered by the scree, access to this particular point would have been difficult if the scree had not provided a foot hold. This slope remains active and numerous rock falls were witnessed during fieldwork. Numerous rocks that have fallen from high above the site are scattered across the lower portions of this area. Due to concerns regarding safety, these panels were not closely inspected nor recorded in any detail. Figure 7.19 is a photograph taken from some distance away (hence no scale).

Figure 7.19: CV6 – painted figures, llama.
Photo: D. Matthews

While not all panels included camelids, the majority of animal imagery were quadrupeds and thought to be llamas. There was no evidence to suggest that camelids were hunted to any extent during the Archaic Period nor was there any evidence for the presence of domesticated species, either llama or alpaca, prior to the Formative Period (around 3500 BP). The abundance of camelid dung during the Late Period does suggest that it was more likely that the images date from that period when occupation may have been at its most intense.

* * *

Overall, excavations revealed relatively little by way of material culture. The investigation targeted deposits of refuse so this was not surprising. However, the material found at Caleta Vitor clearly illustrated the nature and timing of several aspects related to cultural change. The appearance of ceramics ca 2500 BP, along with more complex textiles accorded with previous models that highlight the influence of inland/highland, circum-Titicaca cultures. The evidence of these cultural shifts has been observed in sites in the coastal valleys, particularly those around Arica, and to the east Caleta Vitor. The presence of a *pucu* dish also indicated the presence of Inka during the Late Period.

Rivera (2008: 974) recognises the influence of Altiplanic (highland) traditions but also suggests that a degree of autonomy can be detected at some locations. This, he suggests, resulted in the cultural diversity and social complexity that is evident in northern Chile's prehistory. The extent that such cultural change and external influence affected the local economy should be discernible in the midden remains at Caleta Vitor.

The following chapter includes a discussion on the human remains and burials found at Caleta Vitor. Again, the goal is to discern cultural change and ascertain what changes occurred to funerary rituals through both time and space within these sites.

Chapter Eight

The excellent preservation in which all were found was to be attributed to the absence of rain in Peru: they were covered in and protected by dry sand, and would appear to be imperishable. (Price 1884: 274)

Mortuary and Burial Practices

Variation in burial practices are indicative of cultural change, with abrupt shifts suggesting external influence and imposition of new cultures, while gradual change and reduced variation tends to indicate local development. This chapter includes a summary of regional mortuary practices from the Archaic through to the Late Periods along with a description of the human remains and burials observed at Caleta Vitor. The majority of the descriptions relate to remains and burials that were noted during the surface survey. While not targeted during excavations, several burials were encountered and the contents recorded at a basic level (without removal).

Considering that evidence for more than 9000 years of funerary practices is present in the broader region, it is perhaps not surprising that a broad array of burial practices were noted at Caleta Vitor. In northern Chile, hunter and gatherer groups from the Archaic Period are distinguishable as they regularly laid their dead in a horizontal position, mostly extended on their backs (supine). Variations to this pattern occur where bodies had their legs flexed or hyper-flexed (Arriaza 1995a, 1995b; Standen and Santoro 2004; Standen et al. 2014;). The position and treatment of corpses display important differences between hunter-gatherer funerary rites and those practiced by later farming and pastoralist societies, when flexed burials and mummy bundles became more common along with the use of well-constructed tombs and a broader array of grave goods.

The discussion contained herein clearly demonstrates significant cultural variation within the sites at Caleta Vitor that closely resemble changes in funerary practices on a broader, regional level. Several samples from burials were radiocarbon dated to allow an understanding of the timing of culture change at this specific location. This, along with a chronology developed using other examples of local material culture, allowed a determination of where the people from Caleta Vitor were placed, in a temporal sense, when compared to the broader region.

Human remains are one of the most commonly recognised elements within these sites. Scattered human bones were frequently encountered on the ground surface and burials (both intact and disturbed) were common in exposed sections. It is clear that burials were a feature of the cultural landscape of Caleta Vitor and indicate a range of traditions. As such, the burials themselves can be used as chronological markers in areas where no radiocarbon dates have been obtained. Burials from the Chinchorro period would include extended burials, some with signs of artificial mummification, associated reed matting and an absence of ceramic grave goods; Formative burials are more likely to be flexed and may be associated with ceramics; later periods include flexed bodies wrapped in textile bundles with plaited hair and more elaborate grave goods. Varying burial practices are in themselves indicative of changes in ritual behaviour that can allude to variations in social complexity and stratification. Abrupt change may have signalled dramatic cultural shifts that was the result of colonisation or domination by a foreign entity, in this case, most likely emanating from the highlands.

Using the sectors as defined previously, this chapter will describe the burials located during both the survey and the excavations. During the surface survey, *in situ* burials and clusters of human bone were recorded. Excavations did not target human remains, in fact sites were selected for excavation based on a decreased likelihood of discovering human remains. However, burials were found in several instances (CV1/3, CV4/3, CV4/4 and adjacent to CV2/1).

Samples of bone taken from a number of burials were radiocarbon dated and subjected to stable isotope analysis ($\delta^{13}C$ and $\delta^{15}N$) (see Roberts et al. 2013 for dating of human remains: results below). While many of the dated samples relate to surface samples and cannot contribute significantly to the nature of the site's stratigraphy, the dates obtained are useful in determining an occupational sequence when comparing specific sectors.

Lab No.	Sample ID	Material	δ13C,‰	14C age yrs BP	±	Age (cal 2 sigma)
OZN924	CV2 B2b S2	Human Bone	-12.6	1725	30	969-1304
OZN923	CV2 B2a S2	Human Bone	-12.4	1760	30	989-1336
OZP070	CV6 burial	Human bone				1613-1820
OZP071	CV6 burial	Human bone				1615-1821
OZP072	CV6 burial	Human bone				1635-1872
OZP069	CV6 burial	Human bone				1721-1896
OZN919	CV3 B2 S3	Human Bone	-12.5	2420	35	1694-2119
OZN920	CV4 Sq3	Human Bone	-15.1	2575	35	2072-2422
OZN921	CV1 B1 S2	Human Bone	-12.2	3710	35	3274-3696

Table 8.1: Radiocarbon dates obtained from human skeletal remains at Caleta Vitor.

Burials at Caleta Vitor

CV1

Survey

The surface survey identified scatters of human remains in several locations. One was adjacent to a disturbed area (probably due to military activities) in the mid-section of the site, and consisted of the inferior portion of a cranium, including the base and maxillary portion. The remains are most likely of an adult male, judging from the heavily marked muscle attachment sites on the nuchal plane, the prominent external occipital protuberance, and the large sizes of the mastoids and supramastoid crest, the latter of which formed an angular torus-like structure. The left PM1 and PM2 were still present in the maxilla, but all other teeth were lost post-mortem. This individual also exhibited bilateral auditory exostoses, indicating a regular exposure to cold water during life (probably due to diving for marine resources) (Quilter & Stocker 1983; Wise et al. 1994; Standen et al. 1997). A sample taken from this bone returned a date of 3274-3696 cal BP (OZN921).

Several *in situ* burials were found exposed on the surface towards the southernmost and highest area of CV1, approximately 115m above sea level on a 30° slope. At least three individuals were identified. The burials were extended and with their heads directed to the south. Fine reed matting was located under the exposed bone. There was also a chert flake and some bird bone and human hair found in association with the burial. Further bone was partially exposed, most likely a humeral head, also beneath reed matting and possibly from the same individual.

A loose mandible lay on the ground surface with a layer of feathers and bird skin (with feathers attached) adhering to it. It displayed male characteristics, including a wide, square chin with a prominent mental trigone, gonial eversion, and marked masseteric tuberosity. The left I1, PM2 and M1 and right I1, I2, M1 and M2 were present. All other teeth were lost post-mortem. Based on the minimal level of wear on the molars, age was estimated to be less than 22 years (Lovejoy 1985).

Two ribs were exposed eroding from the ground surface one metre to the east of the mandible. Twined reed matting, bird skin and human hair were associated with them, but may not have been *in situ*.

Figure 8.1: CV1 - human mandible found in association with Chinchorro burials. Note bird skin and feathers – evidence of ritual burial practices where the body was wrapped in animal skin prior to interment. Photo: C. Carter.

A small scatter of human bone was located at the northern (lower) edge of CV1. It consisted of an isolated right femur buried in an oblique orientation and roughly oriented east west. Apart from a medial end fragment of a left clavicle, no further skeletal elements from this individual were located, suggesting that the burial had been disturbed. The diaphysis and distal end of the femur were coated with mud and associated with fragments of reed. Numerous stone artefacts were recovered in the vicinity of the bones.

The nature of the human remains within CV1 – extended burials, associated with reed matting, bird skin and feathers - suggest that they were from the Chinchorro cultural period.

Excavation

CV1/3

Human remains were located between 450-520 mm below the natural ground surface in unit 8. A disarticulated radius, ulna and scapula were found in the north-west corner of the square. A fibula was found in unit 9, immediately below the other bones. A reed matting bundle appeared in the rear wall of the trench in unit 10, approximately 700 mm below NGL and protruding ~100 mm into the trench. A left femur, tibia and fibula (articulated) were located adjacent to the reed bundle. While our team was absent from the site over a weekend, the reed bundle started to deteriorate (probably due to wind erosion) and a calcaneus was exposed from within. Loose bones were removed from the trench to allow the excavation to continue, but were replaced and buried at the conclusion of the excavation. The reed bundle was left intact and later reburied. Figure 8.2 is a photograph of the trench CV1/3. The loose human bone mentioned above was located in association with the reed matting that was exposed in the rear wall of the trench (loose bone is visible to the right of and immediately below the matting). It was suspected that the matting was burial covering and that human remains were inside. This was confirmed later as the matting was disturbed by an intruder to expose human bone.

The exposed stratigraphy of CV1/3 indicated that the body was interred in a shallow grave, possibly even laid on the ground surface. The overlaying deposit appeared to have built up evenly from that time to form horizontally bedded layers.

Comment

Radiocarbon dates from trenches CV1/2 and CV1/3 were dated from the mid Archaic through to the early Formative Period. CV1/3/14 returned a date of 6496-6717 cal BP, and CV1/3/1 a date of 2348-2698 cal BP. It is likely that the reed-wrapped burial dates from the mid to late Archaic.

Figure 8.2: CV1/3 - evidence of burial. Note reed matting which wrapped an interred body. Photo: C. Carter.

The loose bones found in CV3/1/8 and CV1/3/9 may have come from an earlier burial that was disturbed during the interment of the intact bundle.

The Chinchorro regularly used reed matting to wrap the deceased prior to burial, or placed the bodies on reed mats. No ceramics were located within CV1. The dates obtained and the associated cultural material accord with the Chinchorro Culture, and the extended burials associated with reed matting clearly fit within that designation. Using bird skin with feathers attached to wrap or decorate a body is also a trait known to be used by the Chinchorro.

Recent excavations within the city limits of Arica have revealed a high density of burials at some Chinchorro sites. Sitio Colon 10 was such a site, located within the confines of an extant building on the edge of the modern residential area. Following the discovery of number of mummies in 2004, the ownership of the property was transferred to the Universidad de Tarapaca and the site eventually became a museum. The mummies (>30) remain largely *in situ* and a clear, plexiglass floor has been built over them so the public can see them, virtually as they were found. It appeared that bodies were either laid out on the ground surface or buried in shallow graves.

In 2006, construction work at a hotel on Calle Yungay, Arica, approximately 250 m from Sitio Colon 10, resulted in the discovery of 18 mummies within an area no larger than 8 sqms.[1] At both Colon 10 and Calle Yungay, the mummies were buried in close proximity to one another without any particular orientation. In some cases, one mummy would overlay another by only a few centimetres. Sitio Colon 10 is located on the lower slopes of El Morro, a headland overlooking Arica. Earlier excavations at the Morro 1 site, located approximately 150 m south of Sitio Colon 10, produced 134 Chinchorro burials (Standen 1997: 134).

The topography of CV1 is very similar to that of Morro 1, Colon 10 and Calle Yungay, being on the northerly aspect of a moderate to steep sandy hill overlooking a river terrace, although the river in Arica has nowadays been built over. If the burial pattern at CV1 was anything like that revealed at Colon 10 and Calle Yungay, it is highly likely that CV1 contains a relatively high number of Chinchorro burials.

CV2

Survey

When compared to CV1 and CV4, CV2 is a relatively small area. However, this sector contains deep deposit and has been disturbed to a far greater degree than the other two sectors. As such, it provided access to a great deal of sub-surface material without the need for excavation. The surface survey identified scatters of human remains in several locations.

[1] I was involved in this salvage excavation.

Four concrete bunkers (most likely magazines) and two artillery pieces were constructed by the Armada de Chile within CV2. They were cut directly into the midden and through numerous burial chambers (now empty). During our field season, either an earth tremor or a looter exposed an intact mummy bundle in one such burial chamber, located above the corner of the easternmost bunker. Evidence indicates that another burial may have been placed on top of this, but the chamber had been emptied. The mummy bundle above this bunker was originally placed in an excavated chamber cut into the midden. Introduced fill (modern), similar to that found across the paved area of the site, was found within the chamber, suggesting that it had been opened previously. The body was seated and oriented to face the southwest and covered with a layer of reed matting and pelican skin. The bundle was placed on a bed of large feathers (most likely pelican), and several artefacts were located within the chamber, including a wooden spoon, maize cobs, a *chuspa* (textile bag) containing maize cobs and kernels, a gourd, a small woven basket containing several maize cobs, a pair of leather sandals, a textile bag containing an unidentified powder, and a wooden spindle whorl.

Figure 8.3: CV2 – concrete bunker constructed by the Armada de Chile.
Red arrows mark probable burial sites. Photo: C. Carter.

Following a brief examination without removal from the chamber, the exposed mummy bundle was reburied, primarily to conceal it. The site was revisited several months later (November 2010) and the bundle had again been disturbed and part of the body exposed. While not fully exposed, the visible portion of the cranium appeared to be that of a sub-adult or small adult female. The bundle was again reburied and concealed with a layer of small stones and sand. The site was revisited in January 2011 and the mummy had been exposed again. While the body remained *in situ*, the cranium was no longer present. I reburied the remains once again. Another visit in July 2012 revealed that the mummy had been removed from the chamber, placed on the edge of the bunker, and covered with a plastic bag

Figure 8.3 is a photograph of one exposed section within CV2 and probable burial chambers are marked - few contained human remains or grave goods as it is highly likely that they had been targeted by looters.[2] The black plastic

[2] On several occasion during field work, visitors were observed looking over this area of the site and several actually commented that they were looking for '*oro*' - gold.

located to the rear right on the bunker wall was covering a mummy bundle when this photograph was taken (2012).

A disturbed burial was located in a niche lined with reeds and feathers in the natural bank running directly behind the platform area of CV2, to the east of the concrete bunkers. The chamber appeared to have been looted, with fragmentary human remains of at least two individuals, an adult and an infant, scattered below the original burial site. A complete infant left femur and complete adult right 2nd and 3rd metatarsals were recovered from directly below the burial, in the wall.

Two *in situ* burials were located <1m apart close to the base of the escarpment running along the southeast periphery of CV2. Some fragments had eroded out of the section, and on closer inspection there appeared to be bone remaining *in situ*. Samples for dating and stable isotope analysis were taken from the diaphysis of a left tibia, and a complete left talus was also collected. The burial was associated with woven matting and some loose reed matting. One bone sample returned a date of 989-1336 cal BP (OZN923), and the second was dated to 969-1304 cal BP (OZN924) (Roberts et al 2013).

Excavation

CV2/1

No human remains were located within this trench, although a pair of whale ribs were located 800 mm below NGL within unit 31. The whale ribs (paired) were laid out intentionally and appeared to continue to the east, beyond the edge of the trench. The trench was extended to the east at unit 31 to ascertain whether the whale bones were part of a larger assemblage. The extended excavation revealed that the ribs did not continue outside CV2/1 by more than a few millimetres.

However, two cavities were revealed in the southern wall of the trench above unit 31. One had been filled with loose sand and contained five textile bags (one containing coca leaf, another a white powder), a textile cloak, one small red feather (possibly from a parrot), pelican skin and feathers, fragments of decorated polychrome pottery, a [broken] wooden harpoon shaft, a length of sea lion hide cord and a woven cane bag.

The other chamber contained a body, seated and wrapped in a textile bundle. It faced south and was placed on a bed of pelican feathers, with a small bow and five arrows placed upright between the mummy bundle and the chamber wall (see Fig. 7.13, Table 7.10 and pages 252-253 for descriptions). Several bones were located within the burial chamber, but outside the textile bundle. These included a very small ilium (?neo-natal), a sub-adult mandible with deciduous molars erupted, and sub-adult cranial fragments from at least two individuals. The body was removed from the chamber for reasons of security, but was not unwrapped. It was reburied in the trench once the excavation had been completed.

Comment

Numerous burials within CV2 were dug into the midden deposit. The excavated chambers were slightly larger than was required to accept each wrapped body – up to 900 mm deep, roughly circular and ranging in width from 450 – 600 mm. Some were lined with feathers, others with reed or other plant material; many of the exposed chambers appear to have been emptied of mummy bundles and/or grave goods.

Radiocarbon dates obtained from samples taken from the excavation of CV2/1 range from 1880-1723 cal BP (CV2/1/11, UGAMS10511, seed) to 4243-3989 cal BP (CV2/1/58, UGAMS10515, charcoal). Three other dates obtained from excavated samples in CV2 range from 1992-1707 cal BP (Beta 251627, charcoal) to 1992-1707 (Beta 251628, charcoal). Skeletal material located during the surface survey of CV2 has been dated to 1336-989 cal BP (OZN923, human bone) and 1304-969 cal BP (OZN924, human bone). The disparity between the dates from the excavated material and the human remains suggests that the site was utilised for domestic refuse disposal from the Archaic Period through to the Late Formative, when the focus of activity appeared to have shifted from this area. 400 years or so later, this area of the site became a favoured area for burial during the Middle Horizon, and was possibly abandoned during the Late Intermediate and Late Periods.

CV3

Survey

This sector consists of four artificial mounds, *túmulos*, built over a near level terrace to the south of the Quebrada Vitor stream bed. The survey did not include the area to the east, beyond the immediate vicinity of the mounds. Shell, bone and lithic items were commonly seen scattered across the site. Several fragments of human bone were noted. In 2008, an adult human cranium was observed eroding out of the eastern slope of the southern mound. It was covered with small stones and a layer of sand for protection, but could not be located on subsequent visits. It is highly likely that it was illegally excavated and removed as this particular area appeared to have been recently disturbed.

The *túmulos* were constructed in a line running roughly north-south over a distance of 128 m, located on the valley floor immediately to the north of the slope of CV1. The escarpment dividing CV1 and CV2 slopes down quite steeply to the valley floor, where it appears to level out. This section is covered with loose sand and gravel, and formed the arbitrary division between CV3 and CV4. The excavation in CV3/1 exposed bedrock 1.4 m below what was thought to be natural ground level. It was later determined that the bedrock was capped with 1.1m of stratified midden deposit, which in turn became the basal level of the mounds. Radiocarbon dates from CV3/1 indicate that the midden deposit below the mounds had built up over a period of at least 9000 years.

The central area of mounds has been grossly disturbed by non-archaeological excavation and indiscriminate digging. It is difficult to determine if there were originally three or four mounds. A single distinct mound is located at the south end of the line; this is the tallest (~5m high), and measures approximately 42 x 20 m. The central area may have held two separate mounds or a single large ovoid mound that measured 66.5 by 59 m. The northernmost mound is much lower and less distinct. It measured approximately 27 by 29 m.

As mentioned in Chapter Six, the mounds were constructed of alternating layers of soil, grass and reed. No ceramics were located within them, or in the vicinity on the ground surface. Several wooden posts were visible protruding slightly from the top of the southern mound. They may have been grave markers, but no excavation was undertaken.

Human bones were located within the surface material, but it was uncertain if they were part of a burial or reworked from another context. None of the human remains were in articulation. One sample of human bone from the northernmost mound returned a date of 1694-2119 cal BP (OZN919) placing it within the Late Formative Period.

Excavation

CV3/1

No human remains were located during the excavation of CV3/1.

Comment

Regionally, the construction of mounds (*túmulos*) is indicative of the Late Formative Period (ca 2500-1500 BP) within the Alto Ramirez Phase. The date obtained from human remains from the mound at CV3 was 1694-2119 cal BP and places the burial within that particular timeframe. Given that the Chinchorro burials are often associated with midden deposit (e.g. Moro 1, Calle Yungay, Sitio Colon 10), burials from this early period may be found in

CV3 but below the *túmulos*. However, given that CV3 extended over a flat area, burials may have been concentrated further up the slope [of CV1].

CV4

Survey

Despite the large area of CV4, no human remains were observed during the surface survey of this sector. A large portion of this sector is covered by vegetation, both grass cover and a stand of exotic trees (*Eucalyptus* spp. and *Casaurina* spp.). It is also a highly disturbed area. Visitors frequently drive through it (on and off made tracks) and many areas have been used for camping. There were also several naval buildings built within the sector (now demolished), along with a helicopter landing pad.

Excavation

CV4/1

This excavation was situated in the centre of a large flat area below the mounds of CV3. A dense midden deposit that had been previously disturbed by construction work was selected for excavation (CV4/1). The trench was located ~50 m west of CV3/1 (*túmulos*), but no human remains were found. This trench returned dates solely from the Late Period.

CV4/2

As mentioned in Chapter 6, the tops of fifteen timber posts were found in CV4 to the west of the largest *túmulo* in CV3. The excavation at CV4/2 selected one such post (chosen randomly by a member of the excavation team) to ascertain its function. It appears to have been a grave marker as a human burial was found directly beneath it. A layer of reeds was placed above the body but appeared to cover an area far broader than this specific burial.

The skeleton was in a seated position, but slumped, and oriented to the southwest some 450 mm beneath the top of the post. The skeleton was examined without removing it from the trench. There was some hair on the scalp, along with fragments of skin adhering to the facial bones. The position of the body suggested that it was placed within the grave at an angle, neither upright nor laid on its back, with the lower limbs drawn up to the chest (see Figure 8.4). Damage or post-mortem displacement of the torso may have been due to crushing by vehicles, especially if the body was covered by reed matting and decomposition resulted in a cavity forming within the ground.

Cultural material associated with the burial included several fragments of coarse pottery and a shallow coiled basket approximately 250mm in diameter (left *in situ*). A *chope* made out of the rib of a sea lion was located adjacent to the body. No textiles were found in association with this burial.

A radiocarbon date of 2422-2072 cal BP (OZN920, human bone) was obtained from a sample from these remains.

Figure 8.4: CV4/2 – human remains located beneath timber post.
Photo: C. Carter

CV4/3

As with CV4/2, a timber post was located in the centre of this trench (again randomly selected by a member of the excavation team). Human bones were exposed less than 100 mm below NGL. The skeleton was further exposed within the trench to a depth of 200mm below NGL but not removed. The cranium was severely damaged, to the point where the mandible had been crushed so that it was compressed against upper portion of the orbits. The frontal and parietal bones were severely fragmented. The right leg and arm were sufficiently intact and articulated to show how the body had been placed in the grave - lying flexed on its left side with the head to the east. Closer examination revealed that the crushed cranium had been filled with ash, sandy gravel and fragments of wood. A 'bob tail' clump of hair, bound with string, was also associated with the cranium – a common hair style from the Formative Period. A number of shell beads (~6-7 mm diameter) were located around the neck. The burial was also associated with woven reed matting. Figure 8.5 is a photograph of the exposed burial.

Figure 8.5: CV4/3 – human remains located beneath timber post. Photo: C. Carter

Comment
The date from the sample taken from the human remains found in CV4/2 indicated that the burial was from the Alto Ramírez (Later) Phase of the Formative Period.

At CV4/2 and CV4/3, the disposition of the skeletal remains (flexed), grave goods (reed matting and pottery fragments) and hair style (single plait) are indicative of the Formative Period. However, the cranium from CV4/3 had been filled with ash and sand, similar, in part, to artificially mummified Chinchorro burials.

Aufderheide (2003: 148) suggested that all Alto Ramírez mummies were spontaneously mummified and the bodies were interred in a range of positions from supine to semi-flexed. The burial from CV4/3 may be indicative of a transitional phase, between the Chinchorro, 'artificial', mummification practices and the flexed interments of the Formative and later periods. Aufderheide (2003: 141) noted the sequence at Arica moved from extended mummies from the Chinchorro period (both artificial and natural mummies) followed by the Quiani phase with semi-flexed bodies lying on their right side with subsequent burials containing bodies hyper-flexed in the seated, foetal position with the knees draw up under the chin. The burial from CV4/3 may indicate a local tradition, based on Chinchorro funerary practices that continued for some time as artificial mummification techniques were gradually displaced.

The presence of the *chope* suggested that the individual was associated with diving and shellfish collection. The remains from CV4/2 were not removed and those from CV4/3 were so badly damaged that it was not possible determine if the crania had been subjected to deformation nor if auditory exastoses were present in either specimen.

The association of wooden posts with the burials may have been a regional tradition. Bird (1943) reported similar wooden posts at Punta Pichalo. Other similarities at Punta Pichalo include the use of reed matting and horizontal posts associated with burials. Muñoz (1980) also located burials marked with timber posts at the site AZ-70, on the Rio Jose inland from Arica. It is highly likely that the area of CV4 studded with the wooden posts contains more burials and was part of a larger cemetery.

CV5

No human remains were noted within CV5.

CV6

Survey

Numerous clusters of human remains were encountered on the ground surface along the entire length of CV6. Several clusters were located beneath rocks which, at first glance, appeared to be set in mud mortar, but the dynamic nature of this sector make such an interpretation uncertain. The entire sector is capped with a layer of scree which ranges from fine gravel to large (>500 mm) rocks. This region is subject to regular earth tremors and minor rock falls were witnessed during the field season. This sector would not have been a safe and stable place to reside.

One complex of burials with a high density of human skeletal remains was located in the central area of CV6. Burials were located in a niche created underneath a boulder, but had been heavily disturbed and looted. The rear wall of the niche was lined with stones which appeared to be held in place by mud mortar. The skeletal remains were disarticulated and mixed up. An inspection of the elements present revealed a minimum of nine individuals, with at least three adults, at least one late teen to early twenties, at least one juvenile, and at least four infants. Among the remains was a particularly large and robust adult and a naturally mummified sub-adult right foot. There was some reed attached to one radius and some faunal remains, consisting mainly of sea lion, fish and bird. There was also some finely woven matting, textile, twine, and a small shell bead associated with this burial.

Another burial complex was located several metres to the north and down-slope. These remains were also disturbed, disarticulated and mixed up. Some elements were protruding from the slope, and limited excavation exposed a series of infant ribs which were encased in naturally mummified skin, some adult metatarsals, an adult fibula, a left femur, a radius, ribs, and a canine with substantial occlusal wear and a large carious lesion. There was some woven reed matting and textile surrounding the infant remains, and some loose reeds and textiles associated with the adult remains. A pile of stones was placed directly above this burial, upon which was located a possible feline paw and a variety of other skeletal remains, largely from infants and juveniles.

A scatter of human bone was also located on the cliff edge at the southern end of CV6. The bones were disarticulated and located within a hollow beneath a large rock. The scatter included assorted ribs, mandible, cranium, vertebrae, humerus, radius and ulna, tibia and fibula, and one femur.

Four samples from burials at CV6 were taken for radiocarbon dating. The dates all cluster within the late Formative Period, Alto Ramírez Phase – from 1613-1896 cal BP (see Table 8.1).

Excavation

No human remains were located during the excavations of CV6/1, CV6/2 or CV6/3.

Comment

The majority of the burials identified within CV6 had been subjected to looting or dislodged and disturbed by earth tremors. Indeed, it is possible that some of the remains may have been the result of accidental deaths due to rock falls.

The dated samples from the excavations of CV6/1 fall within the Late (Inka) Period (500-543 cal BP, UGAMS 10522; 551-650 cal BP, UGAMS 10523). Four dates were obtained from human remains from burials in CV6 and all fall within the Late Formative Period, Alto Ramirez Phase, (1721-1896 cal BP, 1613-1820 cal BP, 1615-1821 cal BP, 1635-1872 cal BP; OZP069-OZP072). The excavations at CV6 did not reach a sterile layer. Work ceased there due to concerns over safety. It is possible that further excavation may reveal evidence that the area was used for residential purposes and not just for burials. Several exposed sections of the midden deposit south-west of CV6/3 are over 3m deep and are likely to contain evidence of much earlier settlement, including some dating from the Formative Period.

The remains of at least fifteen individuals were noted within CV6. As this number was recorded during a surface survey only, it is highly likely that many more burials exist in the area and that this sector (or parts thereof) was used as a cemetery, particularly during the Formative Period, and the site was later used for more intensive residential purposes.

CV7

Survey

The midden located within CV7 was exposed by road works and confined to a relatively small area along a modern track. However, a few fragments of shell and bone were noted on the ground surface over a broader area. The midden was located at the head of a shallow gully running down to the valley floor, to the east of a spur line that commences high above CV7. There are several rocky exposures within the gully, including some low overhangs which naturally created small voids. Human remains were located within one low (~400 mm) overhang, approximately 50 m southwest within the gully and down the slope from CV7/1.

This burial appears to have been removed from its context and then redeposited in the burial niche, since recently broken cranial fragments had been placed within the cranial cap. The remains were the most complete of any burial recovered, and provided an opportunity to document some details of this individual.[3]

The burial itself had features of a Chinchorro period burial, in that several bones were coated in mud, and reed wrapping was prominent on several, particularly the cranial cap, the right humerus, the distal right radius and ulna, some ribs, and part of the innominate. The disturbed burial chamber contained a great deal of reed and twine, as well as numerous bird feathers and several shell fragments.

Sex

The burial was determined to be that of a female, based on a visual assessment of the morphological features of the cranium, mandible and remains of the sacrum. The glabella was smooth, and superciliary arches were absent. The supraorbital margins were thin and sharp. The frontal bone was rounded and vertical. The mastoid processes were small, and the supramastoid crest was only slightly developed and terminated before the external auditory meatus. There were only slight muscle markings on the nuchal plane. The mandible did not display any gonial eversion or ramus flexure. The masseteric tuberosity was smooth, the mandibular condyles and the mental trigone were small and the chin was pointed. The sacrum was wide and flat.

Age

The superior portion of the left face of the pubic symphysis was present among the skeletal remains. This portion of the pubic bone was weathered and difficult to assess. However, utilising the features that were visible, it was noted that the pubic tubercle was fully separated from the symphyseal face. There was no lipping of the margin and the face was generally fine grained, although there were some remnants of billowing. These features correspond

[3] Jaime Swift and Michael Westaway provided much of the comment relating to this individual.

with the fourth phase from the Suchey-Brooks method, giving an age range of 26 to 70 years with a mean age of 38.2.

Further to the assessment of the symphyseal face, it was noted that the epiphyses of all long bones present, as well the clavicle and the sacrum, were fully fused. Additional indicators of age include evidence of osteoarthritis on the fourth and fifth lumbar vertebrae, discussed further below. There was also heavy wear on the occlusal surfaces of all teeth present, including the incisors, which were worn down to expose the pulp chamber. The pronounced occlusal wear pattern, after Lovejoy (1985), indicates an age range 45-55. The sagittal suture exhibited significant closure. The coronal suture also exhibited significant closure and was almost completely obliterated towards the lateral edges.

Palaeopathology

Numerous modifications to the bone were observed, including a dental abscess at the root of the left PM2 with surrounding porosity in the mandible. There was no evidence of dental caries or calculus. The occlusal surfaces of the teeth were considerably worn.

There was evidence of osteoarthritis with some osteophytic lipping on the inferior, anterior border of the fifth lumbar vertebra, and pronounced lipping on the superior, lateral borders of the fourth lumbar vertebra.

There was a significant depression in the parietals more than halfway along the sagittal suture, posterior to bregma. There was a cut mark within the left, anterior edge of the depression, but it is uncertain if it represents a deliberate incision or shaving of the bone, or an impact with an implement that had a slightly sharp edge. The edges of the incision were still sharp. However, the edges of the depression were rounded and smooth.

There is a gentle oblique pattern of wear on the right mandibular molars. The presence of bevelling on the anterior margin of the right glenoid fossa, when compared to the left, is indicative of right handedness.

The remains may have been a secondary burial, although the presence of reed matting and feathers suggests that it was originally interred in the niche. It is apparent that the body had been removed at some time and roughly replaced. No grave goods were located in association with the remains.

Excavation

No human remains were located in the excavation of CV7/1.

Concluding Comments

The mortuary practices evident at Caleta Vitor display a range of ritual activities that correspond with those seen with the burials at Arica to the north and further south at Pisagua (Punta Pichalo). The temporal range, observed thus far, extends from the early Archaic Period (Chinchorro), through the Formative, Intermediate and Late Periods, into the Colonial era. The entire range of burial practices was located within a relatively small area.

The artificial mummification practices of the Chinchorro culture extended some distance to both the north and south of Vitor. If Arica and Camarones are considered to have been the centres of Chinchorro culture, then Vitor must be included within that zone. Evidence suggests that Vitor sectors CV1 and CV3 contain significant deposits from this period, and are likely to contain a number of burials. Based on previously excavated Chinchorro cemeteries (e.g., Morro I, Sitio Colon 10) it is likely that a large number of burials would be located within CV1.

The Formative Period was well represented with marked graves in CV4 and the *túmulos* of CV3. The burial at CV4/3 was significant in that it displays evidence of a transitional period where artificial mummification practices (filling the crania with ash etc) were gradually replaced and not abruptly removed. The similarity in styles of contemporaneous burials along this section of the coast clearly indicated cultural and societal links amongst coastal populations.

Burial patterns also disclosed distinct patterns of land use. CV1 shows evidence of occupation from the Archaic through to the early Formative, and was used for domestic purposes as well as burial. CV3 displays evidence of early occupation (but no early burials as yet), and is overlaid with what appeared to be Formative material as there are no ceramics present in the vicinity of the *túmulos*. CV2 contains evidence for two distinct phases – from the Late Archaic to the Late Formative it was used for domestic purposes, and as a cemetery during the Middle Horizon. CV6 contained evidence of intensive occupation during the Late Period but was utilised during the Formative, at least as a cemetery, and possibly for residential purposes. CV4, to the rear of the beach, has a high frequency of material from the Late Period but was occupied from at least the Late Formative. The burials located within CV4 were from the Formative Period and may have been placed in association with the *túmulos*. The area of CV4 at the rear of the beach, some distance to the west of the *túmulos*, may have been a locus of domestic activity and not used for burials.

Given the number of burial chambers exposed in CV2 and the quantity of human remains scattered across CV6, the frequency of burial appears to have increased during the Intermediate and Late Periods. Deposition rates of cultural material also increased during these periods.

The evidence of mortuary practices at Vitor provides an insight into the broader social fabric of the region. As the evidence ranges from the early artificial mummies through to the Colonial Period, Caleta Vitor should be regarded as an important heritage resource for the investigation of human settlement of the western Andean region of South America, in general, and northern Chile, in particular.

* * *

The variations in the material culture and burial practices at Caleta Vitor are indicative of at least six significant shifts in the cultural environment of this particular region – early hunter/gatherer/fishers who buried their dead with little or no alteration; a community who revered their dead and introduced complex mummification techniques (Chinchorro); a developing culture that used simple ceramics, textiles and constructed mounds (*túmulos*) and buried their dead flexed but largely unaltered; a more complex culture with access to an agricultural economy and trade items who buried their dead flexed in textile bundles with an array of grave goods; the advanced culture and economy of the Inka; and, finally, traditional burial methods accompanied by Colonial grave goods.

However, did these changes spread beyond death related ritual or items of dress and decoration to their base-line economy? Were such developments and advances in technology transferred to the exploitation of natural resources and improvements to their economy? Did those living at Caleta Vitor shift their focus from the sea, turning inland to rely on the resources of who might have introduced some of the changes from the interior? Or did simple cultural adjustments absorb the impact of change that allowed an existing, successful economy to continue?

Whatever the case, the faunal assemblage at Caleta Vitor should contain evidence to indicate change. An improved or 'better' economy may be evident in an increased array of exploited species; an increase in the size of prey; an increased range in the habitats of prey species (from benthic to pelagic to oceanic); a base diet that includes introduced varieties (exotic plants and animals); as well as non-local production indicative of trade and contact with inland/highland groups.

Chapter Nine

> *Despatches and messages were sent from Cuzco, by Indian runners, stationed at relays, throughout the empire. Fish, for the Inca's table, were carried in the same way from the sea to Cuzco.* (Hutchinson 1874: 323)

Fish

Fishing remains an important commercial enterprise in this region and Arica is a major port, processing small species such as sardines and anchovies into fish meal (an industry that was once a lot more productive than it is today) along with a fleet that target a range of demersal and pelagic species with vessels that range from small, single handed dinghies through to large, ocean-going trawlers.

In an arid environment, such as that found in the Atacama Desert, fish remains in an archaeological context can be well-preserved. While not as obvious as shell, fish remains were clearly visible in many areas at Caleta Vitor. As expected, fish bone was well represented in the excavated assemblage and found in 188 (94.9%) of the 198 excavated units. A total of 17.072 kg of fish bones was retrieved and sorted into dentition, vertebrae, otoliths and miscellaneous bone. The condition of the bone varied considerably; much of the assemblage was fragmented and often very fragile, a number of specimens were encrusted with natural salts and soils; some had been cooked or burnt while others were intact and in very good condition.

The first section of this chapter describes, in general terms, the range of fish likely to have been present in the waters off Caleta Vitor in the past. This is based on those identified from excavated remains, species identified in other archaeological reports as well as assumptions related to species that are captured in the area today. In this section, the category 'fish' includes Osteichthyes (bony fish) and Elasmobranches (sharks and rays) but does not include marine mammals (such as whales or sea-lions). Species are not necessarily listed in order of abundance although the more common species head the list. Common behavioural traits are included to provide some reference as to how, when and where these species might have been captured. Partial results of several archaeological investigations in Peru and Chile where these species are mentioned are also incorporated into this section.

Osteichthyes (Bony Fish)[1]

The following table lists fish identified from excavated remains. Those marked within a cross (+) are typical to the region and are commonly seen at the markets in Arica.

Species	Common Name	Habitat
Sciaena deliciosa+	*Roncacho*	Benthic pelagic
Isacia conceptionis+	*Cabinza*	Neritic pelagic
Cilus gilberti+	*Corvina*	Upper sub-littoral
Trachurus symmetricus+	*Jurel*	Oceanic/neritic pelagic
Hemilutjanus macrophthalmus	*Apañado*	Neritic/benthic sub-littoral
Cynoscion analis	*Ayanque*	Benthic pelagic
Anisotremus scapularis	*Sargo*	Upper sub-littoral
Paralabrax humeralis+	*Cabrilla*	Upper sub-littoral
Sardinops sagax+	Sardine	Neritic pelagic
Engraulis ringens+	Anchovy	Neritic pelagic
Galiechthys peruvianus	*Bagre* - catfish	Upper sub-littoral
Paralichthys microps+	*Lenguado*	Upper sub-littoral
Labrisomus phillipii	*Tomoyo*	Sub-littoral/demersal

Table 9.1: Fish species common to Northern Chile.

[1] Medina et al. 2004 and Kong & Castro, 2002 were the major references and source of photographs used for this section.

Sciaena deliciosa - roncacho

Member of the Sciaenidae family, *roncacho* are a benthic/pelagic species found on sandy bottoms from the shore-line to the edge of the continental shelf. They feed on amphipods, polycaetes and micro-crustacea. The length of the specimens caught locally ranges between 200-300 mm (150-350 gm), up to a maximum of 378 mm (commercial fishing records).

Roncacho (also known as *lorna* in Peru) generally inhabit coastal waters but are known to follow food sources during El Niño events moving into waters up to 150m deep (Arntz and Tarazona 1990: 349).

The *roncacho* is described as having a small mouth. They are an important year round commercial species for local fisheries in northern Chile. *Roncacho* are regularly caught by anglers fishing in the shallow waters of Arica, both within the port area and along the beach front (pers. obs.). The jetty at Chinchorro beach was a favoured platform for local anglers to fish for this species (prior to its removal). The most common bait used locally was *nape*, a small crustacean gathered from the shallow waters of the beach. While they are commonly caught on hook and line today, relatively small steel hooks are used. In the past, shell or thorn hooks had a relatively large 'gap' (~20 mm) and would have been unsuitable to catch any but the larger specimens of this small-mouthed species.

Roncacho are widely distributed and appear to have been relatively common during the prehistoric period. They are mentioned amongst Preceramic remains found at Alto Salaverry (northern Peru) (Quilter and Stocker 1983: 549). At the Ostra Base Camp site in central northern Peru (dated to the Preceramic Period, 6250–5450 BP), *roncacho* made up 16.7% of the total (based on NISP) (Reitz and Sandweiss 2001: 1094).

At terminal Pleistocene Quebrada Jaguay (southern Peru) they made up 11.2% of the vertebrate remains (NISP) (Sandweiss et al. 1998: 1831), although the proportion is likely to have been far higher as 81.9% of the remains at Quebrada Jaguay were unidentified and were likely to have contained more *roncacho*. At Quebrada de los Burros, located just to the north of Arica in southern Peru, *roncacho* made up 55.9% of the total fish remains identified (NISP) between 10,000 and 6000 BP (Lavallée et al. 2011: 338). At La Chimba 13 (central northern Chile) Llagostera et al. (1999:163) found *roncacho* to be the third most abundant species (4.7% of total, MNI based on otoliths) after *sargo* and *cabinza* in layers dated between 10,280 and 9170 BP (Llagostera et al. 1999, 163).

Moving forward to the Late Period, immediately before the Inka conquest in AD 1470, *roncacho* occurred in large numbers at Cerro Azul, in central Peru, (Marcus et al. 1999: 6586). Marcus (1987: 396) observed local fisherman in that area using nets to catch them in large numbers when the fish congregated near the shore to feed on shrimp.

Roncacho were identified via otoliths and dentition (mandible and pre-maxilla). Remains were located in 73.7% (n=145) of excavated units at Caleta Vitor. The MNI count for *roncacho* identified via otoliths totalled 931.

To investigate the relationship between living body size and bone size ranges, a *roncacho* was purchased from the markets at Arica. It was 252 mm long and weighed 220 gm; its mouth was 25 mm wide when fully extended and it had 24 vertebrae (including the caudal). The centrum of the largest vertebra was 6mm in diameter and the smallest was 3.5 mm. The otoliths measured (length x width) 9.3 x 5.4 mm (0.14 gm) and 8.8 x 5.4 mm (0.14gms) respectively. Based on the fish that were for sale, this specimen appeared to be an average size.

Isacia conceptionis - cabinza

A member of the family Haemulidae, *cabinza* are a neritic pelagic species found along sandy shorelines from 0-50m in depth. They feed on crustacea, polycaetes and algae. They are generally regarded as a secondary commercial species. The average length of specimens caught locally is between 170-250 mm (48-180 gm). They have 26-27 vertebrae.

Llagostera (1979) found this species to be dominant in an archaeological assemblage from Abtao-1 (central northern Chile). They were followed by two Sciaenids, *corvina* and *roncacho.* At La Chimba 13 Llagostera et al. (1999:168) found *cabinza* to be the second most abundant species (9.7% of the MNI based on otoliths). *Cabinza* made up 5.33% of the fish bones found at Quebrada los Burros (Lavallée et al. 2011: 338) and one individual (0.7% of total) was identified at Ostra Base Camp (Reitz and Sandweiss 2001: 1094).

Cabinza were identified via otoliths. Remains were located in 21.8% (n=43) of excavated units at Caleta Vitor. The MNI count for *cabinza* identified via otoliths totalled 100.

Cilus gilberti- corvina

Another member of the Sciaenidae family, the *corvina* is an upper sub-littoral species found from the shoreline to the edge of the continental shelf, particularly over a soft sea bed. They feed on small fish, mainly sardines and anchovies, as well as invertebrates. The specimens caught locally are generally larger than *roncacho* and range in length between 270-900 mm (150-7050 gm). They are a very important local commercial species (a valuable export market) and are sought by recreational anglers due to their size and the fine quality of their flesh.

Corvina are relatively easy to identify via their otolith that are generally larger than most and have a distinct morphology. They have been recorded in numerous archaeological assemblages in Chile and Peru. Their numbers, however, are generally lower than those of the smaller, but similar, species such as *roncacho* and *cabinza*. Olguin et al (2015: 11) found that *corvina* made up 4.1% of the total number of fish (MNI=34/826) retrieved from Copaca 1, an Archaic site on the central north coast of Chile. At La Chimba 13 Llagostera et al. (1999:168) found that *corvina* made up 3.8% of the total (MNI based on otoliths). Lavallee (2011: 338) found that *corvina* made up 2.8% of the total (NISP) at Quebrada de los Burros with *roncacho* at 55.9%. At Cerro Azul (Peru) *corvina* made up less than 0.2% of the fish remains (NISP).

Corvina were identified via otoliths. *Corvina* were identified in 25.3% (n=50) of excavated units at Caleta Vitor with a total MNI of 60.

Two *corvina* were sampled from local markets. The first weighed 1130 gm and was 423 mm in length. Its mouth was 38 mm wide when extended. It had 25 vertebrae (including the caudal), the largest was 9.6 mm in diameter and the smallest was 7.2 mm. The otoliths measured (length x width) 13.6 x 7.1 mm (0.40 gm) and 14.1 x 6.9 mm (0.40 gm). Based on the specimens observed in the markets this is a small example of the species. The second specimen weighed 2510 gm and was 585 mm in length. Its mouth was 50.5mm wide when extended. It had 25 vertebrae, the largest being 13.6 mm in diameter and the smallest 9.9 mm. The otoliths measured (length x width) 16.0 x 8.1 mm (0.54 gm) and 15.8 x 8.0 mm (0.53gm). This specimen can be regarded as medium-sized. Large specimens at the market were over a metre long.

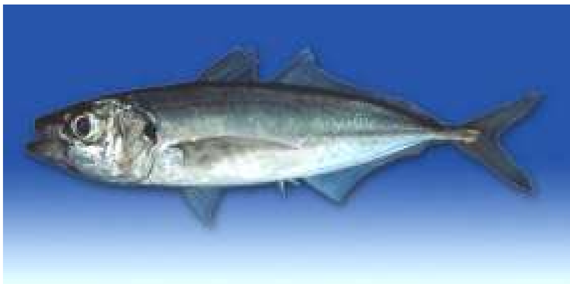
***Paralichthys adspersus* – *lenguado*, flounder**

Flat-fish (flounder) are found on sandy bottoms up to 300m in depth and are common along beaches. Lengths caught locally range between 380 and 680 mm (590 gm to 4.185 kg). They are a commonly caught species at Caleta Vitor today, particularly during the winter months (pers. obs.). They are caught from the shore using hand-lines fishing over sandy bottoms (although anglers appear to favour fishing from rocks that adjoin a sandy sea-bed). Modern anglers fishing from beaches or over sandy bottoms often use small fish, such as *perjerry*, for bait.

Small quantities of flounder were found at Cerro Azul (Marcus et al 1999: 6568); La Chimba 13 (Llagostera et al. 1999: 168); and Quebrada los Burros (Lavallée et al. 2011: 338).

Lenguado were identified via their maxilla and/or dentaries. Remains were located in 22.8% (n=45) of excavated units at Caleta Vitor. The NISP count for *lenguado* identified via dentition totalled 81.

***Trachurus murphyi* – *jurel*, jack mackerel**



An oceanic/neritic pelagic species that is widespread and common over a broad range. *Jurel* mass in large schools and feed mainly in coastal areas but migrate to oceanic waters to spawn. They feed on micro-crustacea (Euphausiids), small fish and larvae. Events that impact on Euphausid levels, such as *El Niño* cycles, affect their abundance (Barber & Chávez, 1986: 284). *Jurel* respond to such events by migrating to cooler, more nutrient rich waters and, as such, are able to survive very severe *El Niño* events and return as soon as water temperature and prey species normalise.

The lengths of the specimens caught locally ranges between 220-270 mm with some recorded specimens up to 600 mm in length. *Jurel* are an important commercial species, used for the production of fish meal and fish oil, as well as being canned for human consumption.

While they are a pelagic species, *jurel* follow prey into shallow, coastal areas. In 1979 Stocker (see Quilter and Stocker 1983: 549) witnessed schools of anchovy swarming off the beaches at Curayacu (central Peru). During the night they began 'leaping' out of the water and on to the beach. People were gathering up the stranded fish, not only for eating but also to use as bait to catch the *jurel* that were chasing the anchovy toward the shore. This suggests that *jurel* could have been caught from the shore more easily at certain times and also captured in nets intended for anchovy.

Jurel bones are commonly identified in archaeological sites in Peru and Chile. Lavallée et al. (2011: 338) reported that 13.7% of the fish remains from Quebrada de los Burros were *jurel*. Lavallée et al. (2011: 338) found they made up 13.7% of the total (NISP) at Quebrada de los Burros; whereas Llagostera et al. (1999: 168) found that *jurel* only made up 1.6% of the total (9/554 MNI) at La Chimba 13. In stark contrast, Olguin et al (2015: 11) found that *jurel* made up 71.4% of the total number of fish (MNI=590/826) retrieved from Copaca 1.

Jurel were identified via otoliths. Remains were located in 11.6% (n=23) of excavated units at Caleta Vitor. The MNI count for *jurel* identified via otoliths totalled 46.

Hemilutjanus macrophthalmus* - *apañado

This benthic/pelagic sub-littoral species is found in rocky areas over 10 m in depth at the base of drop-offs. They are a commercial species often caught with *congrio* which inhabit similar areas. They are also carnivorous and feed on crustacea and small fish. The lengths of the specimens caught locally ranges between 140 and 500 mm (40-2,178 gm).

At La Chimba 13 *apañado* made up 5.1% of the fish remains (24 out of a total of 475 MNI) (Llagostera et al. 1999: 169). Of note, out of the 22 levels excavated, *apañado* were found in only six, with 87.5% (n=21) found in the top five. Level one produced more than 50% of these bones.

Apañado were identified via otoliths. Remains were located in 9.1% (n=18) of excavated units at Caleta Vitor. The MNI count for *apañado* identified via otoliths totalled 20.

Palabrax humeralis - cabrilla

A member of the Serranidae family, the *cabrilla* is an upper sub-littoral species found from the Ecuador to the far south of Chile. They live over rocky sea-floors and feed on crustacea and fish. Lengths caught locally range between 140 and 580 mm although there is significant sexual dimorphism. They are caught on hand-lines or in gill nets and sometimes speared.

Cabrilla have been recorded in prehistoric contexts. At La Chimba 13 Llagostera et al. (1999:168) found *cabrilla* to be relatively abundant, making up 7.5% of the total (MNI based on otoliths) from an assemblage that contained 14 fish species. However, they only made up 1.4% of the total (MNI=2) at the Ostra Base Camp (Reitz and Sandweiss 2001: 1094).

Cabrilla were identified via otoliths. Remains were located in 8.1% (n=16) of excavated units at Caleta Vitor. The MNI count for *cabrilla* identified via otoliths totalled 20.

Cynoscion analis - ayanque

A member of the Sciaenidae family, *ayanque* are a pelagic species that feed on anchovy and sardines. They are similar to *corvina* in both appearance and habit but tend to prefer warmer waters. Their geographic range is reported as being between Santa Elena, Ecuador, and Coquimbo, Chile. They have also been described as 'northern invaders that come as far as Coquimbo' (Llagostera 1979: 316).

Commercial fishery returns indicate that 14 tonnes of *ayanque* were landed in 2000 within northern Chile. Lengths recorded commercially range from 160 to 360 mm but can reach 470 mm.

This species is not often found in Chilean waters and is most abundant around 6° and 7° south latitude off Peru. However, at La Chimba 13, Llagostera et al. (1999) found that *ayanque* represented 11% of the total number of otoliths. However, out of a total of 48 (MNI), 46 were located in the upper three levels (out of a total of 22). Llagostera et al. suggested that the increased incidence was a result of episodes of warm water intrusions. Conversely, only three specimens (0.03%) were located at Quebrada los Burros (Lavallée et al. 2011: 338) and at Ostra Base Camp *ayanque* made up 4.9% (MNI = 7) of the total (Reitz and Sandweiss 2001: 1094).

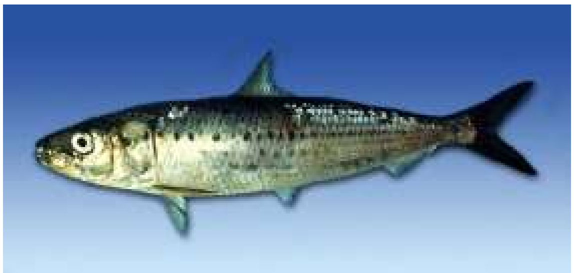
Ayanque were identified via otoliths. Remains were located in 4.5% (n=9) of excavated units at Caleta Vitor. The MNI count for *ayanque* identified via otoliths totalled 13

Anisotremus scapularis - sargo

A member of the family Haemulidae, the *sargo* is a dynamic sub-littoral species found over sandy and rocky sea-beds from 0-30 m in depth. They feed on crustacea, polycaetes and small fish. As a rule, juveniles are found in small schools closer to the shoreline with adults becoming more benthic/pelagic. Lengths of those caught locally range between 130 and 475 mm (35-1,955 gm). They are a secondary commercial species caught for fresh consumption and are sometimes caught by anglers at Chinchorro beach when fishing for *roncacho* (pers. obs.)

At La Chimba 13, Llagostera et al. (1999: 168) reported that *sargo* made up 62.7% (n=298) of the total MNI (475) (identified via otoliths). Apart from some mid-levels that contained no fish bone at all, their occurrence was relatively consistent in the upper and lower levels. This is in stark contrast to Quebrada Los Burros where they only made up 0.6% of the total (NISP) (Lavallée et al. 2011: 338). Similarly, *sargo* at Cerro Azul made up 1.7% of the total (NISP) (Marcus et al., 1999: 6568) and they only made up 1.4% of the total (MNI=2) at the Ostra Base Camp (Reitz and Sandweiss 2001: 1094).

Sargo were identified via otoliths. Remains were located in 2.5% (n=5) of excavated units at Caleta Vitor. The MNI count for *sargo* identified via otoliths was 7.



***Sardinops sagax – sardina*, sardine**

A member of the family Clupeidae, sardines are small epi-pelagic forage fish that are found from the shoreline up to 250 km off-shore. They are filter feeders, consuming plankton. They are an important species for upper trophic level species such as sea-lions, sharks, sea-birds and a number of pelagic fish species. This species of sardine has between 48-54 vertebrae (Whitehead, 1985) and lengths are between 150 and 250 mm (30-80 gm).

In northern Chile, sardines are regularly seen close to the shore, often just beyond the waves. Their presence can trigger 'feeding frenzies' in which sea-lions, dolphins and sea-birds (gulls, terns, pelicans, cormorants) all take part (pers. obs.). They are an important commercial fish, with the majority processed into fish meal for stock feed and aquaculture. Over the past few decades sardine numbers have declined significantly and the fishery is now strictly regulated.

Sardines are susceptible to the impact of *El Niño* events. During the 1982-83 *El Niño*, the sardine catch from Ecuadorean waters decreased to almost zero, decreased only slightly in Peru and increased in Chile (Barber and Chávez 1986: 284) due to their response to increasing water temperatures in the tropics by simply migrating southward. Sardines live close to the surface and near to the shore thus being an easy target for net fishermen (Arntz and Tarazona 1990: 332).

Due to their small size and feeding habits, sardines cannot be caught on hook and lines. Either trawl, drift or scoop nets are used for their capture.

Reports from Cerro Azul, in central Peru, detail how schools of sardines and anchovies used to come into the bay and men standing in waist deep water used baskets to scoop them up in large numbers (Marcus et al. 1999: 6568).

Quilter and Stocker (1983: 548) reported that, in 1979, Stocker witnessed anchovy beaching themselves at Curaycu, Peru. This phenomenon went on for two days and the beach was littered with thousands of the small fish. Local people gathered up the fish for consumption or to be used as bait to catch *jurel* (*T. murphyi*) which were chasing the anchovies and swarming toward the shore.

Clupeiformes (sardines and anchovies) have been recorded in a number of prehistoric sites in Chile and Peru. Due to their small size and fragile nature, they appear to have been underestimated in early reports. However their economic importance has been recognised in more recent times. At Cerro Azul, Marcus et al. (1999: 6568) found that over 80% of fish (NISP) consisted of sardines and anchovies. The oldest dated remains of anchovy are from Quebrada de Tacahuay (southern Peru), between 12,700 and 12,500 cal BP (Keefer et al. 1998: 1834). At Quebrada los Burros, which dates from the Early to Mid Holocene, these species made up 11.8% of the total (NISP) (Lavallée et al. 2011: 338).

At El Paraíso, a Pre-ceramic site from central Peru, Quilter et al. (1991: 279) suggested that anchovies were the chief source of protein drawn from the sea. These findings were used to contribute to the debate regarding the relative importance of seafood versus terrestrial resources and the role of agriculture in subsistence economies during the development of Peruvian civilisations (see also Quilter and Stocker 1983).

Only two specimens of sardine were positively identified at Caleta Vitor and this via partially intact remains. Their presence was assumed due to the size of vertebrae retrieved from the excavations. Vertebrae with a diameter between 1-3mm were assumed to be Clupeidae. In excess of 38,000 vertebrae were recorded at Caleta Vitor and 35% of the total (*n*=13,475) were ≤3mm in diameter.

Engralis ringens - anchoveta, anchovy

A member of the family Engraulidae, anchovies are a shoaling pelagic species found from the shoreline up to 50 km off-shore. They spend the day up to 50 m below the surface but come to the surface to feed at night. They are filter feeders, consuming plankton, phyto-plankton and fish eggs. Lengths caught locally range between 100 and 160 mm (25-45 gm).

Anchovies are an important commercial fishery, once the basis of the world's largest fishery, with the majority of the catch processed into fish meal for stock feed and aquaculture (Barber & Chávez 1986: 284). The abundance of this species is greatly affected by *El Niño* events when warmer water temperatures arise in tropical latitudes and reduce access to the nutrient rich cold waters of the Humboldt Current, their main source of food.

The *El Niño* of 1982-83 had a significant impact on fishery resources but it was the anchovy population that experienced the greatest mortality. The anchovy catch of 1983 was less than one percent of that from a decade earlier. Anchovy prefer cooler water (16-18°) and this leads them to congregate in cooler, nutrient rich areas of upwelling water. If the *El Niño* is weak, there will be no impact on the population. However a strong *El Niño* may lead to the anchovies becoming trapped by warmer waters and mass die-offs result. This can lead to huge fish hauls, as happened during the 1972 *El Niño* in Peru when the purse seiner fleet was able to catch 170,000 tonnes of anchovy in a single day. Despite such a dramatic impact, however, anchovy are resilient; their populations increase rapidly following such events (Barber & Chávez 1986: 285).

Due to their small size, anchovy cannot be caught on hook and line. In the main, they would have been netted although natural phenomena can sometimes result in them coming so close to the shore that fisherman can simply scoop them up.

***Galiechthys peruvianus* – *bagre*, Peruvian catfish**

This is a sub-littoral species not commonly encountered in northern Chile. The only recorded specimen occurs in the Museo del Mar de la Universidad Arturo Prat (Iquique) collected in 1961. It has been suggested that the presence of this species in this area may relate to *El Niño* events (Medina et al. 2004: 24). Andrus et al. (2002) collected a number of live specimens in northern Peru between 1997 and 1999 to compare with samples collected from archaeological sites in that area. No size or behavioural data were included in that article.

Marcus et al. (1999) reported that *bagre* in northern Peru today favour shallow sand or mud flats and are regarded as a poor class of fish (for consumption). They retrieved *bagre* otoliths from an excavation of a number of prehistoric structures at Cerro Azul. However, none were located within elite structures which led them to conclude non-elite consumption. Reitz and Sandweiss (2001: 1094) also found that *bagre* made up 22% of fish bones at the Ostra Base Camp site.

At Quebrada Las Conchas (northern Chile), Llagostera (1979: 316) located 'some' utricular otoliths that he assigned to the Ariidae (catfish) family but he was unable to identify the species. It is possible that these otoliths were from *bagre*.

Bagre were identified via otoliths. Remains were located in 4.5% (n=9) of excavated units at Caleta Vitor.

***Labrisomus phillipii* - *tomoyo*, blenny**

A member of the Labrisomidae family, the *tomoyo* is an upper sub-littoral species found from Peru to central northern Chile. They are found over rocky sea-floors and feed on crustacea and fish. Average lengths caught locally range between 290 and 330 mm (350-600 gm) although there is significant sexual dimorphism. They are a secondary commercial species caught for fresh consumption.

Marcus et al. (1999: 6568) identified *tomoyo* at Cerro Azul but they made up less than 1% of the total (NISP). Similarly at Quebrada de los Burros, *tomoyo* made up only 0.2% of the total (NISP) (Lavallée et al. 2011: 338).

At La Chimba 13 Llagostera et al. (1999: 171) found that *tomoyo* were the most abundant when using the first pre-caudal vertebra to identify species (45.2%, MNI = 66/146). However, out of a total of 475 fish (MNI) identified using otoliths, no *tomoyo* otolith were found at all.

One specimen of t*omoyo* was identified from Caleta Vitor via its maxilla.

Elasmobranches (sharks and rays)

Sharks and rays are cartilaginous fish that are poorly preserved in archaeological sites (Masse 1986: 95). As a result, shark remains are not often reported and, more often than not, are not discussed in any detail.

De Borhegyi (1961) suggested that while shark teeth had been found in a number of North America and Central American sites, there had been few attempts to discuss the role of shark in ritual and economy. He cited both ethnographic and archaeological evidence to support the argument that they were economically important. Rick et al. (2002) cited a number of instances where sharks have been reported but also note the problems in estimating either NISP or MNI due to poor rates of survival. They argued that, despite their under-representation, elasmobranches were a significant contributor in many prehistoric coastal fisheries around the world, particularly due to the high ratio of their flesh to bone weights.

Wing (1974: 41) stated that sharks and rays were common in Mexican coastal sites and in Florida they comprised between 6-14% of marine faunas represented in archaeological assemblages. Archaeological investigations along the west coast of South America have sometimes reported the presence of sharks and rays, for instance Bird at Playa Miller (Arica). But his only remarks about them were that 'fish bones, including some shark, occur throughout the midden but not as abundantly as one might expect' (1943: 211). Bird also mentioned that fish were more plentiful at Punta Pichalo than at Arica but did not refer to the presence of shark. However, I noted shark vertebra in the wall's of Bird's Punta Pichalo trench which was still open early in 2011. He also reported finding a stingray barb at Quiani and suggested that, 'with reservations', it was utilised as a dart point (Bird, 1943: 241).

Marcus et al. (1999: 6597) reported finding shark remains at Cerro Azul but because of poor preservation, the species could not be identified. They did go on to state that "samples will always leave them underrepresented".

Reports from Gramalote, a Formative period site from northern Peru, indicate that while fish only provided 10% of the total meat protein, a species of Sand Shark (*Mustelus* spp.) provided more than all of the other fish combined (Pozorksi and Pozorski 1979: 424). While no positive identification of any particular species was cited, Lavallée et al. (2011: 338) reported the presence of sharks and/or rays from Quebrada los Burros. Likewise, Reitz and Sandweiss (2001: 1094) reported the presence of both sharks (MNI =2) and a ray (MNI=1) from the Ostra Base Camp. But they did not identify the species.

At Caleta Vitor, 413.5 gm of shark remains were identified via teeth and/or vertebrae in 40 (21.3%) of the 188 units containing fish remains.

The following two species are commonly seen in the fish markets at Arica.

Isurus oxyrinchus **– short-fin mako shark**

Mako are a large (> 3m), fast swimming shark, sought after as game fish not only because of their speed but also because of their habit of leaping from the water. They are found globally but prefer offshore waters with temperatures above 16°C. They give birth to live young that are 700mm at birth and grow to an average size of 2.7 m weighing between 60 and 135 kg (the record is over 500 kg).

In Arica, short-fin mako shark are commonly seen in the local fish market although they are rare in coastal waters (Capitan C. Astorga pers. comm.). It is an important commercial species in Chile and is both a by-catch of swordfish long-lining as well as a targeted long-line species (Cerna and Licandeo 2009: 394). The modern fishing grounds for mako are well off-shore, beyond the Humboldt Current, and often outside Chilean territorial waters. While their flesh is the major reason for exploitation, their fins are harvested for soup, livers for oil and their teeth also have commercial value. Mako sharks caught by Chilean long-liners have been used to establish baseline data to determine fish body size relative to vertebral radius (Cerna and Licandeo 2009: 296).

Copaca 1 is an Archaic site on the central north coast of Chile. One specimen of a mako shark was identified within an assemblage excavated there (Olguin et al. 2015: 11).

Prionace glauca – blue shark

Blue sharks are an oceanic species found globally but they prefer cooler waters and often migrate to follow the cooler currents. They become sexually mature at 2.5 m in length and give birth to live young 400 mm in length in litters of up to 80. They often separate into school divided by size and sex.

Today, blue sharks are known in northern Chile for their commercial value. They are fished almost exclusively for the Asian shark-fin market, particularly in southern Peru (Capitan C. Astorga pers. comm.). While no blue shark remains were identified at Caleta Vitor, their presence cannot be ruled out particularly as numerous unidentified small teeth and vertebrae are amongst the Elasmobranch remains.

Rajiformes – skates and rays

The Chilean round stingray (*Urobatis marmoratus*) and Chilean eagle ray (*Myliobatis chilensis*) are found in areas within the Humboldt Current along the Chilean coast[2]. These animals inhabit soft-bottom areas sometimes venturing into shallow waters where they feed on shellfish and crabs.

El Médano is a rock art site in northern Chile about 75 km north of Taltal (Berenguer 2008: 53). There are more than 200 panels which depict, *inter alia*, large marine species that have been interpreted as stingrays.

The tip of one stingray barb was found at CaletVitor.

2 (http://fishbase.ca/Summary/speciesSummary.php?ID=55059&AT=Chileense+ronde+doornrog)

The table below contains a summary of data relating to fish remains from a number of sites along the west coast of Peru and northern Chile, those discussed earlier in this section. The sites are ordered from north to south.

Site ⇨ **Taxa** ⇩	Ostra Base Camp Archaic (Reitz & Sandweiss 2001)	Cerro Azul Late (Marcus et al. 1999)	Cardal Formative (Burger & Salazar-Burger 1991	Paloma Archaic (Reitz 1998)	Copaca 1 Archaic (Olguin et al 2015)	Q. Jaguay Archaic (Sandweiss et al. 1998)	Q.Tacahuay Archaic (deFrance et al. 2001)	Q. Los Burros Archaic (Lavallee et al. 2011)	La Chimba Archaic (Llagostera et al. 1997)	Gramalote Formative (Pozorski and Pozorski 1979)
	NISP	NISP		NISP	MNI	NISP	NISP	NISP	MNI	MNI
Total Fish	2391	13393		5068	826	5996	984	11498	475	
C. gilberti	3	26	present		34	150		328	21	4
S. deliciosa	72	1126	present	21	7	673		6428	26	4
I. conceptionis	3			1	15			613	53	
T.murphyi	3	13	present	1	590			1573	9	
H.macrophthalmus	52								24	
G.peruvianus	27		present			3		27		
C.analis		8		1				3	48	
A.scapularis	6	307		14		1		70	298	
P.humeralis	3	3		2		1		19	41	
P.adspersus	14	77						13	3	
L.phillipi		96						2	57	
Clupidae	41	8996	present	185	36		63	299		
Engraulidae	18	5117	present	3525		11	604	127		
Elasmobranches	44		present		7			40		3

Table 9.2: Summary of fish from regional archaeological investigations.

Chapter Ten

> *Shell heaps, veritable "*kitchen-middens*," fringe the coasts of sheltered bays, whilst far inland piles of shells indicate the main article of food. These shells, which are scattered everywhere among the Indian rubbish, are all at present common on the beach.* (Evans 1906: 20)

Invertebrates

Like the above description, which referred to Taltal in northern Chile, the most obvious archaeological remains at Caleta Vitor are [mollusc] shells scattered over the ground surface. Exposed archaeological deposits (up to four metres deep) show that shells make up a very high proportion of the more obvious midden remains.

A total of 118.286 kg of shell was retrieved from excavations, from 181 (91.4%) of the 198 excavated units – those contexts without shell consisted of large rocks, overburden or sterile fill. Much of the assemblage was highly fragmented due to both initial processing and post-depositional, taphonomic processes. Whole specimens allowed straightforward identification as did larger fragments, however, in many cases, identification was only attempted to distinguish taxa to family or genus level, particularly where there were numerous local species from the same group (eg *lapa*, chiton).

Where possible shell was sorted to genus and species level for each stratigraphic unit and weighed. Non-repetitive elements (NRE) of shell valves, such as hinges or columns, were used to calculate an MNI (for example the total number of umbo of loco gave an MNI; the total number of mussel hinges was divided by two; the total number of chiton plates was divided by eight). Due to the fragmentary nature of much of the assemblage making it difficult to determine separate elements of some specimens, both gross weight and MNI were used in the analysis process.

This chapter describes, in general terms, the shellfish contributed to the economy of those living at Caleta Vitor in the past. While they may belong to separate families molluscs, echinoderm, crustaceans, cephlapods, barnacles and tunicates have been included within this one group (invertebrates) as they are collected in a similar fashion and their remains are often found together in the middens.

Table 10.1 lists some of the invertebrates found along the coast of northern Chile. Those marked with an asterisk (*) were observed as living specimens at Caleta Vitor, both in their natural habitat or collected by divers working in this area. Those marked with a cross (+) are typical to the region and are commonly seen at the markets in Arica. Species/genera are not necessarily listed in order of abundance although the more common specimens head the list.

Many of the species listed in Table 10.1 remain commercially important in the region. Shell fisherman generally using 'hookah' equipment and dive from small boats, although some collecting is carried out along the rocky-shore line at low tide (pers.obs.). Octopus (*pulpo*) are caught by divers using a gaff to drag them out of crevices or under ledges.

Genus/species	**Common name**	**Habitat**
Choromytilus chorus+*	*Choro*, mussel	Rocky shore, inter-tidal to 15 m
Aulacomya ater+*	*Cholga*, ribbed mussel	Rocky shore, inter-tidal to 40 m
Perumytilus purpuratus+	*Chorito*	Rocky shore, inter-tidal zone
Concholepus concholepus+*	*Loco*	Rocky shore, sub-littoral to 12 m
Chiton spp.*	*Quiton*	Rocky shore, inter-tidal zone, numerous similar species
Fisurella spp.*+	*Lapa*	Rocky coast, numerous similar species, littoral to sub-littoral to 3 m
Echinoderm *+	*Erizo*	Rocky coast, sub-littoral to 6m
*Thais chocolata**	*Loca*	Rocky shore, sub-littoral to 3 m
Crepidula dilatata		Rocky shore, sub-littoral
Mesodesma donacium+	*Macha*	Sandy shore, inter-tidal zone
Protothaca thaca+	*Almeja*	Sandy shore, inter-tidal zone
Argopecten purpuratus	*Ostión*	Sandy shore to 7m
*Prisogaster niger**		Rocky shore, inter-tidal zone
Oliva peruviana		Sandy shore, up to 20 m
*Collisella orbigny**	*Señorita*	Rocky shore, littoral
Cirripediae *	Barnacle	Rocky shore, sub-littoral
Tegula spp.*	*Caracol negra*	Rocky shore, inter-tidal zone
Priene rude		Sub-littoral to 60m
Octopus mimus+*	*Pulpo, changos*	Rocky shoreline, sub-littoral to 15 m
Pyura chilensis+*	*Piure*	Rocky shore, inter-tidal to sub-littoral
*Geograpsus lividus**	*Cangrejito de roca*	Rocky shore, supra/inter-tidal.
Cancer edwardsii+	*Jaiba*	Soft bottom, sub-littoral

Table 10.1: List of mollusc species common to Northern Chile.

The following describes each genus and/or species including some of their habits and habitats and how they may have been exploited. Their presence in some archaeological sites from western South America is also included. Descriptions are in approximate order of abundance (by weight). Romero (2002) was the major source for these descriptions.

Mytilidae – mussel

Mussels are a bivalve from the family Mytilidae. They inhabit low and mid intertidal zones and are an often abundant, sessile species that attach to firm substrates via byssal threads. The presence of mussel beds affects species richness at local and regional levels and provide shelter that offers security for a range of fish, invertebrate and algae species (Carranza et al. 2009). Apart from humans, gastropod (including *loco* and *loca*) and starfish are major predators of mussel, particularly younger (thin shelled) specimens. Mussels are a commercially important resource for coastal Chile today and intensive aquaculture is carried out in the southern regions.

Mussels, when abundant, can be harvested in large amounts relatively quickly. They are simply separated from the rocks using a wooden or bone implement, breaking the bonds of the byssal threads, releasing them in clusters (Sandweiss 1996: 140). This can be carried out in shallow water during low tides or by diving in deeper waters.

Mussels were the most abundant (by MNI) of shellfish exploited at the Late Preceramic site of El Paraíso (northern Peru) (Quilter et al. 1991) and Gramalote (Pozorski 1979). Mussel was also a dominant mollusc at Curaumilla-1, an Archaic site from Central Chile (Jeradino et al. 1992). Quilter (1989: 28) found single mussel valves (species not stated) in association with fourteen graves at Paloma (central Peru). Some of these valves were filled with animal fur, hair or red pigment. He also found discs and crescents cut from mussel shell in and around houses at that site (Quilter 1989: 30). While the process of manufacturing shell hooks began with a circular disc of shell, the discs at Paloma had carefully formed circular margins and the outer cortex of the shell had been removed. It is likely that they were utilised for ritual purposes.

The geographic, temporal and functional range of mussel shell found in archaeological deposits clearly demonstrates their economic importance.

The excavation at Caleta Vitor recovered a large quantity of mussel shell (50.574 kg). Whole or relatively intact specimens, particularly those with intact 'beaks' or hinges, were used to identify individual species. A major proportion was made up of fragments (20.525 kg/44.3%) which ranged in size upward from 2 mm. The fragmentary nature of the assemblage often made the identification of left and right hinges difficult and variable. Three mussel species were identified and their descriptions follow.

Choromytilus chorus – choro, **giant mussel**

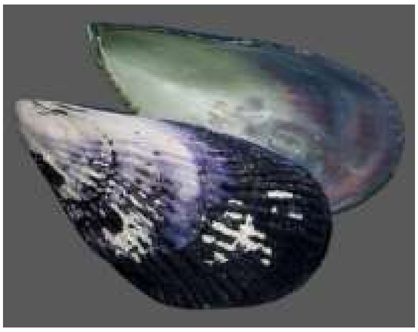
This is the largest of the three mussels found in the region, with adult specimens up to 200 mm in length. *Choro* prefer cooler, sheltered waters and grow on hard sub-strates and sometimes on sandy beds, fixing on loose rocks or kelp. While their presence has been detected in prehistoric assemblages, this species was not commercially recorded as being common in far northern Chilean (<23° S) waters until the end of the 20th century (Avendaño and Cantillánez 2011: 390).

Choro were abundant at the Archaic site of Quebrada de los Burros (Lavallee et al 1999: 37). Due to their size and relative robusticity, *choro* valves were, in the distant past, used as containers, made into fish hooks or were sharpened for use as cutting or scraping tools. Their importance within the Andean region was such that this species was ritually significant and traded widely (including into the highlands) from at least as the Early Archaic Period through the Late Horizon (Sandweiss 1992: 98). Upanca is a site in the Central Andean Peru (near Nazca) that has been dated from the Late Archaic through to the early Intermediate Period (Vaughan and Linares Grados 2006: 595). While this site is over 100kms from the coast, excavations there retrieved a relatively large quantity of marine molluscs with *choro* making up 18.2% of the molluscan assemblage.

As discussed earlier, shell hooks were commonly found in middens in northern Chile, particularly during the earlier phases of occupation (see Bird 1943). He found numerous such hooks at Quiani, Punta Pichalo and Taltal.

Bird (1943) found one *choro* valve containing red pigment at Quiani (Arica). The 'Museo Colon 10' in Arica has a display of *in situ* Chinchorro mummies and artefacts that were discovered during building works in the first years of the 21st century. Large *choro* valves are contained in the display there. In one instance, a valve containing a red pigment was placed in the vicinity of a burial – either with grave goods or left there after the pigment was used during ritual activities (body adornment) (pers. obs.).

A total of 13.77 kg of *choro* shells were located in 63.1% (n=125) of excavated units at Caleta Vitor. Numerous valves (n=43) were whole (or nearly so) and measured between 32 and 103 mm in length.



Aulacomya ater – cholga, **ribbed mussel**

A mid-size mussel species which grows up to 90 mm in length. It lives in crowded intertidal beds on a rocky sub-strate. *Cholga* are susceptible to increased water temperature. A study of populations off Ancón (central Peru) during the 1982-83 *El Niño* established that they died off as a result of the event. Experiments demonstrated that their habitat was initially recolonised by polychaetes which, in turn, slowed the recovery of this mussel (Arntz and Tarazona 1990: 338). While *El Niño* events decimated populations in Peru, the impact of the 1982-83 event in northern Chile was far less pronounced.

In the past, *cholga* valves were also used as containers, particularly for pigment (Sandweiss 1992: 98).

A total of 7599.5 kg of *cholga* were located in 35.3% (*n*=64) of excavated units. A number of valves (*n*=190) were whole (or nearly so) and measured between 23 and 90 mm in length.

Perumytilus purpuratus – chorito

This is a common species found along the Chilean coast today. They are a small mussel species, growing up to 40 mm in length. They form wide belts across rocky substrates in the mid-intertidal zone, often forming dense three-dimensional matrices (Alvarado and Castilla 1996). The stratification of the beds serves to protect them against strong wave action. While their modern distribution is widespread, *chorito* tolerate warmer waters and are not unduly affected by *El Niño* events.

Chorito were abundant, but less so than *choro*, at the Archaic site of Quebrada de los Burros (Lavallee et al 1999: 37).

A total of 6.78 kg of *chorito* were located in 48% (*n*=87) of excavated units. Numerous valves (*n*=88) were whole (or nearly so) and measured between 13 and 39 mm in length.

Concholepus concholepas - loco

Loco are a large species of snail that reside on rocky shores. They are sub-littoral to sub-tidal up to a depth of 30 m. They are an active predator of *chorito* which are a dominant competitor for space on rocky intertidal zones (Jerardino et al 1992: 53). Overall mollusc species diversity is far higher when large numbers of *loco* are present as they create more free space by reducing the dominance of *chorito*. Generally smaller specimens (<80mm) are found in the intertidal zone as the larger specimens move toward the sub-tidal zone. In central Chile, *loco* move toward the shoreline during autumn and winter and form in reproductive groups. It is likely that similar behavioural patterns are found in the northern region.

Loco are one of the most important resources for Chilean artisanal shell-fisheries. They are collected from the shoreline and offshore by divers using 'hookah' equipment (pers. obs.). They can be removed from the rocks by hand however they are usually levered from the rocks using a chisel (*chope)*. During the 20th century, commercial catches remained relatively stable until the mid 1970s when high prices increased exports. Annual catches increased rapidly, from 6000 tons in 1970s reaching 25,000 tons in 1980 (Aburto et al 2009).

The impact of *El Niño* events is less dramatic on *loco* than many other species. Being carnivores, some of their prey either die off or lose their habitat as water temperatures rise. *Loco* respond by moving into deeper waters (Artnz and Tarazona 1990: 346). This would reduce their availability to shore based collectors but would allow for a more rapid recovery when preferable conditions return.

Loco have a relatively heavy and robust shell and, as such, they survive well in archaeological deposits, particularly when compared to lighter shelled species such as mussel. However as they are heavier, they are also more likely to be shelled close to where they are collected, rather than carried back to the site where they are to be consumed, particularly if the site is elevated or some distance from the shore. This may result in a lower number of shells being deposited in a midden than the actual number of specimens collected and consumed.

The robust nature of their shells is such that the shells themselves are a useful resource. The shell as a whole could be used as a container. The thick body of the shell was also used to carve jewellery, particularly beads.

Loco exude a purple coloured fluid when they are shucked. Rocky areas where they are shelled by divers are often stained purple (pers. obs.). This liquid was used in the pre-Columbian period in Peru as a dye (Saltzman 1992: 479). This is not surprising given that the purple dye from the Murex shell was used extensively around the Mediterranean during the Phoenician and Roman period. *Loco* are members of the same family (*Murcinidae*).

Loco were abundant in Archaic and later, ceramic period deposits at Curraumilla-1 (central Chile) (Jerandino et al. 1992: 51) and Copaca 1 to the north (Olguin et al, 2015: 11). At Quebrada de los Burros, Carré et al. (2009: 1174) found loco to be the dominant species of mollusc during the period 7200-7500 cal BP). Bird (1943:210) found *loco* to be the third most abundant species at Playa Miller (Arica) and made the comment that while the proportions varied, the same species appeared from the top to the bottom of the trench. Llangostera (1979) found *loco* to be abundant at Quebrada las Conchas (dating from 9680 BP) and Abtao-1 (dating from 6000 BP). In that paper he proposed that the appearance of a deep water, offshore fish species only in later deposits (*congrio*) was the result of the introduction of rafts to fishing strategies. Llagostera (1979; 1990) also found the incidence and size of *loco* was higher in the later strata and suggested that this occurred as the use of rafts enabled them to be harvested from a broader range of habitats thus reducing the likelihood of overexploitation.

A total 19.719 kg of *loco* shell was retrieved from the excavations at Caleta Vitor. *Loco* was identified in 80.6% (n=146/181) of the units that contained shell.

Measurements were carried out on 201 *loco* valves from CV2/1 and CV6/1 that were sufficiently intact to measure their length[1]. The mean length of those from CV2/1C was 55.0 mm (from 36 to 76 mm); CV2/1PC 55.9 mm (from 29 to 105 mm); and CV6/1 was 51.0 mm (from 26 to 105 mm).

***Chitonidae* – *quiton* or chiton**

Over fifty species of chiton are found along the rocky shores of Chile ranging in size from 10 to 150 mm in length. They are a mollusc whose dorsal shell is made up of eight 'hinged' plates. Species are distributed across a range of rocky habitats with distinctions between those found in tidal pools and boulder fields (including *Chiton latus, Zschnochiton pusio, Tonicia eleguns f. lineolatu, C. cumingsi* and *C. latus)* and those found on rock walls (including *C. barnesi, C. granosus, Cullistochiton viviparus* and *Acanthopleura echinata*) (Otaiza and Santileces 1984). *A. echinata* and *C. latus* are the most common species to reach a large size with larger specimens often found were wave surge is greatest. In some areas densities can reach 500 individuals per square metre.

Chiton attach themselves to rocky substrate via a strong muscle. As such they are difficult to remove by hand without the use of a chisel (*chope*) or knife. At Caleta Vitor today, locations where chiton appear to be most abundant are those rock walls that are within the area of high wave wash. In these locales, the collection of chiton would have been a dangerous exercise other than during periods when the sea was calm and the tide was at its lowest point. Much of this area is a high energy coastline and there are few periods when wave action is not turbulent.

Jerardino et al. (1992: 52) found that chiton (combined species) were the most abundant mollusc excavated at Curaumilla-1. At Copaca 1, central northern Chile, Olguin et al (2015: 9) found chiton to be common but were not one of the most abundant taxa in the assemblage.

[1] Marcelo Rivadeneira from the University of Antofagasta identified and measured intact shells.

8.742 kg of chiton was recovered at Caleta Vitor (MNI = 1072). Chiton plates were found in 80.1% (n=145) of the units containing shell.

***Fisurella* spp. – *lapa* or limpet**

Widely known as limpets, the genus Fisurella are small to medium-sized gastropod. They have a cone shaped shell and adhere to rocky substrates of the intertidal and sub-tidal zones. Several species are common to the region including *F. crassa, F. cumingi, F. latimarginata, F. limbata* and *F. maxima* – these are commonly known as key-hole limpets due to the presence of a 'key-hole' shaped apical foramina. Larger specimens are collected by fisherman and are an important local artisanal fishery.

Lapa were the most abundant shellfish (by NISP) in the midden at Copaca 1 (Archaic) (Olguin et al 2015: 11) and Curuamilla-1 (Jerardino et al. 1992) – both Archaic sites in central northern Chile.
A total of 5.954kg of *lapa* shell were recovered from excavations (MNI = 764). *Lapa* were found in 71.8% (n=130) of excavated units.

Echinoderm – *erizo*, sea urchin.

Sea urchins are a common element of near-shore marine ecosystems worldwide (Vega and Ojeda 1993: 157). The Chilean sea urchin (*Loxechinus albus*) and the black sea urchin (*Tetrapygus niger*) are two of the most common echinoderm species from this region (Villegas et al. 2008: S38). They are found along rocky shores in intertidal and sub-tidal rock pools. These species are often found in large numbers associated with kelp beds (*Macrocystis* spp. and *Lessonia* spp.) at a depth of between 2m and 4m, however their numbers decrease below 7m.

These species can be collected by hand at low tide however, in modern times, they are mainly harvested by divers operating off-shore. They are a commercially important species in northern Chile. In particular, the gonads of the animal are extracted from the body and eaten, generally raw.

Vega (et al. 2005) suggested that the thermal anomalies produced by *El Niño* events modified the spatial distribution of echinoderm over a latitudinal gradient. During the 1997/98 *El Niño* there were mass mortalities of kelp and benthic carnivores off the coast of Peru (Villegas et al. 2008: S38). This die-off did not occur in northern Chile where the continuity of up-wellings moderated sea temperature rises and maintained nutrient levels (Vega et al. 2005: 33). The 1998-2000 *La Niña* cycle increased nutrients which favoured sub-tidal kelp assemblages. This, however, was coupled with an abundance of *T. Niger* and produced local extinctions of *Macrocystis integrifolia* and a reduction in range of *Lessonia trabeculata.*

Echinoderms can be harvested by hand at low tide, however the sharp spines can inflict injuries during handling or if trodden on in bare feet. Pronged spears can be used by divers to collect them from the sea floor.

The remains of echinoderm recovered in archaeological excavations consist of fragments of their test (exoskeleton), spines and feeding complex (known as Aristotle's Lantern). Due to the highly fragmented nature of the assemblage, no attempt was made to differentiate between species.

Echinoderm were abundant in the Chilean Archaic sites of Copaca1 (Olguin et al 2015), Curuamilla 1 (Jerardino et al 1992) and La Chimba (Llagostera 1997). They were also commonly found in a number of sites on the Peruvian coast including El Paraiso (Quilter et al 1991) and Gramalote (Pozorski 1979).

A total of 5.818 kg of echinoderm fragments were recovered. Specimens were collected from all excavated trenches with the majority of units containing at least some fragments (84.5%, n= 153).

Thais chocolata - loca

Loca are a predatory conic snail from the Murcinidae family. They are commonly found along rocky shores within the intertidal and sub-tidal zone to a depth of 3 m. They are easily recognised due to the presence of 'horns' on the shoulder of the body whorl. They are commercially harvested for consumption.

Also known as the 'purple snail', they were a source of purple dye used in pre-Columbian Peru (Saltzman 1992).

1.861 kg (MNI = 120) of *loca* were recovered from excavations. They have a relatively robust shell although many specimens were weathered and/or damaged. *Loca* were located in 32% (*n*=58) of excavated units.

***Crepidula delitata* – slipper limpet**

This species is commonly found in the sub-tidal zone attached to rocks but often found as an epidont[2] on *cholga*.

1.861 kg of this species were recovered from excavations (MNI = 509). The MNI was obtained by counting umbo. *C. delitata* were located in 45.3% (*n*=82) of excavated units. Of the units that contained *cholga (n*=87*),* 73.5% (*n*=64) contained at least one *C. dilitata.* As such, these may not have been a target species and their collection the result of mussel harvesting. Smaller specimens may not have been consumed at all.

[2] Epidont – residing on or attached to another species of mollusc

Mesodesma donacium – macha, **surf clam**

Macha are a burrowing bivalve found along sandy beaches with strong wave exposure from the low intertidal down to 15-20 m deep (Uribe 2012: 714). The species has an Antarctic origin, prefers cooler temperatures and has a low tolerance of warm waters. In times of abundance, this species can provide more than 3.5kg/sqm (Arntz and Tarazona 1990: 345).

Preferring the cold waters of the Humboldt Current, *macha* are found from 5° to 43° S (northern Peru to far south of Chile). Strong *El Niño* events and intense fishing pressure have caused local extinctions particularly on the northern limits of its range (northern Peru). In 2005 Ibarcena et al. reported on the impact of the *El Niño* events of 1982/83 on the *macha* fishery at Tacna, southern Peru (60km north of Arica). The intensity of these events resulted in high mortality rates, with thousands of dead specimens littering the beach at low tide and the commercial fishery collapsed. *Macha* numbers began to increase from 1986 but subsequent *El Niño* events (1997-8) again caused the species to all but disappear.

Bird (1943: 210) while he was excavating at La Lisera, Arica, noted that a 'variety of clam, roughly triangular in shape' was common on the beaches today but was not found in the midden. It is likely that Bird was referring to the *macha* as it is still found on the beaches of Arica (one beach is actually known as '*Las Machas'*. The beaches near Tacna have been an important commercial source of *macha* for many years (Ibarcena et al. 2005).

Macha were the most abundant (by weight) of shellfish exploited at the Late Pre-ceramic site of El Paraíso (northern Peru) (Quilter et al. 1991: 279). Quebrada Jaguay in southern Peru contained evidence of late Pleistocene occupation and an economy relying heavily on marine resources (Sandweiss et al. 1998: 1831). Shellfish remains there are virtually mono-specific with *macha* making up 99% of that part of the assemblage. Nearby sites, but dating from the Holocene, contained a similar high proportion of *macha*.

Quebrada de los Burros is located in the vicinity of Tacna and contains evidence of occupation from the early to mid-Archaic Period (Lavallée et al. 2011). This site contained a large quantity of faunal remains including fish and shellfish. The dominant molluscs were *loco* and *macha*. *Macha* were the dominant species in the earlier phases of occupation (up to 60% of the total). However, in the period around 7000 BP, *loco* became the dominant species and *macha* fell to around 25% of the total (see Lavallée et al. 2011: 341). Evidence from the site does not extend into the Intermediate or Late Periods so it is impossible to ascertain whether a reduction in *macha* numbers was a cyclical or continuing trend.

354.7 gm (MNI = 145) of *macha* shell were retrieved from the excavation. However, out of the total, all were found in units dated to the Archaic Period and, of those, 143 were located in CV1/2.

***Prothaca thaca* – *almeja*, cockle**

This cockle is a sub-tidal bivalve from the family Veneridae that lives just below the sand surface in shallow water to a maximum depth of 20 m. It has a wide distribution range (12 to 45° S) and lives in water temperatures between 5 and 26°C. Unlike *macha*, *almeja* can survive *El Niño* events due to their high lethal temperature threshold and tolerance of rapid temperature increases (Lazareth et al. 2006: 263).

Given its preference for warmer water, it was not surprising to find that it was commonly found in archaeological sites in the Moche Valley, northern Peru (Pozorski 1979: 166).

A total of 639.7 gm (MNI = 69) of *almeja* were retrieved from the excavation. Their distribution through the excavated units is more widespread than *macha* although their numbers per unit are generally low with the highest incidence being five valves located in CV4/1/17 (ceramic phase).

Prisogaster spp./Tegula spp. – caracol

This taxon consisted of several species of small gastropod including at least *Prisogaster niger*, *Tegula tridentata* and *T. luctuosa*. The three species are often found together in rock-pools and rocky shores within the intertidal zone.

A total of 1.838 kg (MNI=292) was recorded. While these specimens were relatively common, they are small with a low return for effort. They may have been collected opportunistically rather than as a target species. However, would have been an ideal resource for children to collect in the relative safety of rock pools at low tide.

***Argopecten purpuratus – ostión*, scallop**

This species, of tropical origin, is found in waters between 5 and 30 m deep (Romero 2002a: 69). *Ostión*, while preferring warmer water, are distributed over a broad range, from 5° to 37° S (northern Peru to southern Chile). They can tolerate a wide range of water temperatures. However, reproductive rates increase in warmer waters. *El Niño* events produce advantageous conditions and increase reproduction rates. The *El Niño* of 1982-83 was particularly severe and the Peruvian 1983 harvest was 40 times higher than that of the previous year. It returned to previous levels once the *El Niño* had passed (Barber and Chávez 1986: 283). Being a prized food item, they are an important commercial species and over-exploitation is a serious threat to long-term survival.

Only 128.4 gm (MNI = 9) of *ostión* valves were retrieved. *Ostión* are a resident of sandy shores however, unlike *macha*, they are not unduly affected by *El Niño* events. Individual specimens were found in both Archaic and Formative/Late units.

Other taxa

Tunicates - *Pyura chilensis* - *piure*

Also known as sea squirts, tunicates are sessile, intertidal to sub-littoral filter feeders that are found on rocky shores. In northern Chile *piure* is harvested and consumed both raw and cooked. It is also an export commodity. *Piure* are a favoured food of *loco* and an over-abundance of this predator can severely impact on local populations.

The edible portion of the animal is contained within a sack-like structure covered with a rough outer covering. Figure 10.1 contains photographs of *piure* prior to extraction and then as it is packaged for sale.

Figure 10.1: *Piure* Left - whole, right – processed. Arica fish markets Phot: C. Carter.

While some tunicate outcrops may have been accessible on rock ledges at low tide, they are more commonly found below the low-tide mark and would have been collected by divers using a *chope* to lever them from the rocks.

Remains of the outer casing of *piure* are tough and leathery and survive in middens in dry conditions. Excavations at Caleta Vitor retrieved 1.975 kg of *piure* outer casing. 1.595 kg (80.7%) of the total was dated to the Late Period (CV4/1, CV4/6/1, CV6/1, 2, 3). Only seven out of a total of 106 archaic units contained *piure* remains. The prevalence of *piure* in the trenches dating from the latter period may have been the result of conditions more suited to preservation.

Decapoda – crab

At Caleta Vitor, crabs were commonly seen along the rocky shore and would have been relatively easy prey. *Geograpsus lividus* are a species that inhabit the supra-littoral and are one of the species found, however they are similar in appearance and habitat as *Leptograpsus varietgatus* (Romero, 2002b: 62-63). Figure 10.2 is a photograph of *Geograpsus lividus* taken at Caleta Vitor. Such species could have been caught by hand, using traps, snares or spears.

Known locally as *jaiba*, *Cancer edwardsi* are a commercially important species from the Arica area (see Figure 10.3). These are found in deeper water over a soft bottom. They may have been harvested while diving and could have also been caught in nets that dragged the sea bottom.

Both rocky and sandy shore crab species are common along this section of the coast. Crabs were identified from excavated material through fragments of exoskeleton and chelipeds (both dactyl and propodus - claws and claw tips). Exoskeleton fragments were very fragile and were generally broken down into very small pieces. Chelipeds, particularly the tips, are more robust and preserve well and were commonly encountered.

The presence of decapods has been noted in archaeological sites along the coast of Chile and Peru but generally without much detail (see Table 10.1). Pozorksi (1979) reported that a significant proportion of the faunal remains at Gramalote was made up of crab (MNI = 297).

A total of 492.1 gm of crab shell (including chelipeds) were recovered.

Figure 10.2: ***Geograpsus lividus, c*****ommon rock crab at Caleta Vitor**
Carapace width approx. 75mm. Photo: C. Carter.

Figure 10.3: ***Cancer edwardsi*** **(*****jaiba*****) – Arica markets.**
Carapace width approx. 100mm. Photo: C. Carter

Cephalapod

The only cephlapod (squid, cuttlefish and octopus) noted at the fish markets at Arica were octopus ('*pulpo*') (*Octopus* spp.). Squid and cuttlefish appear on a few local restaurant menus however were not noted as locally caught. Cephlapod have no real bony parts that survive in archaeological deposits (Reitz and Wing 2008: 45). In rare cases their beak and backbone may be found.

In 1856 Lieutenant Rising R.N. visited Arica and was taken to a 'mummy pit' by an Englishman who was a local resident (Rising 1866). He found 'eyes' in the orbits of several skulls that were located in the pit. Not knowing what they were, Rising returned to England with a number of specimens and presented them to Sir Woodbine Parish of the Ethnological Society of London for identification. They were described as 'amber-coloured hemispherical objects that shell into numerous concentric layers'. A number of 'scientific friends' were shown the objects but could not identify them. Eventually the curator of the Museum of the College of Surgeons, a Mr Clift, recognised them to be the 'crystalline lens of the eye of a large cuttlefish such as abound in the Pacific' (Rising 1866: 60).

In 1893 Miller reported on a number of mummies that were found near Arica following the tidalwave in 1868. In that report he briefly described the mummies and grave goods as well as going on to state that:

> '...the most interesting thing about these mummies is the finding of the so-called "Inca eyes". ... These eyes are of an oval outline, flattened at one end and made up of concentric layers deposited about a central point. ... They were found in the orbit, being held in place by the cloth which was bound about the head. ... The source of supply was doubtless from the squid or octopus, which are still found in abundance along the coast.' (Miller 1893: 74-75).

Figure 10.4: 'Squid' eyes – Bird Collection, AMNH.
Photo: C. Carter

In 1871 another visitor to Arica and was shown a number of mummies and a range of grave goods. Amongst the ephemera located with the burials were 'amber-looking globules that are known to be eyes of cuttlefish' (Hutchinson 1874: 313). He went on to state that he had not seen 'eyes of the fish mentioned' other than at Arica and Pacha-Cámac (sic) where they were put into the wooden effigies of the face.

With regard to his excavations at Arica, Bird stated that 'dried squid eyes appear commonly throughout the pottery period' (1943: 210). He stated further that there was no known use for the eyes (see Figure 10.4).

The remains of at least two cephlapod eyes, possibly those of octopus, were located in CV6/2 and CV6/3. It is likely that they were caught at Caleta Vitor for food, although their eyes may have also been used as ritual objects (see Figure 10.5).

I have not been able to locate any references to cephlapod eyes in the more recent literature (post mid-20th century).

Figure10.5: Cephlapod eye fragments - CV6/2/2.
Photo: C. Carter

* * *

Table 10.2 summarises the results of several archaeological investigations in Peru and Chile with regard to the mollusc assemblages. It has been provided to demonstrate the dominance and range of certain species over this geographic range.

The following chapters detail the analysis and interpretation of the faunal remains from these excavations.

Site → **Taxa** ↓	Ostra Base Camp Archaic (Reitz & Sandweiss 1997)	Curuamilla-1 Archaic (Jerardino et al. 1992)	Cardal Formative (Burger & Salazar-Burger 1991)	Copaca 1 Archaic (Olguin et al 2015)	Paloma Archaic (Reitz 1988)	El Paraiso Formative (Quilter et al. 1991)	Q. Jaguay Archaic (Sandweiss et al. 1998)	Upanca (Nazca) Archaic-Intermediate (Vaughan & Linares2006)	Quebrada Los Burros Archaic (Carre et al. 2009)	Gramalote Formative (Pozorski and Pozorski 1979)	La Chimba Archaic (Llagostera et al. 1997)
	MNI				MNI			MNI		MNI	
Almeja	145			present	10			3		892	
Macha	14		abundant		11	abundant	abundant	11	abundant	106	
Mussel	11	abundant	abundant	present	203	abundant		45	present	674	present
Loco	3	abundant		abundant		present			abundant		abundant
Lapa	52	abundant		abundant	35	present			present		abundant
Chiton	27	abundant		abundant	1	present		3		110	present
Urchin		present	present	abundant		present		1		present	present
Ostion	44					present		10			
Decapod		present	present		9	present				297	

Table 1.2: Summary of shellfish from regional archaeological investigations

Chapter Eleven

> *The corn which grows here is peculiar, the farinaceous portion is large it is roasted and powdered, then mixed with the fruit of the Algarosa tree (a variety of the pine) possessing a sweet taste, thus forming an article of food of much value.* (Blake 1837)

The subject of this chapter concerns flora and fauna not covered in the preceding two chapters. Fauna includes both terrestrial and marine mammals and avifauna.

Floral resources

The preservation of archaeological remains in the Atacama region is exceptional and, as a result, the excavations at Caleta Vitor resulted in the retrieval of a quantity of vegetal material including wooden objects, branches, grass, reed, stems and seed. At this time no detailed analysis has been undertaken other than a basic description of the contents of each excavated unit.

Seeds identified within the assemblage include maize (*Zea mays*), cotton (*Gossipium barbadense*), squash (*Curcubita* spp.), bean (*Phaseolus vulgaris*), *molle* (peppercorn - *Schinus molle*) and *algarrobo* (*Prosopis* spp.). Several abundant seed and calyx types that were not positively identified are likely to belong to the family Solanaceae, most likely genus Capsicum and/or Solanum (peppers and tomatoes). The surface level of CV6/1 also produced a peach stone (*Prunus persica*) and an olive pit (*Olea europaea*) indicative of late (Colonial) deposition.

Table 11.1 displays the presence of plant remains in the trenches excavated at Caleta Vitor.

	Maize	Cotton	Squash	Schinus	Propsopis	UI Seed	UI calyx
CV3/1	A	A	A	A	A	A	A
CV1/2	A	A	A	A	P	A	P
CV1/3	P	A	A	P	P	PA	PA
CV7/1	A	A	A	A	A	A	P
CV2/1PC	A	PA	A	A	A	P	P
CV2/1C	A	PA	P	A	A	PA	PA
CV4/6	A	P	A	P	A	P	P
CV4/1	P	P	P	P	P	PA	P
CV6/1	PA	P	A	PA	P	P	A
CV6/2	P	P	A	P	A	A	A
CV6/3	PA	P	A	P	P	A	P

Table 11.1: Presence or absence of plant remains in each trench.
P=present, A=absent, PA=abundant

The following provides a description and basic history of the main plant species found at Caleta Vitor.

Zea mays - maize

Maize is a domesticated grass that grows to several metres in height and produces multiple cobs or ears of grain. There are numerous varieties of maize, producing grain that ranges in size and colour. The ancestor of this plant is generally accepted to be *teosinte* and that domestication occurred in Mexico (Smith 1998: 151). Maize appeared in Andean Colombia before 8000 BP and in coastal Ecuador before 7000 BP after having rapidly spread from Central America (Pearsall 2008: 113). Coastal Peru and northern Chile were most likely too dry for maize to flourish without irrigation and there was an early shift toward the highland regions.

At Caleta Vitor maize was identified via the presence of stalks, stems, leaves and ears (containing both seeds and cob). The presence of stalks suggests that cultivations were taking place in the near vicinity, particularly with a permanent (or at least semi-permanent) supply of water available from the river. Along with a number of other crops, maize is now cultivated on river terraces of Quebrada de Vitor from a short distance from the coast inland for at least 25 km. Access to the properties that include the river terrace could not be secured while field work was being carried out and no survey of this area was undertaken. As such, it was not possible to determine if evidence of early irrigation exists in the area.

The evidence of maize was particularly prevalent in trenches from the Late Intermediate and Late Periods. The areas containing only Archaic material did not contain evidence of maize production or consumption. CV1/3/10 contained several ears of maize. A sample of plant material from CV1/3/14 returned a date of 6496-6717 cal BP. However CV1/3/10 consisted of an intrusive context which was a hollow filled with grass and also contained the bodies of two dehydrated rodents (the size of a common rat). It is highly likely that these rats had nested in this area in recent times (within the past 50 years) and that the maize was obtained from crops located on the river terraces approximately 200 m to the north. The trench CV1/3 was excavated into the wall of an area of disturbance and the rodents would have only had to tunnel 200-300 mm into the bank to establish their 'nest'.

No maize was located in CV1/2 or CV3/1 which both contained evidence of occupation limited solely to the Archaic Period.

CV2/1 was dated from 3989-4243 cal BP (CV2/1/58) through to 1931-2129 cal BP (CV2/1/1). CV4/6 was dated from 1570-1810 cal BP (CV4/6/10) through to 330-500 cal BP (CV4/6/1). No maize was found in either of those trenches.

CV4/1/1-19 ranged in age from 646 cal BP to 539 cal BP and maize was present throughout the trench (11/19 units). Likewise, maize was abundant in CV6/1 (12/16 units), CV6/2 (3/4 units) and CV6/3 (5/6 units) which are all dated from the Late Period (from 650 cal BP).

While this sample is limited, it appears that maize did not appear in any quantity until at least the Late Intermediate with the Late Period revealing a greater intensity of consumption, most likely linked to local production.

***Gossypium barbadense* - cotton**

Cotton is a naturally perennial shrub that is now generally grown as an annual. The fibres grow inside the fruit capsule or 'boll'. The bolls split open at maturity to expose a tuft of white 'hairs' each of which is attached to a seed (Heywood 1993). Fibres from the cotton plant are classified as textiles as they can be used to weave cloth (as opposed to cordage fibres that are twined to make rope). Cotton prefers a dry climate although it requires a reliable source of water. Wild populations of cotton are found on the coastal plains of south-western Ecuador and north-western Peru (Dillehay et al. 2007: 1890). Cotton from early archaeological contexts has been found at the Real Alto site, Ecuador, and in the Late Preceramic sites of the Ancon-Chillon area in central coastal Peru (see also Stephens 1975). Between 4500 and 3500 BP, cotton became an indicator of what has been called the 'Cotton Preceramic Phase' of Peru. Wise et al (1994) report finding elaborate cotton products associated with a Late Archaic burial at Ilo in southern Peru which indicates relatively early use in this region. Cotton was initially used for fishing lines and nets (and possibly hunting nets), storage bags and clothing (Quilter et al. 1991: 282; Dillehay et al. 2007). Haas and Creamer (2006: 754) suggest that the "... effective exploitation of marine resources up and down the Peruvian coastal plain is inextricably related to the production of cotton ...".

At Caleta Vitor cotton was identified through seed, lint and capsules. Cotton was not located in CV1/2, CV1/3 or CV3/1 (Archaic Period trenches). The earliest evidence of cotton comes from CV2/1/39 where a date of 3346-3458 cal BP (early Formative) was obtained directly from a cotton seed. Evidence of cotton was found in 8/31 of the Preceramic unit and 15/27 units from the Ceramic Period. Cotton seeds, lint and capsules were found in trenches dated to the Late Period – CV4/1:4.

It is likely that cotton grew along the valley floor at Caleta Vitor and was probably originally harvested as a wild plant. Further investigation is required to determine whether a cultivar was introduced during the later periods. It is inferred that nets were used during the early Archaic Period (due to the abundant remains of very small fish species) and that cotton was used for net construction, as well as fishing line, during that period, although no evidence of cotton comes from the trenches dated to the early periods of occupation.

Given the amount of small fish remains found at Caleta Vitor, the importance of cotton for the production of nets and line cannot be understated when discussing its economy.

***Curcubita* spp. - squash**

Squashes grow as herbaceous vines that produce edible fruit. They now come in a broad range of shapes, sizes and colours. Both their flesh and seeds can be eaten. A number species of squash were domesticated in the Americas, with *C. pepo* being one of the most common (Smith 1998: 164) During the prehistoric period, squash were grown and/or collected for both food and, along with gourds, used as net floats (Harvey Coutts et al. 2011: 198).

Early and middle preceramic squash phytoliths have been recovered from the Las Vegas Phase in southwestern Ecuador (10,000 to 7000 yr BP) and the Colombian Amazon (9300 to 8000 yr BP) (Dillehay et al. 2007). Based on starch grains found on human teeth, Piperno and Dillehay (2008: 19625) argue that by 8000 BP in the Zana Valley of northern Peru squash was one of a number of products of an effective farming system that provided a stable and nutritional diet.

Squash seeds were retrieved from only four units at Caleta Vitor – CV4/1/10, 14,16 and CV2/1/31.

Gourd was identified in 14 units, the majority came from CV6/1 (from 7 units) and CV4/1 (5 units). Both of these trenches date from the Late Period. One fragment of gourd was located in CV2/1/31 which dates from 2354-2702 cal BP.

Peppercorn (*Schinus molle*)

The *molle* is native to Peru and is an extremely drought resistant tree that grows in valley bottoms with access to water (Terrell et al. 2003: 343; Goldstein and Coleman 2004: 524). The fruit of the tree grow in bunches and are used to produce a type of *chicha*, an alcoholic beverage that has been produced through the prehistoric period from a variety of plant sources. The most common form of *chicha* is now made from maize but fruit *chicha* is not uncommon in the Andean region (pers. obs.). *Molle* seeds appeared in their hundreds in bunches formed from an inflorescence that may be present for much of the year.

Both *S. molle* seeds and panicles were retrieved from excavations at Caleta Vitor. In several cases, the panicles appear to have been stripped of seeds. The earliest evidence of seed came from CV1/3/4 (>2348 cal BP) followed by CV4/6/8 (<1810 cal BP). The evidence from these trenches appears to be anomalous as *molle* seeds and stems do not become abundant until the Late Period (CV4/1/15,18; CV6/1/1-3,5,7-11; CV6/3/2,3,6).

Prosopis* spp. – *Algarrobo, tamarugal

Prosopis are a genus of hardy, drought resistant deciduous trees that are common in arid areas of the world. These trees are known for their extensive root systems which allow them to tap into deep water sources and they are often able to bear fruit at times when other plants are unable to do so. There are three species that may occur in the region of Quebrada Vitor – *P. Alba, P. juliflora* or *P. chilensis* and are known locally as *algarrobo* or *tamarugal*. Specific identification of the genus Prosopis is difficult and under continued review (Beresford-Jones et al. 2009: 304). A number of archaeological reports have misidentified species and subsequent and continued misidentification has occurred. However, all three species produce long seed pods with both pods and seed being edible. The seeds can be ground into flour and the pods treated as any vegetable. Prosopis are a medium to large tree which, although dense and difficult to work, produce usable timber. Wooden artefacts from the pre-Colombian coastal southern Peru were made from Prosopis (Beresford-Jones 2004: 216). Prosopis posts were also used as grave markers in cemeteries.

Chicha is prepared from Prosopis fruits and a number of coastal cottage industries in Peru still prepare a range of products for human consumption including *algarrobina* syrup, flour, and a coffee-like beverage (Beresford-Jones 2004: 230). Blake (1836) reported on a visit to a village in the highlands between Chile and Peru (close to 1836 border) and located near the Volcan Putana. He described the locals making a dish where roasted and ground corn was mixed with the fruit of the *algarosa* (sic) and "without cooking makes a kind of gruel nutritious and not unpalatable". It is likely that the *algarosa* described therein was a species of Prosopis.

The earliest known consumption of Prosopis in Peru comes from the site of Buena Vista, in central Peru about 35km inland from the mouth of the Chillon River. Along with a range of other food remains found there, *algarrobo* starch grains were identified in gourd containers dated to 4200 cal BP (Duncan et al. 2009: 13202).

Silverman (1993: 293) excavated the ruins of Cauachi, a major Nazca centre and found Prosopis was not only used as an ornamental timber but also made up a major portion of food remains. Her excavations retrieved 4.8kg of *Prosopis chilensis* fruit (as described by Silverman) which made up 34% of the edible plant remains found. Within the same assemblage, maize produced 38% of the plant food remains. The Spanish chroniclers also commented on the importance of Prosopis. In 1653 Cobo (from Beresford-Jones 2004: 228) reported that "The Spanish call the one that produces the best fruits by the name of *algarrobo de las Indias,* but it is different from the one in Spain. The fruits … are good eating and the Indians make flour and bread from them. In some areas, the natives have little sustenance other than these fruits."

Prosopis was useful not only as a food item but also as a source of timber. No evidence of construction was located at Caleta Vitor however timber posts were utilised as grave markers (see Chapters Six and Seven). While they have not been positively identified, the posts appear to be Propsopis and are likely to have been sourced locally. Extant trees were noted at the rear of the beach and along the banks of stream running along the valley floor.

Algarrobo seeds and/or pods were located in 21.8% of the excavated units from all but one of the excavated trenches (CV3/1). The broad distribution of *algarrobo* remains, in relatively small amounts, suggested that it did not provide a significant proportion of the diet, particularly during the Archaic Period. The occurrence of *algarrobo* pods and seeds increased during the Late Formative and Middle Horizon. The diminished presence of seeds and/or pods in CV6 may have been the result of distance from source as no trees would have grown in the vicinity of this sector, whereas *algarrobo* trees are still growing within CV4.

Solanceae

The Solanaceae family contains a large number of genera and species that are found around the world. Many of these species produce alkaloids that are toxic to humans so do not universally produce edible fruit or tubers. However a number of these varieties produce the most commonly consumed fruits and vegetables in the world. This group comprises a number of cultivars including potato (*Solanum tuberosum*), tomato (*Solanum* section *lycopersicum*), chilli and capsicum (*Capsicum* spp.).

Solanum spp. - Tomato

Tomatoes were introduced to the Old World when the Spanish took the fruit and seeds back to Europe from Mexico. They belong to largest genera within the Solonaceae family with some 1,500 species (Peralta et al. 2008: 1). It was initially assumed that the fruit was domesticated in Mexico although Peru has the greatest diversity of wild species (Bai and Lindhout 2007). More recent genetic investigations suggests that pre-domestication processes were of Andean origin and that domestication was completed in Mesoamerica (Blanca et al. 2012: 1)

A number of Solanum species are found along the coast of Peru and northern Chile, particularly in *lomas* formations and occasionally along coastal river valleys (Peralta et al. 2008: .36). These include *S. peruvianum, S. chilense, S. habrochaites, S. pennellii* and *S. pimpinellifolium*. *S. chilense* is one of the most common from northern Chile. It is found in hyperarid rocky plains and coastal desert from sea-level to 3000m ASL. The plants grow to a height of one metre and produce clusters of 3-5 fruit which are globular, 22-32mm long and 12-16mm wide, greenish white with purple stripes. They produce a dark brown flat seed 1.2-1.6mm in diameter. Purple, red and orange fruit are also known in the wild form.

Capsicum spp.

Another member of the Solanaceae family, the capsicum (*Capsicum* spp.) contains 25 species. The plant is widely distributed and a number of species were cultivated in Central and South America from about 6000 BP and at least three species were domesticated in Peru, in both the highlands and along the coast by 4000 BP (Perry et al. 2007). In Peru, capsicum starch grains were found in pre-ceramic sites in association with other domesticates including maize and tubers which suggests that 'sophisticated agriculture was being practiced in both regions [of Peru] before the introduction of pottery' (Perry et al. 2007: 988)

A regular find in most trenches at Caleta Vitor included calyces which appear to be from one genus. Small, dark seeds were also commonly encountered. While they have not been positively identified, it has been suggested that they are a member of the Solonaceae family (C. Latorre, pers. comm.). The morphology of the seed is certainly similar to modern Solonaceae cultivars such as tomatoes or capsicum. While soft and pliable, the calyces have preserved well and were found in levels perhaps as old as 7000 cal BP (CV3/1/25). This type of calyx was found in only four trenches (CV2/1, CV3/1, CV1/2 and CV1/3). None of these trenches date from the Late Period and while CV2/1 is dated as late as 1720 cal BP. They were not found above CV2/1/25 which dates to around 2500 cal BP and were far more prevalent in the lower levels, from around 3000 cal BP.

* * *

Several of the plant species described above are likely to have been native to this area and been growing adjacent to habitation sites while they were occupied. As such, there is a possibility that their remains may have been deposited by natural means, particularly in the sites adjacent to the watercourse or lagoon. The presence of such remains away some distance from these growing areas, such as higher on the slopes (CV1/2 and CV1/3), suggest that their presence was the result of human actions.

Faunal Resources

The evidence for the presence of faunal remains (other than fish and invertebrates) from the excavations at Caleta Vitor was limited to bone, faecal pellets and hide. Identification to species level was uncommon and generally limited to class or order. A detailed analysis of bone has not yet been undertaken due to the unavailability of a suitable comparative collection at present.

Several species of mammal were observed at Caleta Vitor during visits to the site. They include:

South American Sea Lion (*Otaria flavescens or O. juvata)*
Marine Otter (*Lontra felina*)
Rodent (non-specific)

Bone

Bone preserves well in the arid environment of northern Chile. Mammalian bone is commonly seen scattered over the ground surface over middens at Caleta Vitor particularly the large, conspicuous bones of sea lions.

Excluding fish remains, a total of 16.262 kg of bone was retrieved from excavations at Caleta Vitor. This total included portions of two whale rib bones with a combined weight of 4.160 kg. Bone fragments were found in 169/198 units (85.4%) excavated. Bone was often fragmentary, some was encrusted with *caliche* and some found charred or burnt. Detailed analysis of bone and identification of all individual taxa was not undertaken for this project. In this instance, bone was separated into general categories such as avifauna, pinnipeds (sea lion), rodentia and indeterminate mammal.

Pinipeds

South American sea lions (*Otaria juvata and O. flavescens*) are common in the region and have established colonies along the rocky coast, particularly in areas that have no simple terrestrial access. The male of the species can grow up to 2.7 m long and weigh up to 350 kg. Sea lions are affected by *El Niño* events, mainly due to the scarcity of prey in warmer waters.

While undertaking field-work at Caleta Vitor sea lions were regularly observed off-shore ranging from just beyond the wave line to the visible distance, often associated with feeding birds. On several occasions individuals were observed on the beach, particularly during the night.

They could have been clubbed if found on shore. However, in the main, hunters most likely used harpoons with detachable heads to capture these animals while they were swimming. Boats or rafts could have been used as platforms to position hunters within striking distance. Due to their size, it is likely that they were butchered in the vicinity of the point of capture or landing. Only portions of the butchered animal are likely to have been taken back to a base camp for consumption.

As an economic resource they not only provided meat but their hides were useful as coverings, clothing and cordage. Whole skins were also used as inflatable pontoons to construct rafts (Berenguer 2008: 36; see also Chapter 4). There are numerous ethnographic descriptions of this type of raft being used from Islay in Peru to Bio Bio in southern Chile, however, they appear to be more common between Arica and Coquimbo.

The Bandelier Collection at the AMNH holds two items that include sea lion hide cord. One (#B4480) has a large hook (bronze or copper) attached to a length of hide. The other (#B4477) has a barbed, copper spear point attached to a length of hide cord. These items were found at Caleta Vitor.

Bird (1943) noted the presence of sea lion bone in his excavations at Arica and Punta Pichalo but they were not as common as he expected given that he found several harpoons that were used to hunt them. Quebrada de Los

Burros was occupied during the Archaic Period and the inhabitants had a marine based economy (Carré et al. 2009). Sea lion remains were recorded there but it was suggested that hunting these animals was 'probably infrequent and opportunistic' (Carré et al. 2009: 1174). The sites of Quebrada las Conchas and Abtao-1 on the coast south of Caleta Vitor, were occupied from the Early through to the Late Archaic and sea lion remains are mentioned there but were not quantified (Llagostera 1979: 314-315).

The remains of sea lion were noted during the surface survey at Caleta Vitor, particularly in sector CV6. This area had been badly disturbed during more recent times by construction activity. Six sea lion mandibles were recorded scattered across the ground surface immediately in front of the trenches CV6/1 and CV6/3. Of note, no canines were present in any of these mandibles. These teeth appear to have been removed post-mortem as the sockets had been damaged. They may have been removed and used for decoration, possibly worn as a pendant. Another use may have seen the teeth attached to a [wooden] handle and used as a tool for retouching lithic artefacts.

During the surface survey, cordage made from sea lion hide was noted in sectors CV2 and CV6. It was most likely cut from uncured hides. It was used for general binding but was also found attached to a harpoon head in a burial chamber in CV2. Harpoons with detachable heads were used for hunting larger prey such as sea lions and, possibly, sharks and whales.

Sea lion bone was found in all but one (CV3/1) of the excavated trenches and 32 of the 184 excavated units. Their bones were most common in CV6/1 (11/16 units) and CV6/3 (4/6 units). CV4/1 had sea-lion remains in only two units suggesting that the animals may have been butchering closer to the kill site or where they were brought ashore and not all bones were taken back to point of consumption.

Cetacea

Whales are known along this section of the coast with the Blue Whale *(Balaenoptera musculus)* being one of the most commonly seen (Capitan C. Astorga pers. comm..). Dolphins (likely to be Common Bottlenose Dolphin, *Tursiops truncates*) and Burmeister's Porpoise (*Phocoena spinipinnis*) were observed during field-work.

Bird (1943) noted the presence of dolphin (Delphinides) bone at Arica and Punta Pichalo. Llagostera (1979) found their remains at Quebrada las Conchas from a midden dated from the early Archaic Period and Olguin et al (2015) reported dolphin remains from an Archaic midden at Copaca 1.

El Médano is a rock art site in northern Chile about 75 km north of Taltal (Berenguer 2008: 53). There are more than 200 panels within the site and some depict animals that have been interpreted as whales. There are paintings that depict humans on rafts (possibly sea lion skin rafts) hunting these whales. The figures show lines from the rafts linked to harpoons that appear to have been thrust into the whales. 17th century ethnographic records describe whales being hunted in this area just as depicted (Vasquez de Espinoza 1628-29 in Berenguer 2008). Llagostera (1990: 47) suggested that these descriptions relate to the hunting of pilot whales (*Globicephala* spp.) which grow to around 5–8m in length and weigh from 1300 kg up to 2300 kg when fully grown (Norrisand Prescott 1961). They are also in the habit of basking quietly on the sea surface. Llagostera (1990) argued that it was these basking animals that were the targets of the hunt described by Vasquez de Espinoza and not larger species.

Whale bone was noted on the surface in the majority of sectors at Caleta Vitor. Several fragments of whale bone (identified solely due to the size of the specimens) were located scattered over CV1. A single vertebra with a diameter of over 250mm was located on the ground surface at CV6. The size of this vertebra would suggest a large species, such as a Blue Whale. It is difficult to envisage early inhabitants hunting animals of his size so it is more likely that the presence of such remains was the result of a stranding rather than a hunt.

The remains of a Blue Whale were seen at the fisherman's wharf at Arica and the skeleton was obtained from a locally found carcase. In the more recent past, Calogero Santoro (pers. comm.) reported seeing a Blue Whale carcase washed ashore on the beach between Tocapilla and Iquique (central northern Chile).

Two sections of whale ribs were excavated in CV2/1 from unit 20. These weighed 2.8 8kg (510 mm (longest point) x 170 mm (widest point) and 1.28 kg (410 x 154 mm) respectively and were located lying side by side across the trench. They appear to have been intentionally placed in this position although there was nothing to indicate the reason for doing so (the limited size of the trench failed to reveal any associated evidence). The surface of the bone had deteriorated thus removing any sign of butchery marks that may have been present. Again, the size of these bones suggests that there were from a very large specimen, probably Blue Whale.

That smaller species of whales were hunted at Caleta Vitor cannot be discounted. Evidence of sea lion skin rafts (ethnographic records) along with detachable headed harpoons and sea lion hide cords and the possible depiction of such an animal in the rock art all support such an idea.

Camelids

There are four species of camelid found in South America – two wild species: guanaco (*Lama guanicoe*) and vicuña (*Vicugna vicugna*) and two domesticates (llama (*Lama glama*) and alpaca (*Vicugna pacos*). Camelid taxonomy is not clearly defined. There is one argument that each sub-specific form derives from one species (*L. glama),* with the vicuña placed within its own genus (*Vicugna).* An alternative argument is that the *guanaco* was the wild ancestor of the llama and that the *vicuña* that of the alpaca (Wheeler et al. 2001: 2575; Stahl 2008: 126). Genetic research supports the theory that llama were domesticated from the guanaco (*Lama guanicoe)* and alpaca from the vicuña *(Vicugna vicugna)* (see Kadwell et al 2001).

Camelids are an important resource within the economy of the Andean peoples and have been for millenia. Wild camelids were hunted for meat, hides and wool from the earliest periods of occupation (Rivera 1991). Before the development of woven textile technologies in the Late Preceramic, wild camelids provided skins and tendons vital for clothing and bindings. Guanaco hides were much esteemed for clothing by the Yaghan hunter-gatherers of Tierra del Fuego because, unlike the hides of marine mammals – the common prey of both Yaghan and Archaic period hunters – guanco skin is thin and flexible and has heavy hair making it far better to keep out the cold (Beresford-Jones et al. 2015)

Camelid domestication began between 5000-7000 BP in the highland regions of the Andes (Gallardo et al. 1999; Kadwell et al. 2001; Stahl 2008). Domesticated camelids (llama and alpaca) appear around 6000 years ago in the Andean highlands in the Junin region (Stahl 2008: 128). Both species were sources of meat and produced wool and hair although the alpaca produced finer and more abundant wool. The llama was also used as a pack animal and trade was carried out using caravans containing many hundreds of animals.

Settlement intensity along the coast increased as complex societies developed and trade with highland groups intensified. Colonial reports describe coastal communities in southern Peru providing maize, chilli, cotton, dried fish and guano to highland traders in exchange for dried camelid meat and other highland goods (Diez de San Miguel 1567 in Covey 2000: 122). Llamas were provided by the highland groups to facilitate trade.

No camelid bone was positively identified at Caleta Vitor although faecal pellets were found in many of the excavated units with a total of 741.5gm of pellets recovered. The rock-shelter at CV6 contained a substantial quantities of camelid dung on the ground surface as did some areas within CV4. This surface material was not included in the analysis other than to note that these areas may have been where domesticated camelids (either llama or alpaca) were corralled.

Only one camelid faecal pellet was found in units from the Archaic period – CV1/3/10. CV1/3/9 has been dated to 5664-5910 cal BP. Camelid dung was more common from CV2/1/37 (CV/2/1/39 dated to 3346-3458 cal BP, but only small quantities (1-2gm) appear in any one unit within that trench - CV2/1 had dung in 4/31 units from the Preceramic Period, whereas the Ceramic Period had dung in 8/27 units. Camelid dung became abundant during the Late Periods (<660 BP) when quantities increased substantially (between 20-100gm in many units). Table 11.2 displays the quantity and distribution of camelid faecal pellets.

No bone that has been identified as belonging to a wild camelid species (eg *guanaco*) has been found at Vitor. It is more likely that the prevalence of camelid dung coincides with the arrival of trade caravans travelling between the coast and the highlands.

The evidence located at Caleta Vitor thus far does not suggest that wild camelids were hunted during early periods of settlement. It is highly likely that the faecal pellets located were from the domesticated species, *Lama glama*, from animals used for transporting trade goods and supplies. As there appears to be an intensification of occupation during the Late Period, these animals may have been utilised within the trading network that brought in highland goods and took out products such as dried fish and guano.

Evidence of camelids at Caleta Vitor is also found in rock art. Quadrupeds, assumed to be llama, feature in several locations within CV5 and CV6. The caves within CV5 contain painted images of these animals in red/orange, black and white ochres. Another panel was located on the base of the cliff above the trenches at CV6/1 and CV6/2. In this instance, the images were painted with orange ochre on several areas of the cliff face and at least five appear to be llama – a number of images are unclear as they are partially obscured by layers of dust. While it is not certain, the panels at the base of the cliffs appear not to portray any animals other than llama whereas the figures depicted in the caves include humans, fish and sea lions.

The lack of discarded camelid bone amongst other food remains suggests that they were not a common source of meat, and were perhaps more valued as pack animals.

Rodentia

The common domesticated Guinea pig or cuy (*Cavia porcellus,*) is an important food source in Andean households today. They often live in the kitchens of adobe houses and are fed on vegetable scraps as the daily meals are prepared (pers. obs.). The wild species (most likely *Cavia tschudii*) is more gracile than the domesticated varieties. Cuy appears in the archaeological record up to 9000 years ago. Their domestication is likely to have occurred in the Central Andean region, spreading northward between 2000 and 3000 years ago (Stahl 2008: 126). Evidence from the coastal site of Cerro Azul, a Late Period site in northern Peru, has demonstrated that guinea pigs were later raised for both food and ritual (Marcus et al. 1999: 6569).

Small rat-like rodents were seen at Caleta Vitor but observations were of limited duration and the species could not be identified. Fragments of bone tentatively identified as rodent was found in CV2/1/8, CV2/1/39, CV4/6/9 and CV6/3/3.

The dehydrated bodies of two rat sized rodents were located in CV1/3/10 in a nest of feather and fur containing maize cobs. The 'nest' was intrusive and it appears the rodents burrowed into the section through an area previously exposed by earthworkings. These animals appear to be of modern origin as the maize cobs are the local commercial variety, unlike any specimens found elsewhere on the site.

Rodent bone was identified in only two units – CV2/1/39 and CV6/3/30. Faecal pellets from unidentified rodents (size and shape similar to those of domestic *cuy*) were found in 29 excavated units with a total weight of 91.5 gms. Pellets were far more abundant in CV6 than any other sector. 76.9% of the excavated units from CV6 contained rodent faecal pellets.

Rodent faecal pellets were not located in any units older than 650 BP (CV6/1/14). The late appearance of such rodents in the assemblage may be coincident with the introduction of domesticated *cuy* (*Cavia porcellus*) from the highlands during the Late Period.

	3/1	1/3	1/2	7/1	2/1P C	2/1C	4/6	4/1	6/1	6/2	6/3
Camelid	-	2.5	-	-	4.0	8.0	1.7	313.6	336.4	25.5	25.5
Rodentia	-	-	-	-	-	-	0.3	4.4	74.2	0.6	12.0
Units	-	1/26	-	-	4/31	8/27	1/10	17/19	14/16	3/4	5/6

Table 11.2: Dung (weight in grams) found in in each trench.
Number of units with dung presence out of total.

Avifauna

A number of species of birds were commonly seen flocking along this section of the coast and the following species were observed during the field-work season at Caleta Vitor:

Peruvian Pelican, (*Pelecanus thagus)*

Red-legged Cormorant, (*Phalacrocorax gaimardi*).
Neotropic Cormorant, (*Phalacrocorax brasilianus*)
Guanay Cormorant, (*Phalacrocorax bougainvillii*)
South American Tern, (*Sterna hirundinacea*)
Inka Tern, (*Larosterna inca*)
Kelp Gull, (*Larus dominicanus)*
Grey gull, (*Larus modestus*)
Franklin's Gull, (*Larus pipixcan*)
Humboldt Penguin, (*Spheniscus humboldti)*
Blackish Oystercatcher, (*Haematopus ater)*
Peruvian Booby, (*Sula variegate*)
Turkey Vulture, (*Cathartes aura*)
Pacific Dove, (*Zenaida meloda*
Eared Dove, (*Zenaida auriculata)*
Croaking Ground Dove, (*Columbina cruziana)*

A number of species seen nesting on the cliffs during the field-work season included Peruvian boobies, cormorants and Inka tern. Large sections of cliff face were covered with guano suggesting that much of this area is used by roosting and/or nesting birds. Flocks of birds were also observed, almost on a daily basis, feeding off-shore - sometimes just beyond the surf zone as well as much further off-shore. These birds were likely feeding on shoals of sardine and/or anchovy.

Marine birds were hunted for food during the prehistoric period (deFrance 2005: 1131). However, as a resource they provided more than meat. Guano was also collected for use as fertiliser and during the later, agricultural periods, was traded into the highlands as a valued item (Szpak et al. 2012).

Bird bones were used in the manufacture of needles and composite fish-hooks. Feathers and skins were used for both practical and ritual purposes.

The Bandelier Collection at the AMNH contains several items utilising feathers. One item (Cat. No. B4429) consists of a length of fine cotton twine with eights feathers tied at various spacing along its length. These feathers are yellow/green in colour. No species of that colour are known locally and the feathers might have come from cloud-forest or jungle species east of the Andes. Items B4430 and B4432 both contain feather plumes. The larger example is made of plumes from the rhea (*Rhea pennata*). This species is not known locally at present but is found inland at higher altitudes.

Bird (1943:250-251) described four mummies in the Bandelier Collection that were collected from Caleta Vitor in 1894. One was wrapped with textiles that contained a Spanish document dated to 1578. This mummy was wearing a hat that Bird describes as being 'like a Turkish fez ... like a common flower pot. Feathers from pelicans and parrots spread from a small round hole in the center at the top and droop down on all sides to the level of the brim' (Bird 1943: 251).

Bird skin with attached feathers was used to adorn bodies when they were buried. In his report of 1843, Blake described a burial he located to the south of Arica at Tana. He described finding a body in a 'horizontal position dressed in skins of penguin, bow and quiver at his side' (1843: 12). Bird (1943) found several burials adorned with bird-skin robes at Quiani (Arica). Chinchorro mummies were sometimes adorned with bird skin and feather (pers. obs.). Figure 11.1 contains a photograph of a feather clad mummy located within the city of Arica. Feathers were recorded at Caleta Vitor adhering to the mandible of human burial located within CV1. The use of feathers was discussed in more detailed in Chapters Seven and Eight

Bird bone was retrieved in varying amounts from the excavations. Overall, it was found in 28.1% of the excavated units, ranging from 50% of the units in CV3/1 and CV6/3 down to 10.1% of the units in CV4/1. Feathers were also commonly found in all trenches. The only species identified so far is the Brown Pelican (*Pelecanus occidentalis)*, owing to its size.

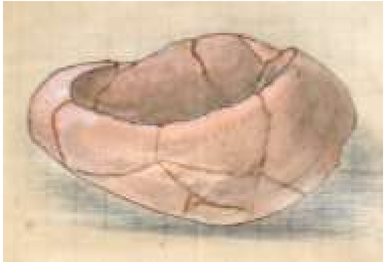
Worthy of note was a single brightly coloured (orange/red) feather that was located in a disturbed burial chamber adjacent to CV2/1. The feather was bright orange/red. No local species of that colour were observed and its presence may indicate material traded from inland.

While not abundant, the evidence from Caleta Vitor suggests that avian fauna played a role in the local economy with a range of uses including consumption, decoration and ritual.

Figure 11.1: Feather wrapped Chinchorro mummy - Museo Arquelogico San Miguel de Azapa. Photo: C. Carter

* * *

Floral and faunal remains were common within all sectors of Caleta Vitor. However, the abundance of fish and shellfish suggest that plants and terrestrial fauna did not contribute significantly to the economy. Maize does not appear until quite late, perhaps not until the Late Intermediate. The few other plant remains suggest that agriculture was not practiced intensively on this section of the coast until at least the Late Period, if at all. Prior to that, locally occurring plant foods, such as *algarrobo* and various wild solanaceae, supplemented their diets as they became available. As fish contributed significantly to the economy, cotton, used for lines and nets, was a very important element in the overall system of production.



The Economy of Prehistoric Coastal Northern Chile
Part Three

When you can measure what you are speaking about and express it in numbers you can know something about it but when you cannot measure it, when you cannot express it in numbers, your knowledge of it is of a meagre and unsatisfactory kind. (Lord Kelvin 1883)

Analysis of Faunal Remains

This part provides an analysis and discussion concerning fish and shellfish remains from Caleta Vitor. The following chapters will examine the evidence provided by the remains of fish and invertebrates retrieved from middens. The discussion will include:

- The chronological range and abundance of identified species;
- Consideration whether animal size increased or decreased over time;
- Calculations of diversity and equitability indices of a range of samples to ascertain if, and to what extent, they changed through time; and
- The potential range of hunting/gathering strategies that may have been employed.

The taphonomic conditions of the sites at Caleta Vitor varied widely, some being loosely packed midden layers containing partially intact fish skeletons and whole shells; calcification affected some deposits; burnt remains that had also been severely damaged by traffic (both foot and vehicular) to become both fragile and fragmented; through to deep, compacted deposits with some that had been badly disturbed by construction activity.

Diagnostic elements such as otoliths, teeth and shell valves were used for species identifications. Along with published comparative material (e.g. Llagostera et al 1999; Zuniga 2002; Medina et al 2004), specimens purchased at markets or from collections held in local universities were also used to assist with species identification.

Both weights and MNIs were used to compare species richness (the number of species within a given sample or community), abundance (the proportion of each species or class in a sample) and diversity (comparison of species richness to evenness of abundance). MNI were used to consider collecting strategies but as many stratigraphic units contained highly fragmented shell, the ability to identify non-repetitive elements (NREs) was reduced. Total weights proved more useful, especially to compare the relative importances of different shellfish taxa in dietary regimes.

Usage of both weights and MNIs has attracted criticism. . Glassow has stated that "neither MNI nor weight proportions, is a universal unit of analysis for addressing the various questions about human predation on shellfish that archaeologists frequently ask." (Glassow 2000:412). This is particularly relevant when comparing numbers of robust shells (such as *C. concholepus - loco*) with lighter shelled animals (such as *Perumytilus purpuratus - chorito*). However, Glassow has also argued that both can be used to complement each other in situations where results can be skewed.

Variationx in the abundance and diversity of the different species present in a midden assemblage may be the result of either natural or anthropogenic factors. Natural factors include water temperature, salinity and nutrient content (the result of *El Niño* events) as well as geomorphological variation due to fluctuating sea-levels and/or sediment deposition. Anthropogenic change may be gradual as techniques and technology evolved through time, a abrupt as techniques and technologies developed elsewhere were introduced via colonisation or trade. Sudden population increases would also have placed greater pressure on resources, local or otherwise.

Abundance, diversity and equitability indices were calculated for each trench and used to compare individual layers within trenches. The abundance of each species was calculated from MNI. For the analysis of fish remains, vertebrae size classes were used in place of individual species to calculate the abundance of each size class (using NISP). Diversity, equitability and similarity indices were then calculated using the relative abundance of each species or size class (see Reitz and Wing 2008: 110-115).

The diversity index reflects how many different types species or size classes are in an assemblage, and takes into account how evenly each individual species or size class is distributed. Diversity values increase when the number of species or size classes increases and when evenness increases. For a given number of types, the value of a diversity index is maximized when all types are equally abundant.

Equitability demonstrates the degree to which each class is equally abundant. An even distribution of classes in a sample would result in an equitability value close to 1.0, whereas a low value would suggest one species or size class being much more abundant than any other.

The Shannon-Weaver function was used to determine diversity values and was calculated thus:

Diversity (H′) calculated:

$$H' = \sum_{i=1}^{s} (pi)(\log pi)$$

where:

H′ = information content of the sample

pi = the relative abundance of the ith size class within the sample log pi = the logarithm of pi.

s = the number of size categories

Equitability (V') was calculated:

$V' = H' / Log_e S$

where:

H' is the Shannon-Weaver function and S is the number of size classes in the sample (Reitz and Wing 2008: 111).

A percentage similarity measure (PSM) was used to compare the abundance distribution of the range of specimens from each trench – the PSM figure relates to the degree of similarity between any two trenches or between two divisions within one trench (e.g. CV2 was divided into Preceramic and Ceramic, other trenches were divided into groups of 4 or 5 levels). A higher PSM denotes a higher degree of similarity between any two samples.

The PSM index (P) is calculated using the formula:

$P = \Sigma \text{ minimum}(p1i, p2i)$

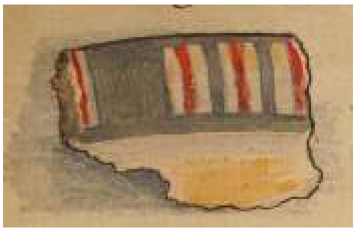
where

P = percentage similarity between samples 1 and 2,

$p1i$ = percentage of species i in sample 1, and

$p2i$ = percentage of species i in sample 2 (Reitz and Wing 2008: 114)

In some instances, MNI was suited to calculate similarity measures for shell. Species such as *loco* have a robust and heavy shell. As such they are more likely to survive and are easy to identify. Mytilidae (mussels), on the other hand, are more fragile and identification of fragments is problematic as several species make up the assemblage. This has resulted in a large amount, by weight, of undifferentiated mussel that did not contribute to the MNIs of individual species.



Chapter Twelve

> *Any culture must, of course, rest upon a basic economy which is adapted to its environment. (Steward & Seltzer, 1938: 7)*

Analysis of Fish Remains

The following table summarises the totals (weights in grams) of fish remains retrieved from each trench[1]:

Trench	Misc Bone	Vertebrae	Otoliths	Dentitions	Shark	Totals
CV3/1	883.42	291.50	18.14	13.87	0.48	1207.41
CV1/3	1847.05	438.76	84.43	8.45	1.41	2380.10
CV7/1	90.40	43.82	2.60	4.56	0.0	141.38
CV1/2	385.1	208.60	29.90	3.98	2.02	629.60
CV2/1	3445.91	915.89	77.04	37.32	30.24	4506.40
CV4/6	532.39	214.92	8.77	5.41	2.97	764.46
CV4/1	2915.94	646.97	30.65	62.38	1.64	3657.58
CV6/3	643.11	686.89	20.22	29.63	175.92	1555.77
CV6/2	81.72	111.2	1.31	4.08	0.0	198.31
CV6/1	970.32	799.79	29.47	40.08	191.47	2031.13
Totals	11795.36	4358.34	302.53	209.76	406.15	17072.14

Table 12.1: Summary of fish remains per trench (weights in grams)

Of the excavated trenches, CV2/1 contained the largest quantity of fish remains (4.506kg, 26.4% of the total). This was not unexpected as it was the deepest trench (over 3.2 m) with 58 excavation units. However, CV4/1 was 800 mm deep (19 units) and contained 3.658 kg (21.4% of the total). CV1/3 (1.75 m deep, 26 units) contained 2.380 kg (13.9%), and CV6/1 (1.15 m deep,

[1] Data in tables is arranged in approximate date order – oldest to youngest.

16 units) had 2.031 kg (11.9%). Both CV1/3 and CV2/1 span considerable periods of time (3500 years and 2000 years respectively. By contrast, CV4/1 and CV6/1 are from the Late Period. CV4/1 consists of material that was deposited during a period of about 120 years, at most, or as little as 50 years. Likewise, CV6/1 was deposited over a period lasting between 100 and 250 years. It is probable that the intensity of occupation was far greater in the Late Period which would account for a more rapid accumulation of material. However, over the long term the deterioration of bone would have resulted in reduced survival rates in the older units.

Eleven species of bony fish were identified as well as one family group. One species of shark was identified via teeth but vertebrae were grouped as undifferentiated elasmobranch.

Otoliths

Otoliths are small bony structures found in pairs within a fish's head. They consist of calcium carbonate (aragonite) and function for acoustic perception and balance (Casteel 1976; Andrus et al. 2002; Reitz & Wing 2008; Disspain et al. 2011). Teleost fish (one of the three classes of ray-finned fish) have three pairs of otoliths contained within sack-like pockets in the cranium. Of the three pockets (sacculus, utriculus and legena), the sagitta, which forms within the sacculus, is usually the largest (Reitz & Wing 2008: 63). Each pair of otoliths is symmetrical, presenting a left and right specimen.

Otoliths grow incrementally in alternating bands that reflect biological and environmental conditions. Due to their inorganic nature and hardness, they preserve well in the archaeological record. They can be used to determine species, the approximate size, growth rate and age at death (Llagostera et al. 1997, Llagostera 1990; Medina and Arraya 2001; Begg et al. 2004; Disspain et al 2011;). Isotopic and trace element analysis can examine palaeo-environmental conditions, salinity and water temperature (Disspain et al. 2011). Furthermore, otolith assemblages can be used to develop inferences relating to fishing practices, subsistence strategies and social structures (Balme 1995).Llagostera (1979: 313) suggested that of all the fish remains within archaeological assemblages, otoliths have been the most useful for the identification of fish species and have been used since at least the late 19th century to compare species from archaeological sites.

However, archaeological assemblages do not necessarily contain a complete array of bone types from each species. For example, Llagostera et al. (1999:171) reported that there were a far higher number of otoliths per species than other bones from excavations at La Chimba 13. Using otolith to calculate MNIs, *sargo* was the most common fish (298/475), followed by *cabinza* (53/475) and *ayanque* (48/475). They reported that in levels containing both otoliths and first pre-caudal vertebrae, the MNI of *sargo* based on otoliths was 128, yet only 22 first pre-caudal vertebrae from that species were located. Some 82.8% of first pre-caudal vertebrae were missing from the assemblage. Conversely, using first pre-caudal vertebra to identify species and calculate MNI, *tomoyo* were the most common (57/146) followed by *sargo* (22/146). No *tomoyo* otoliths were identified at all.

1841 otoliths were recovered at Caleta Vitor, sorted from other fish remains, brushed, but not washed, and sorted into individual species where possible. Portions less than 50% (estimated) of original full size were not included in the analysis. Each specimen was weighed and recorded as left or right. No dimensional measurements were taken as a high proportion of specimens had damage and/or weathering on the margins. Species were identified using Medina and Arraya (2001), Llagostera et al. (1999) and Llagostera (1979) assisted by comparative samples from the Universidad de Tarapacá. MNI was calculated by counting left and right otoliths for each stratigraphic unit, the side with the higher number was recorded as the MNI for that unit (total MNI = 1212). These data were used to calculate species composition and abundance, equitability and diversity, and distributions in both temporal and spatial terms.

While otoliths are generally robust, survive well in archaeological contexts and are less likely to be damaged during handling, no otoliths from very small species such as sardine or anchovy were located. Otoliths from these species are very small (less than 1mm wide) and extremely thin. Thus, the excavated sample is not representative of the complete range of fish resources. However, comparisons for larger fish species can be made across all trenches. Evidence for very small species is discussed later.

Nine species of fish were identified via otoliths. The following table contains the MNI for each species recorded per trench:

	Trenches											
Species	**3/1**	**1/3**	**7/1**	**1/2**	**2/1P**	**2/1C**	**4/6**	**4/1**	**6/3**	**6/2**	**6/1**	**Total**
Roncacho (S. deliciosa)	67	258	3	103	200	37	33	69	55	5	101	931
Cabinza (I. conceptionis)	15	61	0	0	4	5	0	4	4	0	7	100
Corvina (C. gilberti)	6	6	2	3	11	9	1	11	3	0	9	61
Jurel (T. symmetricus)	0	3	0	2	23	6	2	5	3	0	2	46
Apañado (H. macrophthalmus)	3	6	0	1	4	0	1	5	0	0	4	24
Cabrilla (P. humeralis)	0	3	0	0	9	3	1	1	1	0	1	19
Bagre (G. perivianus)	0	6	0	0	8	0	0	0	0	0	0	14
Ayanque (C. analis)	0	1	0	0	0	0	2	7	0	0	0	10
Sargo (A. scapularis)	0	0		0	0	0	0	6	1	0	0	7
Total	91	344	5	109	259	60	40	108	67	5	124	1212

Table 12.2: Distribution of species (MNI) as identified via otoliths

Selected Species

Roncacho

Roncacho were by far the most common species identified via otoliths (76.8% MNI = 931) (followed by *cabinza* - 8.2%, MNI = 100). The mean abundance[2] (per trench) was 77.3% (ranging from 61.7% in the CV2/1C to 94.5% in CV1/2). Table 12.3 displays MNI (based on otolith pairs) for *roncacho* from each trench and unit:

There were significant shifts through time in the abundance of *roncacho*. From the trenches dated to the Archaic Period, CV1/3 has the highest incidence with a total of 258 (MNI) and a mean of 8.32 per unit; CV1/2 has a mean of 6.05; and CV3/1 of 3.05. Trends are evident within these trenches, in which the abundance of *roncacho* shifts significantly, with units containing 10 or more clustered in groups of four or five and flanked by units containing only one or two. This is likely due to seasonal variation in the occurrence of *roncacho* in this particular area or it may relate to fluctuations in water temperature, as during *el Niño* events (this argument is discussed in more detail later). It could also reflect widely dispersed *roncacho* consumption events, with a subsequent scuffage of bones into several levels.

CV3/1/31 contains the earliest evidence of occupation for the entire site (9271-9487 cal BP). The incidence of *roncacho* otoliths from that level is the highest for that trench. The mean incidence per level for CV3/1 was 3.05 but out of a total of 67, 14 were located in CV3/1/31. This not only indicates that *roncacho* were commonly caught over an extended period but also suggests that the desire, skill and technology required to capture them was present during the earliest known period of occupation, over 9000 years ago.

[2] Abundance of specimens identified from otoliths.

Level	CV3/1	CV1/3	CV7/1	CV1/2	CV2/1P	CV2/1C	CV4/6	CV4/1	CV6/3	CV6/2	CV6/1
1	0	1	0	0	1	0	3	0	1	0	7
2	0	2	0	1	2	1	7	3	12	0	7
3	0	3	0	0	1	2	2	1	21	2	4
4	0	6	0	2	2	1	1	19	9	3	3
5	0	1	0	4	2	2	2	4	9		20
6	0	11	0	1	0	2	0	1	3		0
7	0	2	0	12	1	1	1	2			12
8	0	6	0	26	0	1	3	1			10
9	0	2	2	14	3	0	5	11			7
10	3	25	1	27	10	1	8	7			10
11	8	28		1	7	0		6			6
12	4	25		2	8	4		0			0
13	0	17		4	3	0		2			4
14	0	7		4	4	3		3			4
15	1	5		0	5	0		0			5
16	1	1		0	4	2		0			2
17	3	19		5	13	0		6			
18	1	14			22	2		2			
19	5	0			15	1		1			
20	5	33			28	4					
21	1	23			22	1					
22	1	0			0	3					
23	2	3			25	0					
24	0	3			16	2					
25	0	20			1	1					
26	3	1			0	0					
27	2				0	3					
28	2				2						
29	7				0						
30	4				0						
31	14				1						
Total	**67**	**258**	**3**	**103**	**200**	**37**	**33**	**69**	**55**	**5**	**101**

Table 12.3: Distribution of *roncacho* otoliths (MNI).

There were too few radiocarbon dates obtained to divide each trench precisely into specific periods. However, it was possible to divide the trenches and levels into Archaic and Formative/Late Period chronological groups. The overall otolith mean count of the Archaic units[3] was 6.2. CV2/1 spans the Formative and Middle Horizon and displays a significant contrast between the two (means of 6.38 for Preceramic and 1.37 for Ceramic). While the contrast may be due sampling bias, it could also have been the result of altered site use. The number of exposed burials across CV2 (noted particularly in the walls of bunkers) suggests that the area was used as a cemetery during the Middle Horizon, whereas during the early Formative Period this area may have been more commonly used for domestic purposes, with a greater amount of refuse discarded. The presence of some food remains within the later units of CV2 indicates that while this area was used more for burials, consumption continued to take place, perhaps during ritual events.

Units from the Late Period trenches CV4/1, CV4/6, CV6/1 and CV6/3 have means of 3.63, 3.30, 6.31 and 9.16 otoliths respectively. The disparity between CV6/1 and CV6/3 is likely due to a sampling bias as CV6/3 was not excavated to the same depth as CV6/1. These trenches were abandoned prior to completion for reasons of safety. CV6/3 also lacked stratigraphic integrity and appears to have a mixed/disturbed deposit.

Roncacho are not a large fish (see Chapter Nine) and were most likely caught in nets. Concentrations of their otoliths may have been the result of specific events, perhaps indicative of a successful fishing expedition, something that occurred regularly but perhaps not on a daily basis.

[3] The number of units in CV3/1 used to calculate this figure was reduced as the upper 10 units were virtually devoid of faunal remains and consisted primarily of the material used to construct the *tumulos* which overlay the midden deposit.

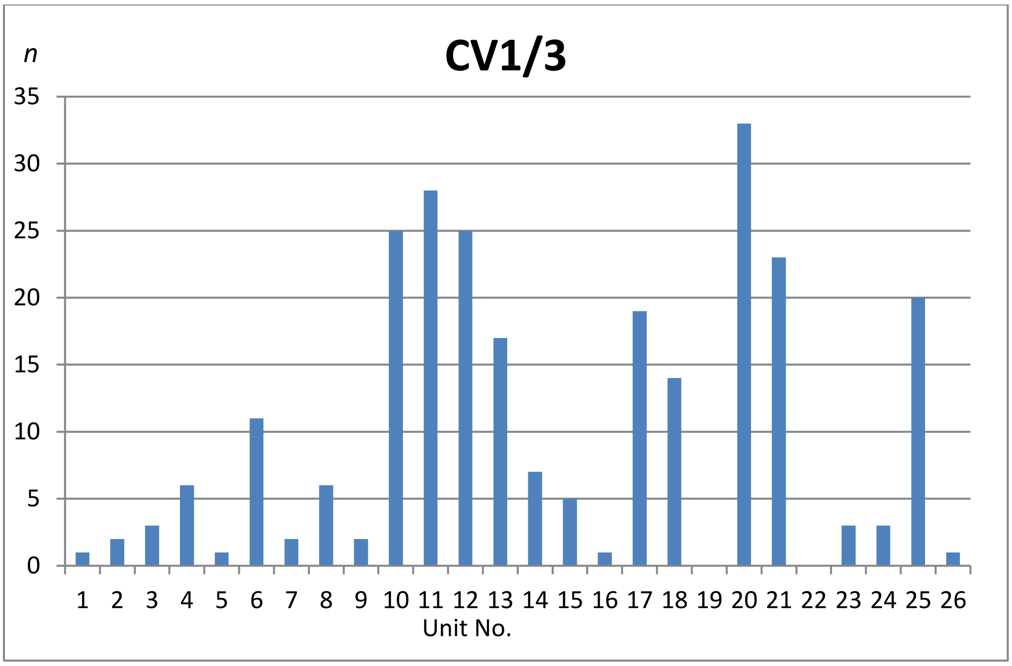


Figure 12.1: Distribution of *roncacho* otoliths from CV1/3

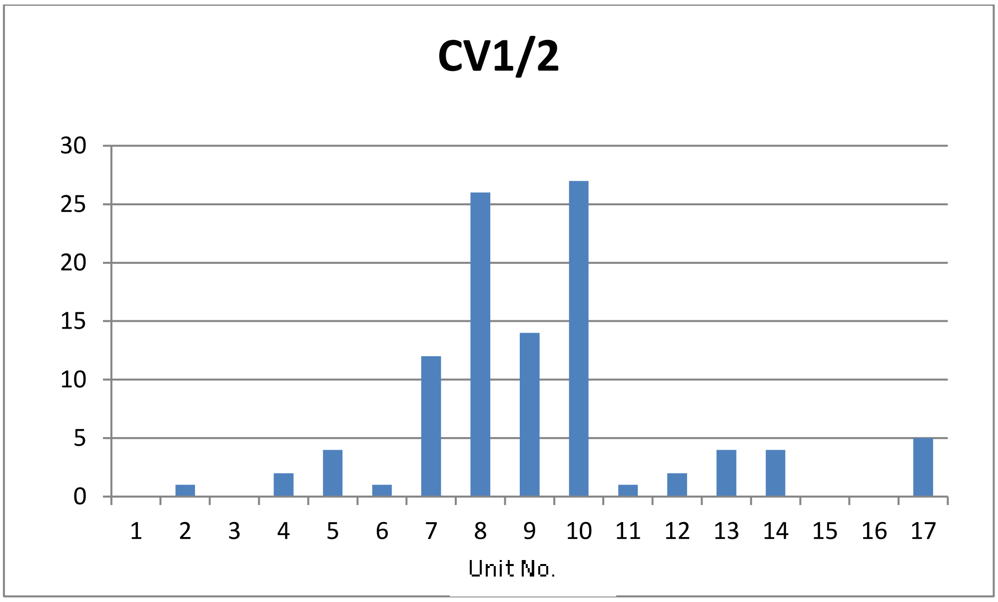


Figure 12.2: Distribution of *roncacho* otoliths from CV1/2

Figures 12.1 and 12.2 display the distribution of *roncacho* otolith in trenches CV1/2 and CV1/3. CV1/3 appears to display at least three, possibly four cycles where *roncacho* were more abundant whereas CV1/2 has only one distinct phase where their numbers are significantly higher.

Table 12.4 contains the mean otolith weights for trenches and layers as well as the number (NISP) from each group. CV6/3 and CV7/1 were excluded as they had only three and two otoliths respectively. The unshaded area within the table indicates the relative depth of the trench – shaded areas are beyond the excavated area.

	Trench (CV) & NISP																	
Units	**3/1**	***n***	**1/3**	***n***	**1/2**	***n***	**2/1P**	***n***	**2/1C**	***n***	**4/6**	***n***	**4/1**	***n***	**6/3**	***n***	**6/1**	***n***
1-5	0.16	*11*	0.14	*12*	0.12	5	0.16	*8*	0.14	*6*	0.19	*21*	0.22	*34*	0.15	*31*	0.17	*45*
6-10	0.15	*21*	0.16	*52*	0.18	99	0.16	*6*	0.12	*6*	0.13	*11*	0.19	*24*			0.15	*45*
11-15	0.13	*1*	0.17	*114*	0.13	17	0.15	*39*	0.15	*12*			0.21	*16*			0.16	*22*
16-20	0.14	*32*	0.17	*104*			0.13	*68*	0.15	*7*			0.17	*10*				
21-25			0.17	*75*			0.18	*97*	0.12	*10*								
26-30							0.20	*17*										

Table 12.4: Mean otolith weight (gm) for selected trenches (*n* =NISP)

The overall mean otolith weight was 0.18 gm. The largest specimen weighed 0.47 gm and the smallest 0.03 gm. While there was some fluctuation in the mean weights, there appears to be a general consistency through time. The oldest levels come from CV3/1 and the mean weight for those levels is 0.14gm (*n*=32). CV6/3 is a trench dated solely to the Late Period and the mean weight for that trench is 0.15gm (*n*=45). Fluctuations appear to be cyclic rather than a consistent increase or decrease through time. Figure 12.3 contains a box plot depicting the mean weight of *roncacho* otoliths across all trenches.

The range of individual otolith weights is broad. However, overall it falls within a relatively limited span, particularly when comparing early to later periods. For example, CV1/2 is dated to the Archaic Period and CV4/1 to the Late Period yet their ranges are similar as are their means. There appears greater variation between CV1/2 and CV1/3 which are both Archaic. This supports the idea that size fluctuations are more likely to be seasonal than to reflect any long-term trend.

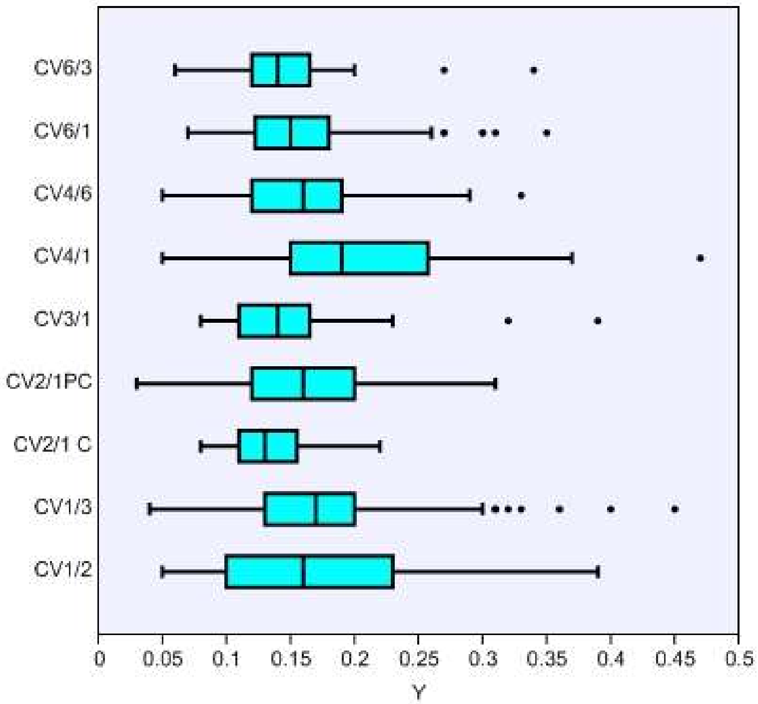


Figure 12.3: Box plot showing mean otolith weight (gm) for *roncacho* in each trench. The 25-75 percent quartiles are drawn using a box. The median is shown as a line inside the box. The whiskers are drawn from the top of the box up to the largest data point less than 1.5 times the box height from the box (the "upper inner fence"), and similarly below the box. Values outside the inner fences are shown as dots as outliers.

Otoliths were sampled from 72 *roncacho* purchased in the Arica fish markets (Disspain 2015 in prep.). The whole fish ranged in length from 218 mm (138 gm) to 400 mm (887 gm) and the mean otolith weight was 0.14 gm 22% smaller than the mean weight from the prehistoric sample from Caleta Vitor. Furthermore the largest otolith in the modern sample was 0.24 gm compared to 0.47 gm in the prehistoric sample (CV2/1/47). This is a significant reduction in size.

However, there appears to have been no overall reduction in *roncacho* size during the prehistoric periods of occupation. A substantial fishery at Arica targets *roncacho* nowadays and this may have impacted on their mean size in the relatively recent past, most likely within the past century.

Cabinza

Cabinza were the second most abundant species (8.2% MNI =100) at Caleta Vitor. They are similar in size range and habit to *roncacho* and may well have been caught using the same methods. 60% of the *cabinza* total (MNI=60) came from CV1/3 and their otoliths were spread consistently through the entire trench (17 out of the 26 units). None were found in CV1/2. CV1/2 and CV1/3 are both located in the same sector (~150m apart), within the same topographic unit and both date from the Archaic Period, with at least 1000 years of overlap.

CV3/1 is also dated to the Archaic Period and *cabinza* were found in six out of 21 units. CV3/1/31, dated to 9271-9487 cal BP, contained four otoliths from *cabinza*. CV2/1 contained 58 units and had nine *cabinza* otoliths divided between the Ceramic (MNI=5) and Pre-ceramic layers (MNI=4). Late Period trenches CV6/1, CV6/3 and CV4/1 contained *cabinza* (MNI=15) distributed across 11 of the 41 units.

Cabinza made up a reasonable proportion of otoliths within CV1/3 (23.6%, 61/258). Figure 12.4 displays the abundance of *cabinza* compared to that of *roncacho* in CV1/3, and it is clear that their numbers fluctuated in relatively high correlation. This may be a result of the use of similar techniques, in similar locations catching fish with similar habits.

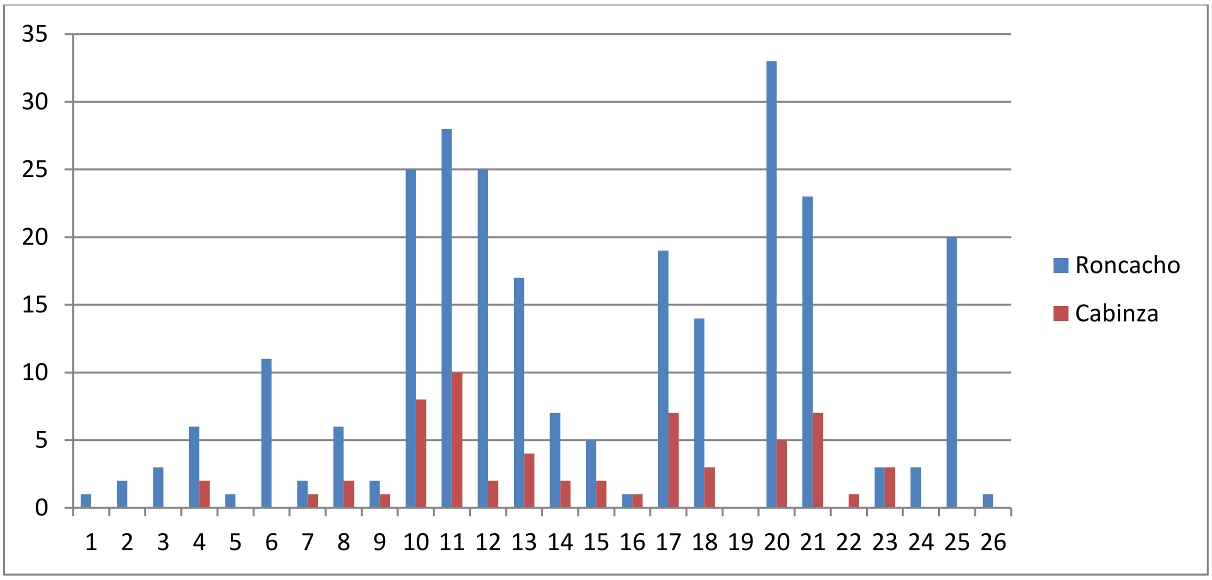


Figure 12.4: Comparison of abundance of *cabinza* compared to *roncacho* in CV1/3 (MNI).

Corvina

Corvina represented 5.2% (MNI=63) of the otolith sample. This is a large species that would have contributed a far higher proportion of meat weight than its low MNI would suggest. *Corvina* otoliths were conspicuously and consistently larger than those of other species within the assemblage. For instance, the mean weight of *roncacho* otoliths was 0.17 gm, whereas *corvina* otoliths had a mean weight of 0.69 gm. A modern sample of *corvina* provided otoliths that weighed 0.40 gm each from a whole fish that weighed slightly more than 2.5 kg. It is likely that *corvina* caught at Caleta Vitor in the past were quite large and averaged over 4 kg in weight, since the largest otolith weighed over 2 gm with several others over 1 gm. Whole fish with otoliths of this size are likely to have weighed well in excess of 8 kg.

The mean weights of *corvina* otoliths by context ranged significantly – from 0.25 gm (CV1/3/25, CV2/1/38, CV2/1/48 et al) to 2.08 gm (CV1/2/14) (see Figure 12.5). Smaller *corvina* were a similar size to larger *roncacho* and may have been captured using similar techniques. Large *corvina* would have required more robust hooks and strong lines and may also have been caught in nets used to capture the small fish that were *corvina* prey. They could have also been hunted with spears and/or bows and arrows. In 1909 Uhle reported that:

> '…throwing-sticks were used for fishing, and thus are not likely to be found farther inland. In Arica fish were shot with arrows. In 1896 the writer saw in Lomas, 18 miles north of Chaviña, a native armed with a harpoon shooting "corvinas" in the shallow shore water.' Uhle (1909: 626)

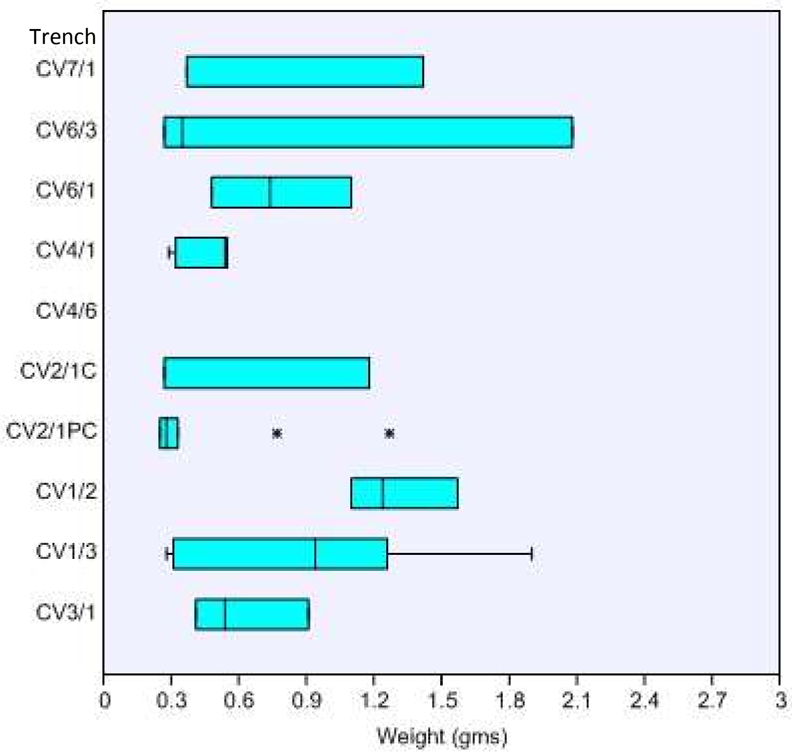


Figure 12.5: Box plot showing mean otolith weights (gm) by trench for *corvina*

There is considerable variation in otolith sizes, but this may be the result of the relatively small sample size.

Large otoliths were found in all trenches from the Archaic to the Late Periods, suggesting that the ability to capture large fish was present from the early periods of occupation. However the incidence of large fish increased over time (i.e. higher abundances in CV2/1 [6.5%], CV4/1 [10.3%]

and CV6/1 [7.6%]. This may have been the result of improved tackle particularly after metal hooks became available.

Otoliths from other Species

Of the remaining species, *jurel* (3.8%, n=46), though relatively low in number, were spread through the assemblage with a slightly higher abundance in CV2/1, particularly in the early units (MNI of 8 in CV2/1/47). *Apañado* (MNI=24) and *cabrilla* (MNI=19) were similarly widespread, in both temporal and spatial terms. *Ayanque* (MNI=10) were only found in three trenches (CV1/3, CV4/1 and CV4/6) and *bagre* (MNI=14) in only two (CV1/3 and CV2/1PC).

Otoliths from seven *sargo* were found at Caleta Vitor. While this species made up a significant portion of the assemblage at La Chimba 13, to the south of Caleta Vitor (Llagostera 1999), the low frequency of this species at Caleta Vitor is similar to that at Quebrada de los Burros (Lavallee et al. 2011). The lower incidence of *sargo* at Caleta Vitor may have reflected the lack of preferred habitat rather than the ability to catch them.

Dentition

A total weight of 345.36 gm (NISP = 425) of dentaries and/or maxilla were recorded. Five species were identified by dental remains including *roncacho, corvina* and *sargo* but also *lenguado (P. microps)* and *tomoyo* (*L. phillipii*) – the latter two not identified within the otolith assemblage. Dentitions from several other species were also found, but the reference materials were not comprehensive enough to enable identification. It is likely that some of the dentition may be from species also identified via otoliths but this cannot be confirmed. Table 12.5 gives numbers of dentaries and pre-maxilla found at Caleta Vitor.

Species	3/1	1/3	7/1	1/2	2/1P	2/1C	4/6	4/1	6/3	6/2	6/1	Total
Roncacho	3	93	1	1	4	9	11	43	15	3	31	214
Corvina		2		3		1		38	1		3	48
Sargo					1	2		35	1			39
Lenguado	6	5	4	1	16	6	1	10	23	2	10	84
Tomoyo						1		4			1	6
Ind.	2	6		2	2	3	2	11	4		2	34
Totals	11	106	5	7	23	22	14	141	44	5	47	425

Table 12.5: Distribution of species (NISP) as identified via dentition.
(Ind. = indeterminate)

Roncacho pre-maxillae were clearly identifiable and were the most abundant. There were far fewer dentaries found compared to otoliths overall (an MNI of 931 based on otoliths compared to a NISP of 214 of dentaries and premaxillae), although the second most abundant species identified via dentitions was *lenguado* and there were no otoliths identified from that species at all.

Based on observations of anglers at Caleta Vitor in 2010, *lenguado* could have been caught from the shore by casting a line and lure or angling with a baited hook.

Vertebrae

Fish vertebrae generally consist of a drum shaped core (centrum) formed from a pair of concave discs fused to form the body of the bone. Individual centra are linked to form the vertebral column of the animal and number from 20 to over 50. The atlas is the first vertebra, directly articulated with the skull. The vertebral column is divided into thoracic, pre-caudal and caudal vertebrae (Casteel 197; Reitz and Wing 2008:372). Most vertebrae have at least one spine attached via an arched bone. The upper process consists of the neural arch and spine and the lower is the haemal arch. Not all vertebrae have haemal arches and spines. Various other processes project from the column and arches.

The centrum is the most robust part of a vertebra, but weathering and handling processes can cause centra, from both large and small vertebrae, to break into two separate discs. The arches, spines and processes of vertebrae are generally fragile, particularly when desiccated, and in an archaeological context are less likely to survive intact than the centra themselves. Figure 12.6 is a diagram showing the basic form of a thoracic vertebra of a typical bony fish.

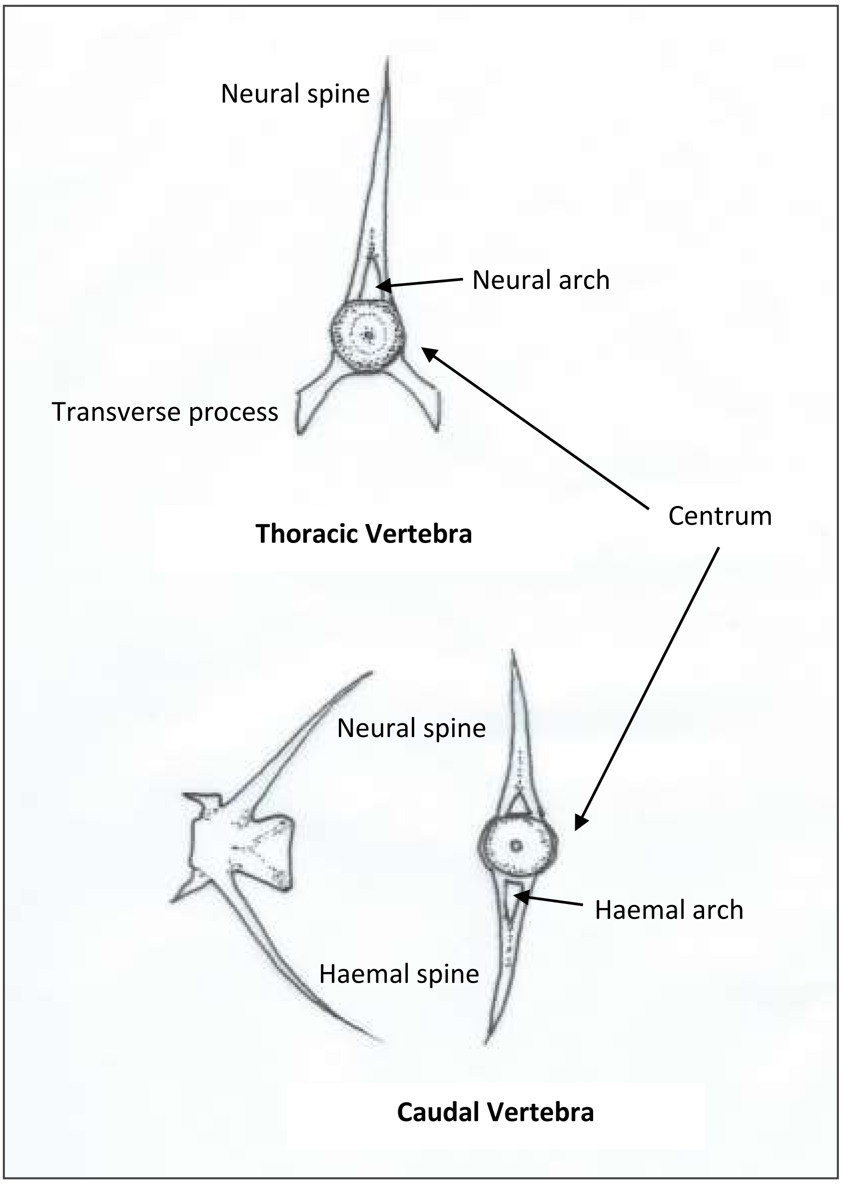


Figure 12.6: Drawing of thoracic vertebra from a common bony fish
Drawn: C. Carter

The diameters of centra range in size from each fish species. While it is not always possible to determine whole fish size via individual vertebrae, they can be measured and placed within a size class. Fluctuations in the abundance of individual size classes can then be studied.

In excess of 38,000 fish vertebrae (4.004 kg) were retrieved from excavations at Caleta Vitor. This total does not include elasmobranches (discussed later). Vertebrae were sorted into six size classes based on the centrum diameter[4] – very small (1-3 mm VS), small (4-6 mm S), medium (7-9 mm M), medium-large (10-12 mm ML), large (13-16 mm L), and extra large (>16 mm XL). Complete centra (those with two discs) were counted as one specimen; single centrum discs from broken vertebrae were counted and the total divided by two to calculate a minimum number of whole specimens per size class. While there was no attempt to positively identify fish species via vertebral remains, basic assumptions were made to attribute some size classes to genus and/or species. These assumptions are described later.

The conditions of vertebrae varied considerably with some later period specimens being very well preserved while others were crushed and/or deformed. Those vertebrae that could not be accurately measured were excluded from the sample. A count of NISP (relating to size) was recorded for each unit within each trench.

Table 12.6 displays the mean diameters of the total samples of vertebrae from each trench in approximate order of age (youngest uppermost). The mean vertebrae diameter from the total assemblage was 4.646 mm with means ranging from 3.461 mm (CV1/3 – Late Archaic)) to 6.742 mm (CV4/1-Late Period) (CV7/1 was excluded due to the low numbers of vertebrae from that trench). In simple terms, this would suggest an increase in average fish size, through time, from small to medium.

[4] Vertebrae measuring greater than the whole number were placed within the next size class – eg a specimen measuring 3.1 was classed as size 4.

Trench	Mean Diameter in mm (*n*)
CV3/1	5.233 (2038)
CV1/3	3.461 (12,223)
CV7/1	6.821 (207)
CV2/1P	4.20 (4982)
CV2/1C	5.72 (2396)
CV4/6	4.981 (2350)
CV4/1	6.742 (3024)
CV1/2	4.498 (3586)
CV6/3	6.347 (2932)
CV6/2	5.992 (207)
CV6/1	4.842 (4554)
Total	**4.646 (38,499)**

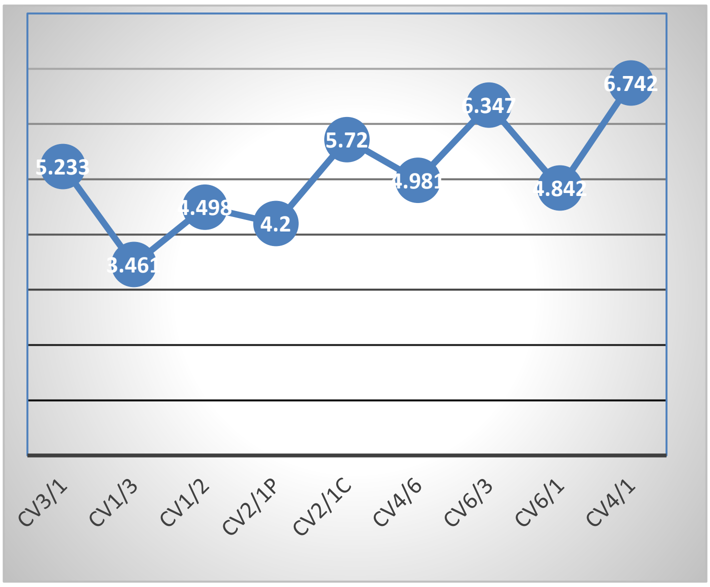


Table 12.6: Mean diameter of vertebrae per trench. The graph on the right shows the gradual increase in mean diameter of vertebrae (CV7/1 and CV6/2 were omitted due to their small sample size)

Table 12.7 displays mean vertebrae diameter across trenches divided into grouped levels. CV6/2, CV6/3 and CV7/1 were not included due to the small sample size (CV6/2, CV7/1) or lack of stratigraphic integrity (CV6/3). The mean sizes for those trenches and/or units that fall within the Archaic Period are generally lower than the later periods. CV1/2 and CV1/3 reveal a consistency in diameter with an increase of almost 1mm from the earliest to the latest levels (CV1/2: 4.11-4.99, increase of 0.88 mm; CV1/3: 3.45-4.51, increase of 1.06 mm). CV2/1 spanned over 2000 years across 58 layers, in which the mean diameter increased from 3.59 mm in the lowest level to over 6mm in the uppermost layers. CV3/1 displayed an initial decrease prior to an increase in the upper levels (down from 5.33 to 4.42 mm then up to 7.02 mm in the upper layers). CV4/1 spanned a relatively short period with a consistent mean above 6mm. CV6/1 was anomalous as it was contemporaneous with CV4/1 yet had a much lower mean. The mean diameters in CV6/1 decreased in the upper layers to be similar to those dated to the Archaic Period.

Level	CV3/1	CV1/3	CV1/2	CV2/1P	CV2/1C	CV4/6	CV4/1	CV6/1
1-5	7.02	4.51	4.99	4.99	6.84	5.19	6.14	4.41
6-10	4.42	3.82	4.72	4.72	6.03	4.44	6.91	4.72
11-15	4.57	3.15	4.11	4.11	4.69		6.46	5.42
16-20	5.72	3.51	4.11	4.11	5.56		6.97	
21-25	5.33	3.45		3.69	5.19			
26-30				3.59	6.06			

Table 12.7: Mean vertebrae diameter within trenches and units.

Abundances of size classes

Relative abundance of the six size classes were calculated for each trench (based on NISP). Table 12.10 displays the results sorted into approximate chronological periods.

Small vertebrae are the most abundant throughout the assemblage with an overall mean abundance of 0.526 (52.6%). The sample specimen of *roncacho* had vertebrae within the range designated as 'small'. Given the abundance of *roncacho* otoliths within the assemblage, it is likely that the majority of small vertebrae were from *roncacho*.

	Size	VS	S	M	ML	L	XL	Period
Trench	4/1	.058	.475	.327	.115	.019	.007	Late
	6/1	.292	.553	.106	.032	.014	.002	
	6/2	.227	.464	.121	.116	.039	.034	
	6/3	.115	.746	.077	.029	.026	.006	
	4/6	.206	.673	.089	.025	.005	.003	Middle Horizon
	2/1C	.230	.551	.118	.072	.025	.005	
	2/1P	.368	.412	.126	.072	.012	.002	Formative
	7/1	.068	.377	.406	.116	.034	0	Archaic
	1/2	.286	.600	.094	.016	.004	.001	
	1/3	.600	.351	.036	.008	.004	.001	
	3/1	.169	.657	.095	.060	.016	.003	

Table 12.8: Abundance of vertebrae by size class (NISP).

CV1/3/25 is the penultimate unit toward the base of that trench and dates from the Middle Archaic. It contains a high concentration of very small and small fish vertebrae (VS=1177, S=605(NISP)). CV3/1/30 and 31 are the basal units of that trench and date from the Early Archaic. These units have a relatively high number of very small and small vertebrae (VS=58, S=428). CV2/1 contains 58 units, of which the lower series (CV2/1/27-58) date from the Late Archaic to the early Formative. Again, these units contain high numbers of small vertebrae (VS=1148, S=1046). Conversely, large vertebrae numbers are low and represent the remains of only two or three fish (CV1/3/30-31, L-XL=17; CV2/1/27-58, L-XL=67; CV3/1/30-31, L-XL=40).

The class 'very small' (1-3mm) totalled 13,475 (NISP). Such a value validated the need for using sieving screens with small mesh sizes during excavation. Of course, most of the vertebrae under 1mm in diameter would not have been collected and it is probable that this size class is under-represented in the collected assemblage.

The overall mean diameter of the vertebrae is 4.646mm, which is classified as being from a 'small' fish (4-6 mm). Small fish, such as *roncacho*, are commonly caught today by anglers fishing from the piers and beach at Arica using very small steel hooks (i.e. small when compared in size to prehistoric shell hooks). Very small fish, such as sardines and anchovies, are not caught by hook and line at all, even with the smallest steel hooks. The presence of such small fish at Caleta Vitor would suggest that nets were used to catch them from the earliest period of occupation.

It is likely that the majority of the very small vertebrae are from sardine or anchovy. These species are common in the area today and are present in archaeological assemblages along the coast of Peru. Three sardine skeletons located in CV4/1 were sufficiently intact to enable species identification – thus the presence of very small vertebrae could be attributed, at least in part, to these species.

Roncacho were the most abundant species identified via their otoliths (76.8% - 931/1212 MNI). They have 24 vertebrae per specimen, and dissected sample specimens had vertebral diameters from 3 to 6 mm. The majority of vertebrae from the 'small' category are likely to be from *roncacho*. The majority of the larger vertebrae are likely to be from Sciaenids such as *corvina* or *ayanque*.

Using the median number of vertebrae per fish species, a conservative MNI can be calculated to provide a simple assessment of fish weight using the known whole weights of certain species. *Roncacho* have 24 vertebrae and *corvina* have 25 per whole specimen. Sardines and anchovy do not have the same number of vertebrae per individual and range from 48 to 54 in living species (Whitehead 1985).

Using the overall totals of vertebrae, a conservative total weight of consumed fish can be calculated. The assumptions used for this calculation are as follows:

- Very small vertebrae are assumed to be from anchovy or sardine, with an average of 50 vertebrae per specimen and a mean individual weight of 35 gm (calculated from the weights of six fresh specimens purchased locally);
- The remaining vertebrae are attributed to Sciaenidae with an average of 25 per individual, in the following categories;
    - Small fish, mean weight 200gm (based on the average weight of fresh *roncacho*);
    - Medium fish, mean weight 800 gm[5];
    - Medium-large fish, mean weight 1.5 kg;
    - Large fish, mean weight 3.0 kg;
    - Very large fish, mean weight 6.0 kg.

[5] The weights for medium to extra large fish are based on length/weight parameters for *Argyrosomus japonicas*, a Sciaenid that is morphological similar to both *S. deliciosa* and *C. Gilberti (see http://www.fishbase.org/summary/Argyrosomus-japonicus.html).* No such figures were available for *either S. deliciosa* or *C. gilberti.* Weights assumed for each size range are very conservative and based on minimum size specimens for that range – very large fish can weigh in excess of 20kg .

Table 12.9 displays the calculated MNI for each size class and a minimum total weight and overall percentage.

Size	VS	S	M	ML	L	XL	Total
NISP	13,475	19,077	3903	1492	442	110	38,499
% of total (NISP)	35	49.5	10.1	3.9	1.2	0.3	100
MNI	270	764	157	60	18	5	1274
% of total (MNI)	21.2	60.0	12.3	4.7	1.4	0.4	100
Weight (kg)	9.45	152.8	125.6	90.0	54.0	30.0	461.85
% of total (wt)	2.0	33.1	27.2	19.5	11.7	6.5	100

Table 12.9: Potential MNI and fish weight based on classes derived from vertebrae diameter.

Based on the above assumptions, small fish such as *roncacho* and *cabinza* made up a significant proportion of the total fish weight represented in the assemblage (33.1%). However, larger fish, including *corvina* and *ayanque*, potentially provided over 60% of the meat weight.

This calculation shows clearly that very small vertebrae provide a significant proportion (NISP) of the assemblage by number (35%). However, the potential total body weight of these very small fish is very low (2%). On the other hand, the economic value of very small fish may have been higher during the Late Period when agriculture was flourishing in the highlands, owing to their use as fertiliser Such a commodity could be traded for exotic goods or highland foodstuffs (e.g., grain, camelid meat), ceramics and metalware. Furthermore, as sardine and anchovy were favoured prey of a number of species, they would have been useful as bait for larger fish. In addition, both very small and small vertebrae were from fish that would have been caught using nets, accounting for at least 35% of the total weight of fish caught.

The presence of very small fish in the earliest dated unit suggests that nets were in use from the Early Archaic Period. Further analysis was conducted by classifying the fish into two groups using vertebrae size to calculate MNI - smaller specimens caught with nets and larger specimens caught on a line or speared. The mean abundance of each size class was calculated for each trench and unit. The overall mean abundance of the smaller category was 0.63 suggesting 0.37 of the total fish were captured on hook and line or speared. Abundance ranged between 0.45 (CV4/1) and 0.78 (CV1/3). The oldest trench, CV3/1, had a mean abundance of small specimens of 0.62 and the abundance in the Late Period trenches of CV6/1 and CV6/3 were 0.68 and 0.62 respectively. Of course, larger specimens may have been caught in nets along with small fish so such a trend may not accurately reflect how large fish were captured. There is, however, an overall consistency in the capture regime through time.

Diversity and Equitability

Diversity and equitability indices were calculated separately using MNIs of species identified via otoliths and NISPs within each size class (Tables 12.10 & 12.11).

		Diversity	Equitability	Period
Trench	**4/1**	1.307	0.628	**Late**
	6/1	0.736	0.411	
	6/2	0	0	
	6/3	0.734	0.410	
	4/6	0.735	0.410	**Middle Horizon**
	2/1C	1.170	0.727	
	2/1PC	0.902	0.463	**Formative**
	7/1	0.673	0.971	**Archaic**
	1/2	0.269	0.167	
	1/3	0.834	0.401	
	3/1	0.814	0.506	
	Mean	0.817	0.506	

Table 12.10: Diversity and equitability of fish species identified via otoliths (MNI)

The indices based on otolith pairing resulted in generally low to moderate diversity and equitability values (see Table 12.10). Given the abundance of *roncacho* over other taxa, it is not surprising to find low equitability across most trenches. CV1/2 is an outlier with very low diversity and equitability values (0.269 and 0.167 respectively). Such low values occurred because *roncacho* otolith made up over 94% of the assemblage. The upper units of CV2/1 (Formative) and CV4/1 have the highest diversity and equitability indices (CV7/1 and CV6/2 were excluded from this calculation due to their low numbers). CV6/1 and CV6/3 are contemporaneous and located within 15m of each other and there is a very strong correlation between them. This suggests that CV6/1 and CV6/3 were both sampling a single homogenous assemblage. Conversely, CV1/2 and CV1/3 are located in the same sector, approximately 150m apart, yet display a significant divergence, perhaps not surprising given the range of dates (2484-2697 cal BP in CV1/3/1 to 6411-6631 in CV1/3/25). The wide range of equitability and diversity within CV1 may have been the result of changing site use through time or perhaps a consequence of fluctuating environmental conditions.

		Diversity	Equitability	Period
Trench	4/1	1.241	0.693	Late
	6/1	1.109	0.619	
	6/2	1.423	0.803	
	6/3	0.894	0.499	
	4/6	0.964	0.526	Middle Horizon
	2/1C	1.224	0.683	
	2/1PC	1.160	0.647	Formative
	7/1	1.280	0.795	Archaic
	1/2	0.982	0.548	
	1/3	0.861	0.480	
	3/1	1.054	0.588	
	Mean	1.108	0.625	

Table 12.11: Diversity and equitability of vertebra size classes (NISP)

These diversity and equitability indices based on vertebrae size classes reveal an increase over the values based on otoliths (see Table 12.10). CV1/2, which had the lowest diversity and equitability based on otoliths, had far higher values based on vertebrae size class, only slightly lower than the mean. Disregarding CV6/2 and CV7/1 again, diversity ranged from 0.861 (CV1/3) to 1.224 (CV2/1C) and equitability ranged from 0.480 (CV1/3) to 0.693 (CV4/1), showing more consistency through time than values based on otoliths.

Percentage Similarity Measures (PSM)

A PSM was used to compare the range of fish retrieved from each trench. In Table 12.12 the figures at lower left compare fish size classes based on the diameter of vertebrae; the figures at upper right compare a similarity measure based on otoliths.

Of note, the highest PSM figures were recorded from disparate trenches – CV1/2 (pre-ceramic - Late Archaic/Early Formative) and CV6/1 (Late Period); CV3/1 (Archaic Period, and the source of the oldest date at the site) and CV4/6 which dates from the Late Formative through to the Late Period.

CV	1/2	1/3	2/1	3/1	4/1	4/6	6/1	6/2	6/3	7/1	2/1C	2/1PC
1/2		77.7	79.93	77.61	71.53	84.02	87.18	93.20	87.54	64.85	66.84	83.02
1/3	67.9		81.82	93.01	72.73	79.8	85.28	74.9	83.57	61.80	72.19	81.30
2/1	86.2	72.3		81.14	79.93	81.93	76.03	74.11	87.47	66.47	83.67	96.14
3/1	88.4	56.8	80.4		78.82	76.88	87.29	71.76	82.21	67.06	76.55	77.76
4/1	64.8	45.8	73.5	70.7		83.36	80.94	64.49	78.47	70.28	79.71	74.23
4/6	91.6	60.6	79.0	94.9	65.6		87.13	79.49	87.59	62.56	68.70	84.88
6/1	95.1	69.2	90.7	86.5	91.9	88.1		81.36	94.31	67.63	77.02	85.74
6/2	80.6	62.7	90.0	80.7	78.4	79.3	82.6		82.09	60.00	61.02	77.20
6/3	81.3	51.5	70.2	89.7	66.4	89.90	79.0	71.7		64.48	76.04	89.86
7/1	54.0	46.6	65.8	61.6	89.6	56.5	82.10	71.60	55.70		75.25	64.40
2/1C	89.6	62.9	95.2	85.9	74.7	88.00	93.50	91.10	80.20	66.00		79.8
2/1PC	81.9	76.8	90.1	75.7	73.5	79.00	86.20	85.40	65.40	65.60	85.30	

Table 12.12: Percentage Similarity Measures between trenches using otolith data (upper right - blue) and vertebra size classes (lower left - grey).

PSM figures from spatially related trenches from similar time periods (eg CV6/1, CV6/2 and CV6/3, all Late Period) only display moderate levels of similarity. However, three trenches from the Archaic (CV1/2, CV1/3 and

CV3/1) have PSMs ranging from 56.8% to 88%. CV1/2 and CV3/1 are quite similar (88.4%), whereas CV1/3 and CV3/1 are not (56.8%). CV1/2 and CV1/3 both date from the Archaic period although CV1/2 extends into the Formative. They are both located within the same topographic unit and only 150m apart yet the PSM between CV1/2 and CV1/3 is only 67.9%. CV1/2 has a higher affinity with trenches from the later periods, CV4/6 (91.6%) and CV6/1 (95.1%).

Elasmobranches – sharks and rays

Elasmobranches were easily identified through vertebrae and dentition (teeth). A total of 413.5gm of shark remains were recorded at Caleta Vitor. As they are easily identifiable and are often larger than many other specimens, shark vertebrae were commonly observed in exposed midden and were obviously a resource that was regularly and widely exploited at this site. The teeth found at Caleta Vitor were identified as belonging to the short finned mako shark (*Isurus oxyrinchus*) (see Figure 12.7). The broad range in tooth morphology is typical of this species. It is assumed that the majority of the shark vertebrae found were from the same species, due to their sizes and associations with the teeth.

The largest shark centrum found at Caleta Vitor had a radius of 16mm (from CV6/1/9). Based on fishery data (Cerna and Licandeo 2009: 394), and assuming that this was the largest vertebra from that specimen, the live animal was at least 2m in length, weighing in excess of 81.5 kg (possibly as much as 150 kg). The mean diameter of centra from Caleta Vitor was 11.17 mm (n=617). Again, based on the assumption that these were the largest vertebra, the mean total length for mako sharks would have been 1.156m, with a mean weight of 14.75kg[6].

[6]http://www.fishbase.org/PopDyn/LWRelationshipList.php?ID=752&GenusName=Isurus&SpeciesName=oxyrinchus&fc=9

Figure12.7 – Sample of teeth from short-finned mako shark - CV6/1
Photo: C. Carter

The sectors dated to the earlier periods, CV1 and CV3, only had 7 units out of 74 that contained elasmobranch remains. This may be due to a range of factors. The Archaic age of the material in this sector may have resulted in deterioration. Or, since this sector is the most distant from the shoreline and CV1 is elevated, larger fish, such as shark, may have been butchered where they were landed and only the flesh and limited skeletal material returned to the habitation areas. Another possibility is that the skills and/or technology to capture prey of this size and type regularly were not present during the earlier periods. As techniques and technology improved through time, shark became a more favoured and more desirable target.

CV2 is closer to the modern shore line than CV1 and at a lower elevation. The Late Archaic through to early Formative lower units of CV2 contained more evidence of shark (in 23 of the 31 units, 17.81 gm) than those from the later Formative to Middle Horizon (6 out of 27 units, 3.43 gm).

CV4/1 had shark remains in 3 of 19 units, whereas CV4/6 had shark in 4 out 10 units, all dating from later periods. However, the quantities in these trenches were minimal - 1.64 and 2.97 gm respectively.

The highest incidence of sharks occurred in CV6 where 18 out of 26 units contained their remains. Those from CV6 make up 90.4% of the overall total (by weight) of shark found within all trenches. The CV6 trenches all date from the Late Period and were located only a short distance from the current shoreline in a relatively sheltered area where boats could have landed to unload their catch. Initial processing may have been carried out in this area, and the flesh distributed to habitation sites elsewhere.

Mako sharks are commonly found off-shore. This may mean that until boats were more widely utilised for fishing, they were not a regularly caught species. Llagostera (1979 & 1990) suggested that the use of boats to fish off-shore did not occur until the Late Formative Period. At Punta Blanca, to the south of Caleta Vitor, he found that off-shore species, such as *congrio* (*Genypterus chilensis* and *G. maculates*), appeared in middens during that period and not before. *Congrio* are found today in waters 20 to 300 m deep and are caught by fisherman working 0.5 to 3 km off-shore. Based on the dates he obtained at Punta Blanca, Llagostera (1979: 322) suggested that boats were not used for off-shore fishing until around 1720 BP.

Contrary to this argument, Olguín et al. (2015) reported finding a tooth from a large mako shark at Copaca 1 (northern Chile), a site dated entirely to the Archaic period, occupied between 7866 and 5040 cal BP. While only one specimen of shark was found at the site, they also retrieved the remains of large billfish including marlin (*Tretapturus audax*) and swordfish (*Xiphias gladius*) (Olguín et al 2015: 11). They suggested that neither mako shark nor such large billfish could be caught from the shore and from this inferred that they were 'caught by skilled fisherman using some kind of oceangoing vessel' over 5000 years ago (Olguín et al. 2015: 12).

Figure12.8: Tip of stingray barb found in CV6/1/5

The tip of a stingray barb was found in CV6/1/5. Only a small portion of the barb was located (<9mm long, see figure 12.8) and may have been brought back re unintentionally, for instance in the body of a sea-lion or shark, or in the hull of a boat.

Unless Caleta Vitor is an exception, sharks and rays are likely to have played a more important role in the economy of coastal northern Chile than the majority of investigators have previously reported.

Fishing Techniques & Technology

The identification and abundance of certain species can be used to develop inferences relating to fishing techniques. An increase in fish size or a change in the abundance of particular species may be indicative of changes in fishing gear or strategies employed.

Ethnographic and historical evidence from Peru clearly demonstrate how nets were used from the shore or boats to capture a range of fish, from smaller species such as anchovy and sardine to shark (see Marcus, 1987; Marcus et al, 1999). The remains of a range of net types in archaeological deposits have been found in Peru, for example at Cerro Azul (Marcus 1987), El Paraiso (Quilter et al. 1991) and Huaca Prieta (Hudson 2004). Elsewhere along the coast of western South America, the presence of small and very small fish in archaeological deposits has led investigators to infer that nets were used for their capture (see Sandweiss et al (1998) at Quebrada Jaguay; Keefer et al (1998) and deFrance et al (2001) at Quebrada Tacahuay; Lavallée et al (2001) and Carré et al (2009) at Quebrada de los Burros).

The larger vertebrae present in trenches from the Late Period (CV4/1, CV6/1 and CV6/3) represent a higher percentage of large specimens. The presence of more large fish in younger levels may have been the result of improved technology (e.g. copper or bronze hooks) and/or the use of watercraft that increased catches when fishing off-shore.

However, the majority of species represented in the otolith sample – *roncacho, cabinza, corvina, ayanque* and *sargo* - 93.3% of the total are those that frequent open water and clear sea floors, areas that are more suited to the use of nets. Deep-water species such as *apañado* and *jurel* only make-up 5% of the total and *cabrilla,* a rocky sea bed dweller, makes up only 1.7%.

In conclusion, the evidence provided by fish remains indicates that for those living at Caleta Vitor:

- the early settlers at Caleta Vitor had established skill sets and technology that enabled them to catch fish species that were locally available;
- very small species such as sardines and anchovies were caught in large numbers and were economically important;
- *roncacho,* sardines and, possibly, anchovies were regularly caught in significant quantities using nets;
- sharks were a common resource and, while their remains were present in the early periods, were caught in greater numbers during the Late Period;
- over time, improved tackle, including metal hooks, resulted in the capture of larger fish;

- boats were used for fishing, particularly during the Middle Horizon and Late Period;
- throughout the entire period of occupation, there was little variation in the range of fish species that contributed to the local economy.

Chapter Thirteen

> *It is learned that the process of development and succession of periods of old Peruvian culture has been a long one. Stratum was laid over stratum during thousands of years.* (Uhle 1902: 758)

Analysis of Invertebrates

The following section contains an analysis and discussion relating to most invertebrate taxa assessed as supporting the base-line economy at Caleta Vitor.

Tables 13.1 and 13.2 contain a breakdown of invertebrate remains by MNI and weight per trench.

Mytilidae – mussel

The excavations at Caleta Vitor recovered 50.574 kg of mussel shell (50.9% of total shell by weight). Whole or relatively intact specimens, particularly those with intact 'beaks' or hinges, were used to identify species. A major proportion was made up of fragments and recorded as 'indeterminate species' (22.429 kg/44.3%). Fragments ranged in size upward from 2 mm. The fragmentary nature of the assemblage also made the identification of left and right hinges difficult and variable. For this reason the MNI was calculated simply by dividing the total number of hinges by two. A total MNI of 3862 were recorded. Three mussel species were identified and discussed in more detail below.

	Trench											
Species MNI	**1/2**	**1/3**	**2/1PC**	**2/1C**	**3/1**	**4/1**	**4/6**	**6/1**	**6/2**	**6/3**	**7/1**	**Total**
Lapa (Fisurella spp.	24	16	133	55	50	179	53	182	18	41	12	**763**
Loco (C. concholepus)	29	30	125	69	116	99	76	149	5	162	21	**881**
Choro (C. chorus)	123	49	50	19	42	161	15	79	4	47	6	**595**
Cholga (A. ater)	94	38	273	45	5	4	1	317	0	309	3	**1089**
Chorito P. purpuratus)	8	99	108	33	791	1026	105	26	1	40	1	**2238**
Quiton (Chitonidae)	17	53	138	109	103	237	92	241	5	63	14	**1072**
Herizo (Echinodermata)	10	60	127	34	16	30	32	35	5	36	8	**393**
Loca (T. chocolate)	0	10	25	3	12	2	5	39	6	22	1	**125**
Slipper Limpet (C. dilatata)	6	49	87	117	31	14	5	136	0	61	2	**508**
Macha (M. donacium)	143	1	0	0	1	0	0	0	0	0	0	**145**
Almeja P. theca)	2	21	1	5	6	16	7	8	1	2	0	**69**
Caracol (Tegula spp.)	12	13	17	13	22	39	16	80	26	50	4	**292**
Ostion (A. purpuratus)	4	0	1	0	0	2	1	0	0	1	0	**9**
Other[1]	0	3	5	1	4	4	4	10	0	5	0	**36**
Total	**472**	**442**	**1090**	**503**	**1199**	**1813**	**412**	**1302**	**71**	**839**	**72**	**8215**

Table 13.1: Mollusc species recovered at Caleta Vitor (MNI)

[1] Other includes at least 3 species of small/medium gastropod.

	Trench											
Species Wt (Gm.)	**1/2**	**1/3**	**2/1PC**	**2/1C**	**3/1**	**4/1**	**4/6**	**6/1**	**6/2**	**6/3**	**7/1**	**Total**
Lapa	112.1	96.1	819.9	233.6	382.5	1541.9	502.4	1615.8	272.8	301.2	74.1	**5952.4**
Loco	474.4	847.4	3750.5	1394.6	2871.4	2674.5	1539.5	2575	97.2	3244.1	193.6	**19662.2**
Choro	952.7	743.4	1256.1	145	1681.1	5394.9	245.3	1825.5	115.4	1326.7	80.7	**13766.8**
Cholga	622.6	504.6	1468.2	430.2	49.6	24.9	3.4	1492.5	0	2969.7	33.8	**7599.5**
Chorito	8.2	284.3	155.1	50.3	2916	2500.8	730.9	53.4	1.2	78	0.4	**6778.6**
IND mussel	729.1	2176	3542.5	1052.4	1896.4	1119.5	502.2	8004.7	160.1	3246.7	0	**22429.6**
Quiton	90.7	338.3	1077.7	846.4	863.5	2245.8	697.5	1928.4	47.4	526.0	81.2	**8742.9**
Herizo	35	959.1	2187.9	327.8	14.9	393	560.3	515.5	80.9	661	43.4	**5778.8**
Loca	0	183.3	317.8	29.4	296.2	54.6	33	516.5	0	417.6	3.5	**1851.9**
Slipper	9.1	212.9	291.4	207.6	77.1	40.1	14.1	263.4	0	196.9	3.8	**1316.4**
Macha	332	15.4	0	0	7.3	0	0	0	0	0	0	**354.7**
Almeja	1.5	324.6	2.5	14.3	53.4	129.6	41.4	54.6	2.5	13.5	0	**637.9**
Caracol	65.6	48.3	251	28.9	274.4	342.6	96.7	362.2	217.4	153.8	42.9	**1883.8**
Ostion	70.6	0	13.9	0	53.4	13.3	19.5	0	3.1	8	0	**181.8**
Other	0	19.1	91.1	20.9	64.5	10.5	13.9	102.7	0	69.9	0	**392.6**
IND	97.1	242	1130.5	384.3	663.4	393	294.5	193.8	42.4	221.4	81.6	**3744**
Total	**3600.7**	**6994.8**	**16356.1**	**5165.7**	**12165.1**	**16879.0**	**5294.6**	**19504**	**1040.4**	**13434.5**	**639.0**	**101073.9**

Table 13.2: Mollusc species recovered at Caleta Vitor (weight in gm)

Choro or giant mussel – *Choromytilus chorus*

Choro were located in 63.1% (n=125) of excavated units at Caleta Vitor. A sample of valves (n=43) were measured and ranged between 32 and 103 mm in length with a mean of 64.1 mm[2]. Apart from indeterminate mussel fragments, *choro* were the most common mussel species by weight (13.766/50.574 kg) but the least common by MNI (543/3862). A typical *choro* valve was not only dimensionally larger than *cholga* and *chorito* but was far more robust thus skewing the MNI/weight ratio considerably. *Choro* had an overall abundance by weight of 0.13 and by MNI of 0.08. They were the dominant mussel species by MNI in CV1/2 and by weight in CV1/2, CV1/2, CV4/1 and CV6/1. They ranged in abundance by weight from 0.02 in CV2/1C to 0.35 in CV4/1 and by MNI from 0.03 in CV3/1 to 0.26 in CV1/2.

Table 13.3 lists recorded *choro* by trench in approximate date order. In simple terms it appears that there is a substantial increase in the frequency of *choro* during the Late Period. However there are a number of factors that may have influenced the results. CV2/1 (PC & C) consisted of 58 units dated from the Early to Late Formative and was over 3m deep. Both the preceramic and ceramic units contained a relatively large amount of indeterminate mussel (3.542/1.052 kg respectively). Due to the depth of the trench, taphonomic processes may have resulted in gross fragmentation of specimens. Lower units contained very fragmentary specimens and included a number that were calcified. The upper units lie within an area that contained numerous burials and these units might have suffered damage as graves were excavated. Numerous ashy lenses (e.g., in units CV2/1/7, 8, 13, 20, 22) also indicated that specimens may have been burnt, thus becoming more fragile.

In general terms, the mean MNI and weight per unit fluctuated considerably. The oldest trench, CV3/1, had a mean of 1.9 (MNI) and 76.4 gm and the youngest, CV4/1, had a mean of 8.5 (MNI) and 283.9 gm.

[2] Marcelo Rivadeneira from the University of Antofagasta identified and measured intact shells.

However this did not equate to an increase over time as CV1/2 (Archaic) had a mean of 7.2 (MNI) and 56.4 gm and CV6/1 had a mean of 4.9 (MNI) and 114.1 gm. Such fluctuations are discussed in more detail later.

	3/1	1/3	1/2	2/1PC	2/1C	4/1	4/6	6/1	6/3
***Choro* (wt. grams)**	1681.1	743.4	952.7	1256.1	145.0	5394.9	2[3]45.3	1825.5	1326.7
Mean wt/unit	76.4	28.5	56.4	40.5	6.8	283.9	24.5	114.1	221.1
MNI	42	49	123	50	19	161	15	79	47
Mean MNI/unit	1.9	1.8	7.2	1.6	0.9	8.5	1.5	4.9	7.8

Table 13.3: Summary of *choro* recorded at Caleta Vitor (MNI and weight in gm). Trenches in approx. chronological order – oldest to left.

As mentioned, due to their more robust shell, *choro* were utilised for more than food. Shell hooks were fashioned from *choro* and relatively common in many archaeological excavations in this region. Only one fragment of a shell hook was found at Caleta Vitor – within an Archaic trench CV3/1/19. This medial fragment was around 19 mm in length and 4 mm wide, it has been shaped using an abrasive tool, most likely a basalt rasp.

Choro valves containing red pigment were found in two units, CV6/2/4 and CV4/1/16 – both trenches dating to the Late Period. The use of mussel valves is known to have occurred from the Archaic Period (see discussion in Chapter 7, see Figure 7.10). Iron oxide was the likely source of this type of dye and it is clear that such a use continued over several thousand years. The mining of this mineral was known to have taken place some 12,000 years ago near Taltal in northern Chile (Salazar et al 2011). Wooden items found as grave goods adjacent to CV2/1 were found to be dyed red with what appeared to be this type of pigment.

Overall, *choro* were clearly a favoured and valuable resource at Caleta Vitor, although at times it appears that they were not always available. Their scarcity at times was likely due to fluctuations in water temperature as this species is known to prefer cooler waters.

[3] CV7/1 and CV6/2 were left from these tables due to their low frequencies of shellfish.

Cholga or ribbed mussel – *Aulocomya ater*

Cholga were located in 35.3% (*n*=64) of excavated units. A sample of whole valves (*n*=190) was measured and ranged in length between 23 and 90 mm with a mean of 47.9 mm.

Cholga had an overall abundance of 0.07 by weight and 0.13 by MNI. They were the dominant mussel species in CV/21PC, CV2/1C, CV6/1 and CV6/3 (both via MNI and gross weight). They ranged in abundance by weight from nil in CV6/2 to 0.17 in CV1/2 and by MNI to 0.37 in CV6/3. As with *choro, cholga* fluctuated broadly through time, including between contemporaneous squares.

Their valves were not as robust and are smaller than *choro* and, therefore, not as useful in practical terms. However*, cholga* were clearly a favoured and targeted resource at Caleta Vitor.

Cholga	3/1	1/3	1/2	2/1PC	2/1C	4/1	4/6	6/1	6/3
(wt. grams)	49.6	504.6	622.6	1468.2	430.2	24.9	3.4	1492.5	2969.7
Mean wt/unit	2.2	19.4	36.6	47.4	15.9	1.3	0.3	93.3	494.9
MNI	5	38	94	273	45	4	1	317	309
Mean MNI/unit	0.2	1.4	5.5	8.8	1.6	0.2	0.4	19.8	51.5

Table 13.4: Summary of *cholga* recorded at Caleta Vitor (MNI and weight in gm).

Chorito – Perumytilus purpuratus

Chorito were located in 48% (*n*=87) of excavated units. A sample of whole valves (*n* =88) were measured with a range between 13 and 39 mm with a mean of 25.7 mm

Chorito had an overall abundance by weight of 0.06 and MNI of 0.19. They ranged in abundance by weight from 0.02 in CV1/2 to 0.23 in CV3/1 and by MNI from 0.016 in CV1/2 to 0.66 in CV3/1. They were the dominant mussel species by MNI in CV1/3, CV3/1, CV4/1 and CV4/6 and by gross weight in CV3/1 and CV4/6. The frequency of *chorito* fluctuated broadly through time.

Chorito were a favoured resource at Caleta Vitor and during periods of abundance could have been collected in large numbers relatively quickly. However, due to their small size, they required a greater effort in collection and processing for a similar return to that of the larger species such as *choro* and *cholga*.

	3/1	1/3	1/2	2/1PC	2/1C	4/1	4/6	6/1	6/3
Chorito (wt. grams)	2916.0	284.3	8.2	155.1	50.3	2534.1	730.9	53.4	78.0
Mean wt/unit	94.1	10.9	0.5	5.0	1.8	133.4	73.1	3.3	13
MNI	791	99	8	108	33	1026	105	26	40
Mean MNI/unit	25.5	3.8	0.5	3.5	1.2	54	10.5	1.6	6.6

Table 13.5: Summary of *chorito* recorded at Caleta Vitor (MNI and weight in gm).

Loco – Concholepus concholepus

A total 19.662 kg of *loco* shell was retrieved at Caleta Vitor. They were identified in 80.6% (n = 146/181) of the units that contained shell. An MNI of 881 was calculated using a count of the umbo[4]. *Loco* had an overall abundance of 0.19 by weight and 0.11 by MNI. The difference is the result of both a large amount of fragmented mussel shell that could not be used to calculate the MNI, thus reducing their overall total and because *loco* have a more robust and heavier shell (per fragment) which contributed to this bias.

Measurements were carried out on 201 *loco* valves from CV2/1 and CV6/1 that were sufficiently intact to measure their length. The mean length of those from CV2/1C was 55.0 mm (ranging between 36 and 76 mm); CV2/1PC 55.9 mm (ranging between 29 and 105 mm); and CV6/1 was 51.0 mm (ranging between 26 and 105 mm). Given the time span between CV2/1PC (Early to Middle Formative) and CV6/1 (Late) there appears to minor (<10%) reduction in size of the whole animal over that period.

[4] Umbo – proturberance at base of shell – hinge point of bi-valves, remnant in single valve species.

Loco ranged in abundance by weight from 0.12 in CV1/3 to 0.29 in CV4/1 and by MNI from 0.05 in CV4/1 to 0.19 in CV6/3. *Loco* was the dominant mollusc species by weight in CV2/1PC, CV2/1C, CV4/6, CV6/1 and CV6/3 as well as overall (discounting indeterminate mussel shell).

The distribution of *loco* varied. The oldest trench CV3/1 returned a far higher mean than the other two Archaic trenches. The lowest means per unit came from CV1/3 and CV1/2 respectively. These trenches were also the furthest from the source (rocky shoreline) and the result may have occurred as such large molluscs may have been shelled when brought ashore and only the meat returned to the point of consumption.

Loco shell, being thick and robust, was used to manufacture beads and was also a source of purple dye for dying textiles.

Loco were an economically important resource at Caleta Vitor. Today, this species is regarded as a gourmet food and valuable export commodity for the region.

	3/1	**1/3**	**1/2**	**2/1PC**	**2/1C**	**4/1**	**4/6**	**6/1**	**6/3**
***Loco* (*wt. gm*)**	2871.4	847.4	474.4	3750.5	1394.6	2674.5	1539.5	2575.0	3244.1
Mean *wt/unit*	130.5	32.6	27.9	120.9	51.65	140.7	153.9	160.9	540.7
MNI	116	30	29	125	69	99	76	149	162
Mean *MNI/unit*	5.3	1.2	1.7	4.0	2.5	5.2	7.6	9.3	27.0
Abundance (*MNI*)	0.10	0.06	0.07	0.10	0.14	0.05	0.18	0.11	0.19

Table 13.6: Summary of *loco* recorded at Caleta Vitor (MNI and weight in gm).

Quiton or chiton - Chitonidae

8742.9 kg of chiton was recovered from the excavations (MNI = 1072). Chiton plates were found in 80.1% (n = 145) of the units containing shell. The majority of specimens were weathered and/or damaged. No attempt has been made to differentiate between species at this time. The MNI was calculated by dividing the total number of plates by eight – as numerous plates were encrusted or weathered, there was no attempt to differentiate between proximal or distal plates. Broken plates were included in the count where broken pairs were regarded as a single plate. Overall, chiton were the third most abundant shellfish taxon by MNI and fourth by weight.

	3/1	1/3	1/2	2/1PC	2/1C	4/1	4/6	6/1	6/3
***Quiton* (wt. gm)**	863.5	338.3	90.7	1077.7	864.4	2245.8	697.5	1928.4	526.0
Mean wt/unit	39.2	13.0	5.3	34.7	32.0	118.2	69.7	120.5	87.6
MNI	103	53	17	138	109	237	92	241	63
Mean MNI/unit	4.7	2.0	1.0	4.4	4.0	12.5	9.2	15.1	10.5
Abundance (MNI)	0.08	0.12	0.04	0.13	0.22	0.13	0.22	0.18	0.07

Table 13.7: Summary of *quiton* recorded at Caleta Vitor (MNI and weight in gm).

The frequency of chiton per trench increased significantly in the trenches dating from the Late Intermediate to the Late Periods. Again the lowest incidence occurred in the trenches that were the most distant from the rocky shorelines (CV1/2 and CV1/3). Abundance (MNI) ranged between 0.036 (CV1/2) and 0.22 (CV4/6), showing an increase from the Archaic to the Late Period trenches.

At Caleta Vitor today, locations where chiton appear to be most abundant are those rock walls that are within the area of high wave wash. Much of this area is a high energy coastline and there are few periods when wave action is not turbulent. In such situations, the collection of chiton would have been a dangerous exercise other than during periods when the sea was calm and the tide was at its lowest point.

Lapa or limpet – *Fisurella spp.*

A total of 5.954 kg of *lapa* shell were recovered from excavations (MNI = 764). At least five species were identified including *Fissurella maxima, F. latimarginata, F. crassa, F. costata* and *F. cumingi* (pers.comm. M. Rivadineira). *Lapa* were found in 71.8% (n=130) of excavated units. The majority of specimens were weathered and/or damaged. The MNI was obtained by counting the shells or parts of shell that contained an intact 'key-hole'.

Measurements were carried out on 156 individual shells from CV2/1 and CV6/1. They ranged in size from 12 mm to 85 mm. The mean length within CV2/1C was 45.8 mm, CV2/1PC was 46.9 mm and CV6/1 was 52.1 mm. As the increase in size was minimal, the mean size and increased frequency does not indicate that exploitation impacted on the population of this taxon to any degree.

Lapa	3/1	1/3	1/2	2/1PC	2/1C	4/1	4/6	6/1	6/3
(wt. grams)	382.5	96.1	112.1	819.9	233.6	1541.9	502.4	1615.8	301.2
Mean wt/unit	17.4	3.7	6.6	26.4	8.65	81.5	50.2	100.9	50.2
MNI	50	16	24	133	55	179	53	182	41
Mean MNI/unit	2.3	0.6	1.4	4.3	2.0	9.4	5.3	11.3	6.8

Table 13.8: Summary of *lapa* recorded at Caleta Vitor (MNI and weight in gm).

Lapa were far more common in trenches dated to the Late Period (CV4/1, CV6/1, CV6/3) with lowest incidence occurring in CV1/3. The frequency was irregular as there was an increase in the early Formative units of CV2/1PC while the later units of CV2/1C showed a decrease, most likely due to changes in site use. The lowest frequency occurred in the CV1/2 and CV1/3, both trenches that are the most distant from the likely source. While not as heavy as *loco, lapa* may have been processed at the shore and consumed elsewhere.

Herizo, sea urchin. - Echinodermata

A total of 5.778 kg of echinoderm fragments were recovered. The remains of echinoderm recovered in the excavations consist of fragments of their test (exoskeleton), spines and feeding complex (known as Aristotle's Lantern). Bulk weight of echinoderm fragments from each excavated unit was used for comparison. Specimens were collected from all excavated trenches with the majority of units containing *herizo* fragments (84.5%, n = 153). Due to the highly fragmented nature of the echinoderm specimens, no attempt was made to differentiate between species.

Echinoderm were commonly consumed throughout all sections of Caleta Vitor. There was considerable variation although this does not appear to be consistent, with neither an increase nor decrease evident through time.

Echinoderm	3/1	1/3	1/2	2/1PC	2/1C	4/1	4/6	6/1	6/3
(wt. grams)	14.9	959.1	35.0	2187.9	327.8	393.0	560.3	515.5	661.0
Mean wt/unit	0.67	36.8	2.1	70.5	12.1	20.6	56.0	32.2	110.2

Table 13.9: Summary of *herizo* recorded at Caleta Vitor (weight in gm).

Macha or surf clam - *Mesodesma donacium*

354.7 gm (MNI=144) of *macha* shell were retrieved from the excavation. However, out of the total, all were found in units dated to the Pre-ceramic and, of those, 142 were located in CV1/2, with 93.6% of the total distributed throughout that trench. Only one unit in CV1/3 and one in CV3/1 contained *macha*. The lack of this species elsewhere is likely to be the result of local extinction either due to the effects of an intense *El Niño* event with no subsequent recruitment or a significant change in the morphology of the shoreline during the mid-Holocene.

At Caleta Vitor today, the shoreline is flanked to the east by a relatively flat sandy shelf running eastward for some 200 m. It is backed by very low dunes with a rock shelf (tuff) defining the boundary between the beach and the valley floor. Given that the sea-levels were up to 0.5 m higher between 6-4000 BP, the shape of the beach would have been different from today. The waterline is likely to have reached almost the rock shelf which would have created a shallow shelving sea-floor. Today the sea-floor rapidly deepens only a short distance from the water-line. *Macha* are found today in Arica and Tacna on beaches that are only slightly shelving with a very long and shallow surf zone. Falling sea-levels after 4000 BP coupled with silt discharged during flood peaks created the beach as it appears today. *Macha* may have found these conditions unfavourable and, possibly combined with an *El Niño* event, became locally extinct. Further research in this area would assist in better understanding the nature of the early shore-line and how this may have impacted on early settlement. Geological coring of the beach from the rock shelf to the water-line would provide data that could be used to calculate rates of silt discharge and the changing morphology of the beach.

Macha	3/1	1/3	1/2	2/1PC	2/1C	4/1	4/6	6/1	6/3
(wt. grams)	7.3	15.4	319.9	0	0	0	0	0	0
Mean wt/unit	0.3	0.5	18.8	0	0	0	0	0	0
MNI	1	1	138	0	0	0	0	0	0
Mean MNI/unit	0.05	0.03	8.1	0	0	0	0	0	0

Table 13.10: Summary of *macha* recorded at Caleta Vitor (MNI and weight in gm).

Other molluscs

Several other mollusc species were included in the assemblage but were either small species (eg *caracol*) or low in number suggesting that they were not important contributors to the economy.

Ostiones (scallop) are an important commercial species in some areas of Peru, generally in northern areas with warmer ocean temperatures. They were recorded at Caleta Vitor in trenches from the Archaic through to the Late Period but in very low numbers (total MNI of 9 and never more than one per unit) suggesting that they were not necessarily a target species but collected, on occasion, as they were encountered.

Caracoles (at least three species small gastropod) were found in far higher numbers than *ostiones*. However, they are a small species and would not have provided a significant return for effort even though they are relatively simple to collect. They are commonly found on rocks and may be exposed at low tide or in rock pools. They may have been collected during periods when it was too rough to dive in the deeper water or may have been collected by those who were not able to dive or forage further afield – women, children or older persons.

Slipper limpet were found in relatively high numbers (MNI = 508) but they were often very small. They are commonly found as an epidont on *cholga* and may have been inadvertently collected.

A total of 637.9 gm (MNI = 69) of *almeja* (*Protothaca thaca*) were retrieved from the excavation. This species favours a similar habitat to *macha* – shallow sandy shores. Their distribution through the excavated units is more widespread than *macha* and *almeja* were found in 8/10 trenches. MNIs per unit were generally low with the highest incidence being five valves located in CV4/1/17 (Late Period). The highest count for *almeja* was 21 MNI in CV1/3 (Archaic) followed by CV4/1 (Late) with an MNI of 16 with an overall mean of 6.9/trench. The widespread appearance of this species suggests that it did not succumb to the same fate as *macha* and was able to endure whatever caused the latter to disappear. *Almeja* are able to withstand temperature increases far better than *macha*. This tends to support the idea that it was an *El Niño* event that caused the demise of *macha* at Caleta Vitor.

Loca (*Thais chocolata*) are a relatively large gastropod. A total of 125 (MNI) were found with the highest incidence occurring in the trenches dating from the Late Period (39 in CV6/1; 22 in CV6/3). However, CV3/1 contained an MNI of 12 and CV2/1PC had 25 which suggests that they were exploited from the earlier periods of occupation.

Other categories

The following discusses taxa that were not included in the shellfish collection.

Decapod

A total of 492.1 gm (MNI=798) of crab shell was recorded. This sample of the assemblage was very fragmentary with only very small fragments of carapace present. The most recognisable elements were chelipeds (claws) or cheliped tips as there were the most robust part of the animal. The MNI was calculated by divided the total count of cheliped divided by four. No specific species were identified but live specimens observed at Caleta Vitor include *Geograpsus lividus* and *Leptograpsus variegatus.*

Decapod	3/1	1/3	1/2	2/1PC	2/1C	4/1	4/6	6/1	6/3
(wt. grams)	135.9	153.0	24.0	48.3	50.5	29.3	1.7	13.5	21.9
Mean wt/unit	6.2	5.9	1.4	1.6	1.8	1.5	0.2	0.8	3.6
MNI	345	151	24	64	84	53	10	26	18
Mean MNI/unit	15.6	5.8	1.4	2.1	3.1	2.8	1	1.6	3.0

Table 13.11: Summary of decapods recorded at Caleta Vitor (MNI and weight in gm).

Over 75% (150/198) of the units contained some crab shell with a mean MNI of 4.03 per unit. However, occasional specific units contained disproportionate numbers of cheliped tips, with a maximum of 594 (MNI=149) from CV3/1/17. The three units CV3/1/17-20 contained a total of 1061 chelipeds (MNI=266) whereas CV3/1/16 contained 20 (MNI=5) and CV3/1/21 contained 9 (MNI=3). The square CV2/1 consisted of 58 excavated units with an overall total of 514 chelipeds (MNI=148) with a mean of 2.53 per unit. Dividing CV2 into pre-ceramic and ceramic units results in a slightly higher mean for the preceramic period (2.2 compared to 2.7). CV1/3 had a mean of 6.2, CV1/2 had 1.7 and CV3/1 had 15.6. The much higher mean within CV3/1 results from two units that had elevated numbers of chelipeds. By removing these outliers, a mean of 6.5 is very similar to that of CV1/3.

Concomitant with the high incidence of crab in CV3/19-20, these layers also had a relatively high number of molluscs, particularly *chorito*, *loco* and *quiton* as did CV3/1/31. While this unit contained a reasonable number of crabs (MNI=27), there were far fewer than CV3/1/17-20. In some instances, the higher incidence of molluscs correlated with a higher incidence of crabs, for example CV2/1/47-48 had an MNI for crab of 12 and 10 respectively and had a higher MNI for shell - 163 and 126. The MNI for crab in CV1/3/17 was 21, yet there were only 29 (MNI) shells in that unit. On the other hand the MNI of shells in CV4/1/11-12 were 312 and 303 and the MNI for crab was 2 and 4 respectively. As such, there does not appear to be a strong correlation for the incidence of crabs and molluscs.

The high numbers from CV3/1/17-20 may have resulted from a single event or series of events whereby crabs were prevalent during a particular season where migration patterns had brought crabs together *en masse*. Large decapods follow a similar behavioural pattern and many species have a seasonal migratory pattern (Hunter et al. 2013). The best known crab migration is that of the red crabs of Christmas Islands where millions of crabs move from their burrows on land to the sea to spawn during November and December (Adamczewsk and Morris 2001). The knowledge of seasonal movement of species today allows commercial fisheries to target the desired prey more efficiently and effectively. In prehistoric times, the spawning migration of crabs across the shore-line would have facilitated their capture as higher numbers became accessible. This may be the main factor which resulted in high numbers within CV3/17-20. The remains from CV3/1/17-20 may represent a feast or series of feasts resulting from such a harvest. The evidence of such activities may be limited in range but occur regularly as discrete deposits throughout the site.

Figures 13.1 and 13.2 show the MNI of crab found in each unit within CV2/1 and CV3/1. CV3/1 clearly shows a period (CV3/17-19) where crab was either much more common or specifically targeted for that period. CV3/1/1-8 should be ignored as those strata consist of alternating layers of reed and grass that form the *tumulo* which was constructed directly over the midden deposit. CV2/1 shows more consistency but does display periods where crabs were more commonly caught but there are no indications that crabs were anywhere near as prolific as at CV3/1/17 or CV3/1/19. The fluctuations within CV2/1 (and elsewhere) are likely to have been the result of seasonal cycles.

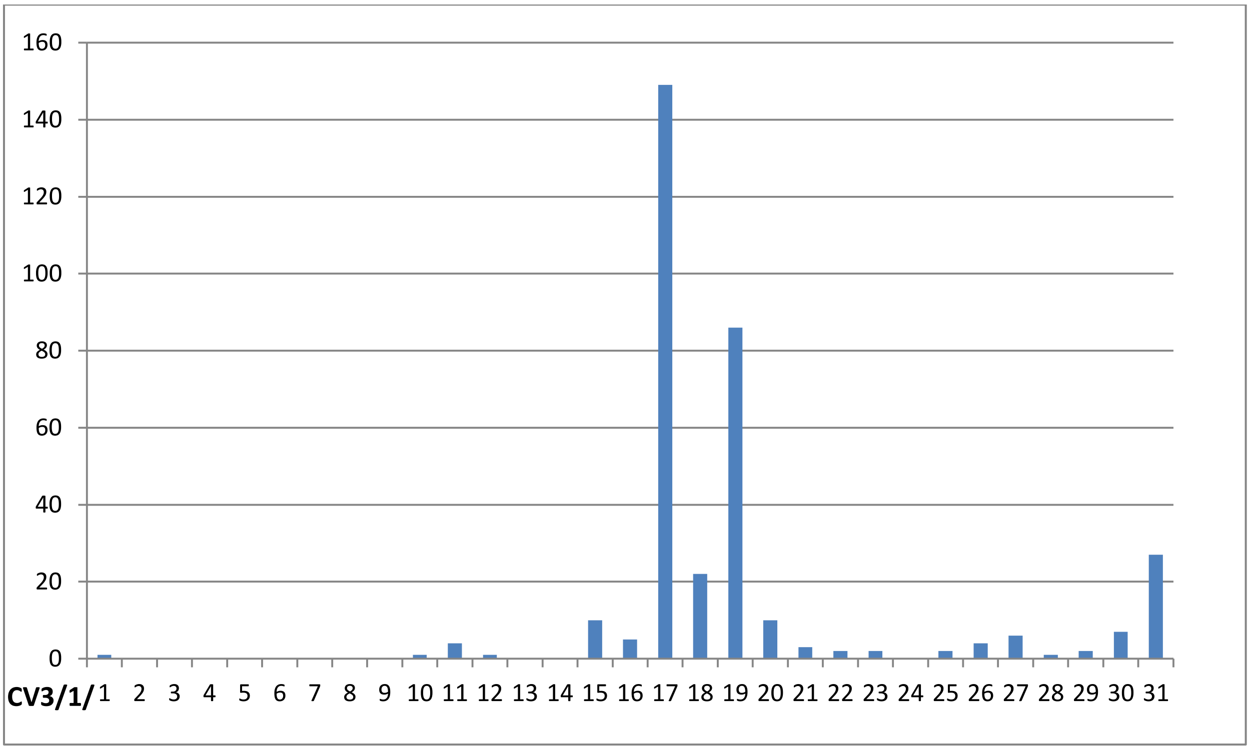


Figure 13.1: CV3/1 - Decapod - MNI per Unit

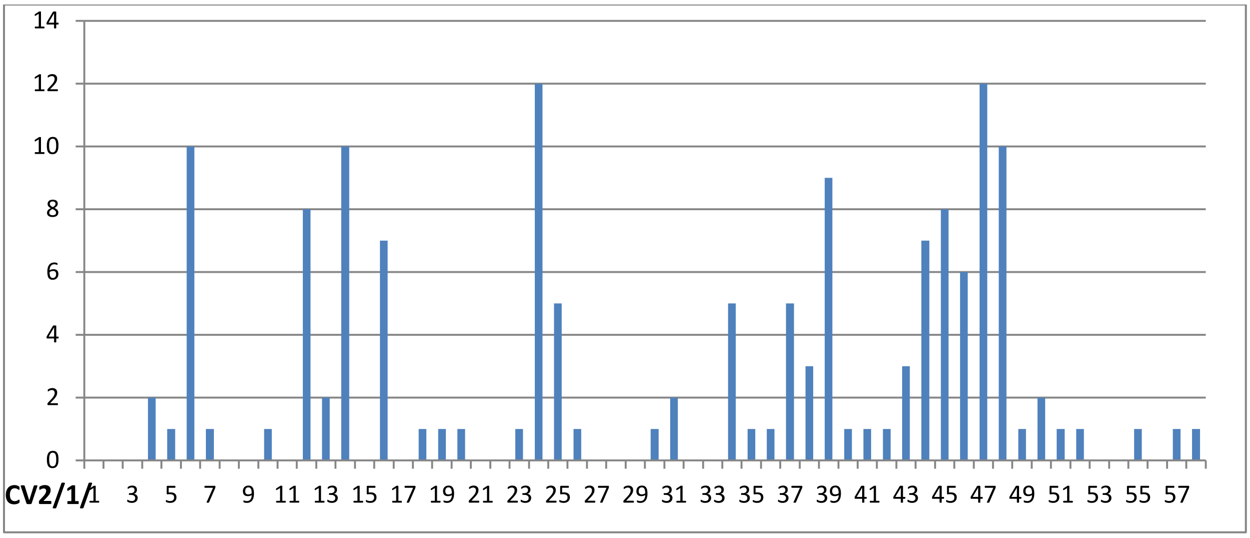


Figure 13.2: CV2/1 - Decapod - MNI per Unit

Diversity & Equitability

	Trenches											
MNI	**1/2**	**1/3**	**2/1PC**	**2/1C**	**3/1**	**4/1**	**4/6**	**6/1**	**6/2**	**6/3**	**7/1**	**Overall**
Diversity	1.874	2.244	2.033	2.069	1.301	1.426	1.955	2.106	1.753	1.976	1.939	**2.150**
Equitability	0.754	0.875	0.818	0.833	0.524	0.570	0.762	0.847	0.798	0.770	0.842	**0.815**
Weight												
Diversity	1.991	2.179	2.158	2.061	2.020	1.876	2.057	1.917	1.941	1.966	1.981	**2.246**
Equitability	0.754	0.805	0.797	0.781	0.729	0.693	0.779	0.726	0.809	0.726	0.826	**0.810**

Table 13.12: Diversity & Equitability per trench (MNI and weight in gm).

The mean diversity (range of species)/equitability (evenness of distribution) was 2.013/0.765 by MNI, 1.879/0.763 by weight. In the main, the difference between diversity and equitability indices between MNI and gross weight is relatively low, often very similar. The highest variation occurs in CV3/1 and 4/1. This is most likely the result of a very high MNI of *chorito* valves (small, light species) which does not equate directly to an increased weight for the same species. Both diversity and equitability were generally moderate to high, indicative of high species richness.

The mean diversity/equitability indices based on shellfish MNI for the Archaic trenches (CV3/1, CV1/2, CV1/3, CV7/1) were 1.839/0.748, for the Formative (CV2/1) 2.051/0.825 and for the Late Period (CV4/1, CV4/6, CV6/1, CV6/2, CV6/3) 1.843/0.749. The mean diversity/equitability indices based on gross weight for the Archaic trenches (CV3/1, CV1/2, CV1/3, CV7/1) were 2.043/0.778, for the Formative (CV2/1) 2 2.175/0.789 and for the Late Period 1.951/0.746. In both cases there is a slight increase in diversity and equitability for the Formative Period and the Late Period displayed a slight decrease. Diversity and equitability indices appear consistent through time with little discernible change and species richness remains high. This contrasts markedly with that of fish species. Fish, as identified via otoliths and as per size classes, had a far lower diversity and equitability - species identified via otolith had a diversity/equitability of 0.947/0.431 and as per size classes resulted in the figure 1.108/0.625. Apart from having fewer identified species, the disparity between fish and shellfish was due the dominance of *roncacho* in the otolith assemblage and 'very small' and 'small' sizes in the vertebrae assemblage.

Changes in frequency and diversity of faunal species present in a midden assemblage may be the result of either natural or cultural changes. Natural fluctuations may occur as the result of changing water temperature, salinity and nutrient content (the result of *El Niño* events) as well as geomorphological variation due to fluctuating sea-levels and/or sediment deposition.

Comparative Analysis

The distribution of shell remains varied considerably. The highest abundance of shell comes from CV6 where the three trenches there contained 34.02 kg with a mean of 1.308 kg per unit. This is far higher than CV1 where the shell total was 10.850 kg with a mean of 0.252 kg per unit. CV2/1 had 21.538 kg with an overall mean of 0.371 kg per unit. As the trenches at CV6 spanned a time-frame of 250 years or less and CV1 spanned at least 6000 years, it may be that the intensity of occupational activity at CV6 was higher than other sites. However, the deposit at CV6 may have been far larger simply because the shellfish were being processed close to where they were harvested or brought to shore from boats. This would save having to carry larger volumes of unused material back to a domestic site. Given the weight of *loco* shell, they may have been shucked before being brought back to camp.

Mussels were collected in large quantities and they may have been processed in a similar manner. Today, mussels are dried or smoked and sold in the markets on 'strings' (pers. obs.). It is possible that this method was adopted well into the past and that processing took place on the shoreline and the shells were discarded there. Processing shellfish destined for trade inland may also have been an economic activity from the Late Period that simply did not occur in the Archaic Period.

The varying frequency of the three species of mussel are worthy of further discussion. The correlation between *cholga* and *chorito* suggest that when one of the species was abundant, the other was not. *Choro* appear more consistently throughout the assemblage. The mean abundance of *choro* through all trenches was 0.42 of the total [identified] mussel by weight.

CV6/1 and CV4/1 are contemporary, over 500m apart and within different topographic units. The average abundance of *choro* was 67.8% for CV4/1 and 54.1% for CV6/1. Conversely though, the abundance of *cholga* was 0.3% for CV4/1 and 44.3% for CV6/1 with *chorito* at 31.9% for CV4/1 and 1.6% for CV6/1.

Mussels, in one form or another, consistently provided food for the occupants at Caleta Vitor. The varied response to *El Niño* events by the different species resulted in at least one being available, in reasonable quantities, at most times. The consistency in their appearance in the assemblage suggests that they were either naturally replenished at a reliable and rapid rate or that the mussel beds were managed by those harvesting them.

Overall, mussel shell comprised 22.429 kg of indeterminate fragmentary mussel shell, 13.911 kg (MNI = 598) of *choro*, 8.030 kg (MNI = 1089) of *cholga* and 6.826 kg (MNI = 2238) of *chorito*. These results clearly display the disparity when comparing total weight and MNI. Indeed, when comparing abundance indices, *choro* was 0.48 by weight and 0.15 by MNI, *cholga* was 0.27 by weight and 0.28 by MNI and *chorito* was 0.25 by weight and 0.57 by MNI. Such figures represent a reversal in order of abundance for the three species.

Choro are not only a larger species but the shell is far more robust which results in far fewer *choros* weighing more than twice as much as *chorito*. The larger shell fragments of *choro* were also more easily to identify than the smaller fragments of *chorito*.

Within each unit, the abundance[5] of the three mussel species was more often than not dominated by one of the species[6]. By weight, *choro* were the most abundant of the three in 62.4% of the units, *cholga* in 21.8% and *chorito* in 15.8%. Using MNI, *choro* were the most abundant in 37% of the units, *cholga* 31.7% and *chorito* 36.4%. While there is significant discrepancy when comparing weight and MNI, the range of abundance of each species is also significant in that where one species was dominant, more often than not, the frequency of the other species was lower. On occasions where there was a more even distribution across the three species, it appears that this was the point where one species was decreasing in

[5] This relates to abundance of each of the three species of mussel not all shellfish.

[6] CV6/2 and CV7/1 were not included in this section due to the overall low frequency of shell.

prevalence and another was increasing, rarely was there any consistency in distribution.

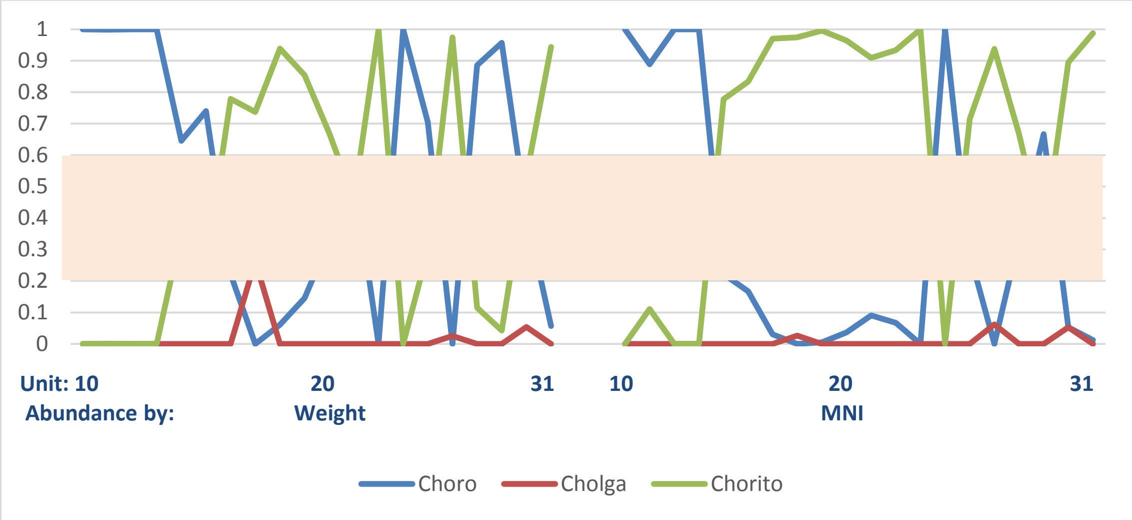


Figure 13.3: Abundance indices of mussel species in CV3/1.

Figure 13.3 displays the abundance indices of the three mussel species from CV3/1[7] (a trench dated to the Archaic Period). While there is a significant variation between abundance by weight and MNI, in both cases it is clear that *cholga* were uncommon throughout the trench and *choro* and *chorito* showed considerable fluctuation. When *choro* was dominant, *chorito* was absent or almost so. The reverse also occurred, where *chorito* almost completely replaced *choro*.

[7] Units 1-9 were not included as they contained very few shell remains (mound construction)

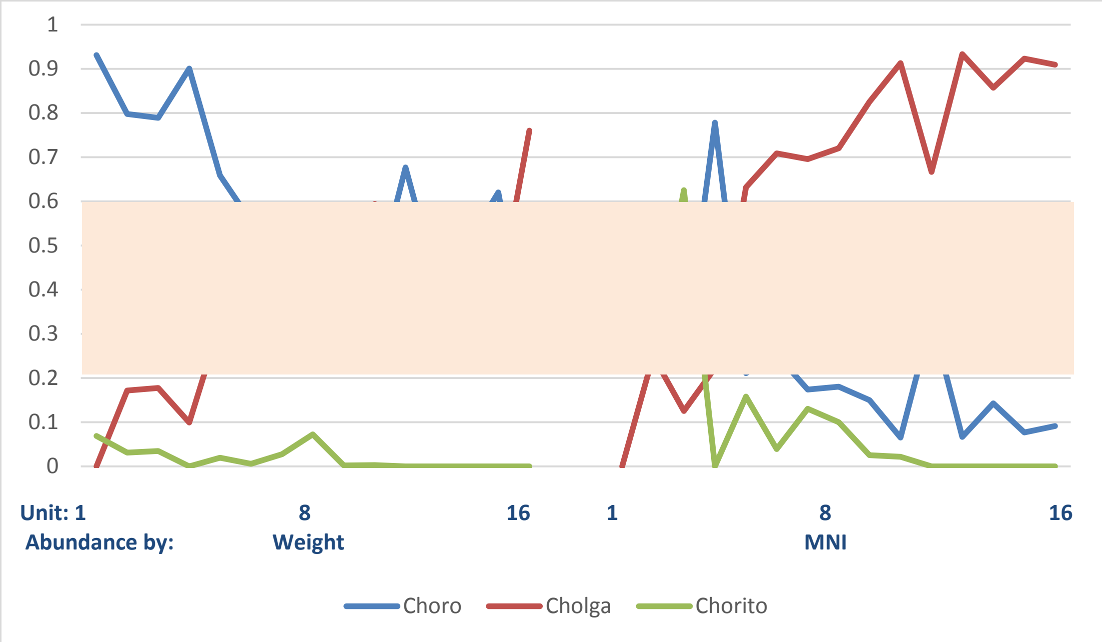


Figure 13.4: Abundance indices of mussel species in CV6/1.

Figure 13.4 displays the abundance of mussel in CV6/1 (a trench dated to the Late Period). There were very few specimens in units 1-4 which skews the results. However, it is clear that in this trench, *chorito* was the least abundant species and that *choro* and *cholga* fluctuated broadly. In this trench, the variation between *choro* and *cholga*, at least by weight, was less pronounced than in CV3/1.

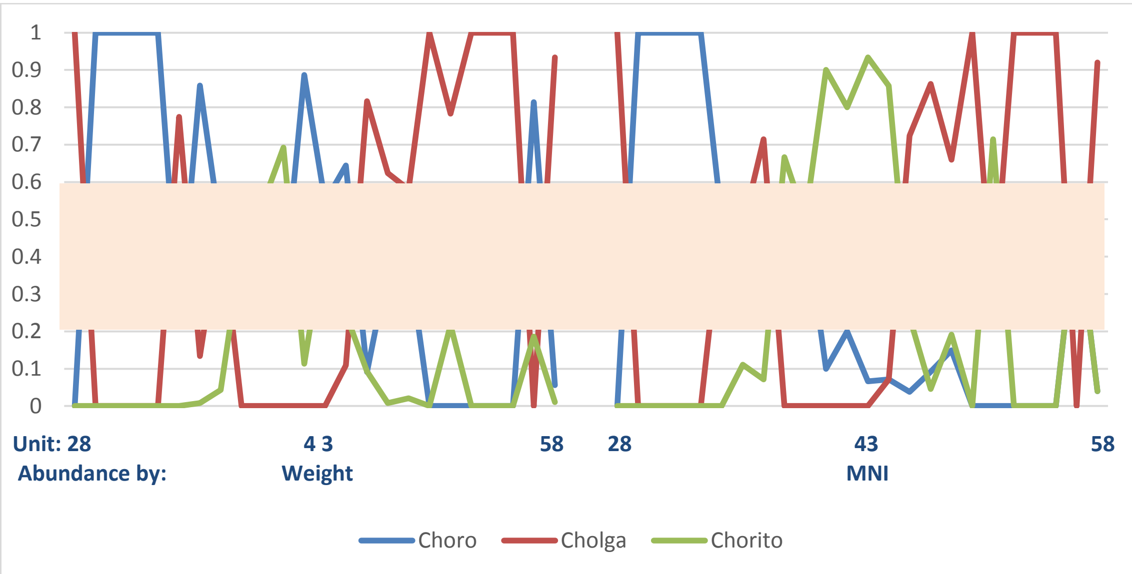


Figure 13.5: Abundance indices of mussel species in CV2/1PC.

Figure 13.5 displays the abundance of mussel in CV2/1PC (dated to the Formative Period). Again, the abundance fluctuates broadly and regularly one species virtually disappears. However, in this case, each of the species is absent on at least one occasion.

Similar fluctuations are evident in the remaining trenches and it is only on rare occasion where the abundance of any two of these species is similar. The three mussel species are often found in similar locales and their habitat range extends from Peru to the Straits of Magellan. As mentioned in Chapter 10, choro prefer cooler, sheltered waters, cholga are susceptible to increased water temperature but chorito can tolerate warmer waters and are not greatly affected by El Niño events. The vacillation between mussel species may thus be explained as each species responds to changes in water temperatures.

The overall abundance of mussels suggests that, collectively, they were an important part of the diet of those living at Caleta Vitor. While an individual species might be absent or present in low numbers on occasion, it is evident that one of the other species was able to replace it. Were other molluscs affected the same way? Did the overall economy suffer as a result? In an attempt to answer this query, the abundance of other molluscs must be compared in a similar manner.

Lapa, loco and *chiton* are all molluscs that inhabit rocky shorelines. *Lapa* and *chiton* are often seen together within the wave wash zone while *loco* are subsurface dwellers. These three taxa were the most abundant at Caleta Vitor after mussel. Figures 13.6 -13.8 display the abundances indices based on MNI of the three species for the trenches CV3/1, CV6/1 and CV2/1PC.

While there are occasions where one taxon is not represented at all, these generally occur where there were particularly low numbers in that unit. Generally, there is a far greater consistency in abundance. For example between units CV3/1/15 and CV3/1/24, the abundance of the three species ranged between 0.09 (*lapa*) and 0.63 (*loco*) with *chiton* ranging between 0.22 and 0.62, with no particular species dominating any individual unit - as was the case with mussel.

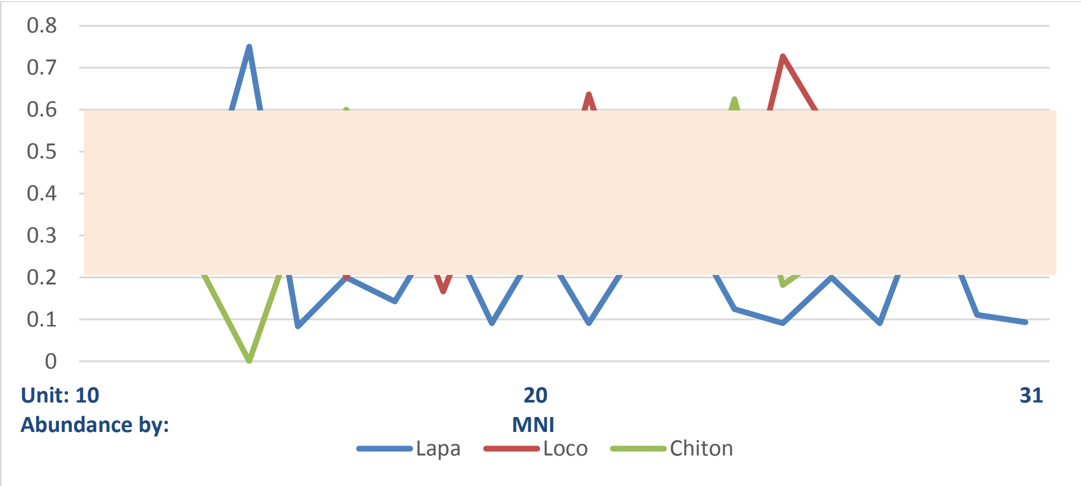


Figure 13.6: Abundance indices of *lapa*. *Loco* and *quiton* in CV3/1.

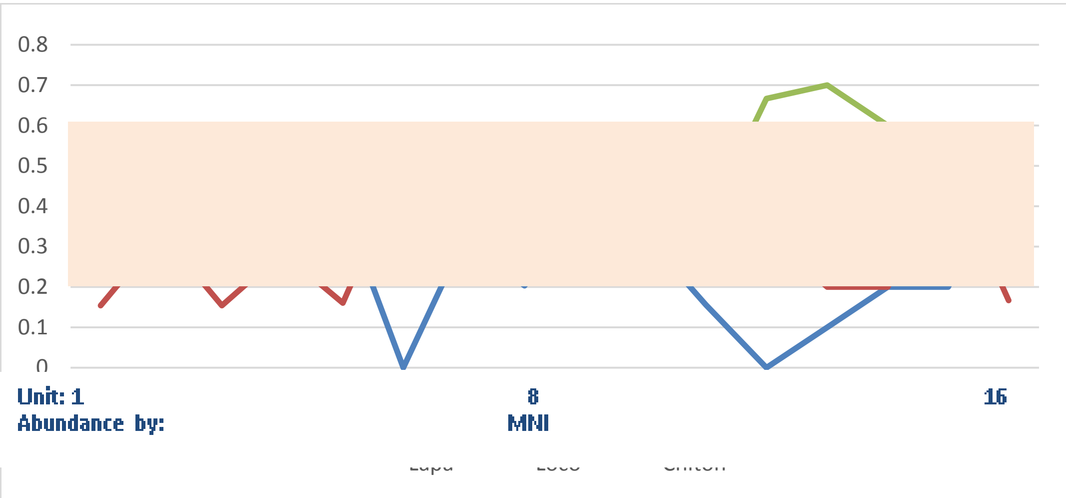


Figure 13.7: Abundance indices of *lapa*. *Loco* and *quiton* CV6/1.

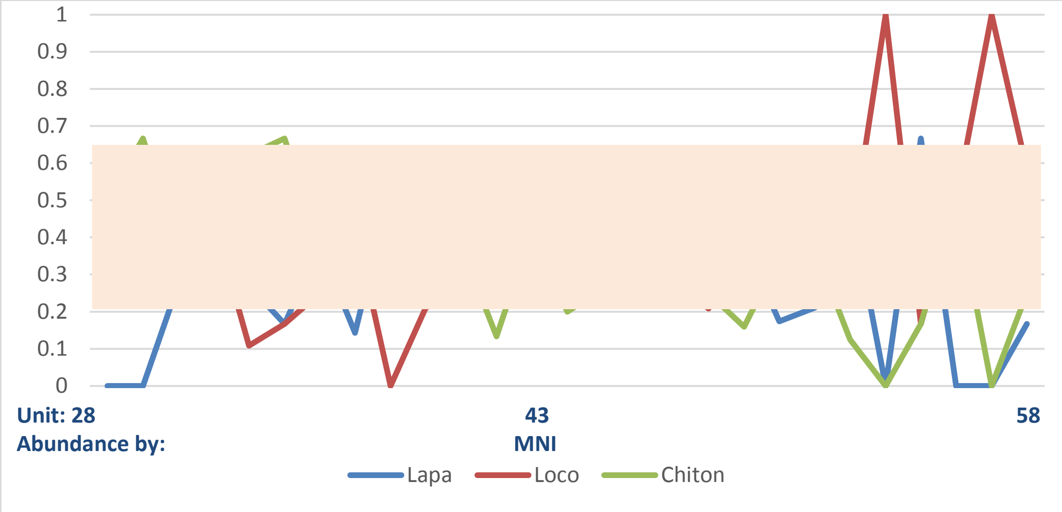


Figure 13.8: Abundance indices of *lapa*. *Loco* and *quiton* in CV2/1PC.

To summarise the Figures 13.3 to 13.8, it is apparent that there is no pattern of distribution for *lapa*, *loco* and *quiton*. The consistency in their distribution is that they are regularly mixed, without one particular species being dominant. Mussels, on the other hand, show that one particular species is more often dominant (often up to 100%) within a unit. Such dominance of one species rarely occurred between *lapa*, *loco* and *quiton*. The shaded area within the figures covers the spread of abundance between 0.2 and 0.6 (20% to 60%). There is a far higher occurrence within this range for *lapa*, *loco* and *quiton* than for the mussel species.

The cockle, *amleja,* is a species that tolerates higher water temperatures. They are found across all trenches but in low numbers – the mean MNI being less than one per unit. There were only five cases where more than one individual was located in a single unit. CV1/3/20-21-22 had an MNI for *almeja* of four, five and four respectively. While these are low numbers, it is a significant increase and may indicate warmer water temperatures. These units coincide with an increase in the presence of *chorito* (49 MNI) and fewer *choro* (4 MNI).

Macha prefer cooler waters and can die off in warmer waters. As mentioned, they were abundant in very few units and generally absent in all but three trenches. CV1/2 contained 93.6% of the total by weight and 98.6% by MNI with the majority found in units 7-11 where an MNI of 133 (out of a total of 143) were found. *Choro* and *cholga*, both species that also prefer cooler temperatures, were found to be more common in those units that contained *macha*. A combined total of 162 (MNI) of *choro* and *cholga* were found in CV1/27-11, whereas only 2 *chorito* were located in those units. Such a coincidence supports the theory that mussel species fluctuate with varying water temperatures, most likely in accordance with *El Niño* cycles.

There appears to be some correlation between the appearance of certain mussel species and the abundance of fish. Increased coastal upwellings bring with them nutrients that support the entire marine food chain. Upwellings also coincide with cooler water temperatures. As such, an increase in fish numbers may correlate with an increase in the numbers of shellfish species that prefer cooler water, such as *macha* and *choro*. An abundance of species that prefer warmer temperatures should, therefore, correlate with a decrease in the abundance of fish, particularly shoaling species. However, fluctuations in water temperatures are likely to have occurred on a relatively short time scale, most likely decadal or less. Few archaeological deposits are likely to provide evidence that is discrete enough to discern fluctuations at this level.

At Caleta Vitor, CV4/1 and CV6/1, both dating to the Late Period, are the most likely trenches to provide such evidence as they were deposited over a relatively short timeframe. CV6/3 lacked sufficient stratigraphic integrity to be considered as a likely source of such evidence.

As mentioned, *macha* prefer cooler waters and were only found in any quantity in CV1/2, particularly in units CV1/2/7-10. There is a strong correlation within these units with mussel species that prefer cooler water (*choro* and *cholga*) and vertebrae numbers are also high. Table 13.13 contains the data that highlights this correlation.

CV1/2 - Unit Species (MNI)	6	7	8	9	10	11	12	13	14	15
Macha	1	11	52	19	49	2	3	4	-	-
Choro	2	1	14	9	27	52	2	2	1	1
Cholga	5	8	7	5	28	11	14	3	1	1
Chorito	-	1	-	-	1	-	-	-	4	-
Vertebrae (n)										
Very small	10	17	57	98	162	29	116	335	108	0
Small	20	47	317	310	654	44	131	407	82	9
Medium	2	13	67	23	93	5	9	52	41	1

Table 13.13: Incidence of *macha*, *choro*, *cholga* and *chorito* and fish vertebrae – CV1/2/6-15.

Table 13.13 shows a correlation between the incidence of *macha*, *choro* and *cholga* – species that prefer cooler water. There is an increased incidence in the number of fish vertebrae during the same period, although the incidence of fish increased prior to shellfish. This may be because fish are far more mobile and respond to changes in water temperature far quicker than shellfish.

CV4/1 - Unit Species (MNI)	7	8	9	10	11	12	13	14	15	16
Choro	9	1	15	18	11	1	9	22	12	5
Cholga	-	-	-	-	-	-	1	1	-	-
Chorito	155	21	14	22	247	287	53	64	24	17
Vertebrae (n)										
Very small	1	0	15	11	24	-	9	27	24	-
Small	96	2	242	371	188	29	59	52	36	13
Medium	87	21	121	229	74	1	32	31	37	59

Table 13.14: Incidence of *choro*, *cholga* and *chorito* and fish vertebrae – CV4/1/7-16.

Table 13.14 displays the incidence of the three mussel species within a range of units from CV4/1. CV4/1/11-12 in particular had a high incidence of *chorito*, a mussel that tolerates a wide temperature range. In this trench, both *choro* and *chorito* appear in similar numbers in several units but there is a significant increase in the number of *chorito* in units 11 and 12. The incidence of fish vertebrae decreases as *chorito* increase which may indicate an increase in water temperature. This contrasts to CV1/2 where *choro* and *chorito* do not often appear in the same unit. In CV1/2, *choro* and *cholga* are found together, the opposite that occurred in CV4/1.

It appears that on occasion there is a correlation between the high incidence of fish and shellfish species that prefer cooler water temperatures. In the main, the excavated material does not provide evidence with a resolution that is fine enough to discern fluctuations that may be only a few years apart. However, the evidence clearly shows that Caleta Vitor is not unduly impacted upon by *El Niño* events and that episodes of warmer water temperatures are not of a duration or intensity to disrupt the economy completely.

Adaptation to such fluctuations would have been minimal. Once the area had been settled and economy stabilised, a decrease in certain species would be easily recognised as would the presence of an alternative resource.

* * *

In conclusion, the evidence provided by invertebrate remains indicates that for those living at Caleta Vitor:

- had a relatively broad range of shellfish available to them and were able to efficiently harvested them;
- shellfish from a range of habitats were exploited and included those obtained at the water's edge, along the rocky shoreline, as well as from diving in the waters immediately offshore;
- species richness was higher than that of fish;
- mytlidae (mussel) provided the bulk of the shellfish in their diet;
- shellfish contributed significantly to the overall economy;
- *El Niño* events did not significantly impact on the economy as the wide range of shellfish species present ensured that when one was negatively affected, another was able to take its place.

Chapter Fourteen

> *Any culture must, of course, rest upon a basic economy which is adapted to its environment. This adaptation is human ecology.* (Steward & Setzler 1938: 7)

Conclusion

Caleta Vitor attracted my attention shortly after the locale allowed public access. The extensive middens that were visible there appeared to contain a considerable amount of evidence that, *prima facie*, could provide insight into the lives of the prehistoric settlers. The investigation targeted a range of locations scattered across the site that, hopefully, would provide information relating to the local economy from the period of early settlement until at least the early Colonial period. The results were then used to determine:

I. The gap in the archaeological record along this section of the coast;
II. The significance of the impact of El Niño events in this region;
III. When the first people settled this region of South America and their migratory pathway;
IV. The faunal composition, structure, and dynamics of the middens at Caleta Vitor;
V. Whether the development of the local economy was an adaptive mechanism of early, more generalised hunter/foragers or if it was developed earlier, elsewhere and introduced by the first settlers?

Excavation targeted food remains and artefacts that related to the means by which resources were collected and processed. Such evidence would provide a base from which to describe and analyse the base-line economy of those living at Caleta Vitor. Analysis examined resource richness; how and where those resources were harvested; how the range of resources changed through time and whether individual resource species varied in individual size and abundance. Interpretation then attempted to explain any apparent variations.

Evidence uncovered thus far demonstrates that Caleta Vitor was initially occupied during the early Holocene, over 9000 years ago. It is highly likely that more evidence of early occupation can be found there and could even go deeper into the past, perhaps into the Pleistocene. The trench at CV3/1 was located beneath a *tumúlo* and the earliest deposit was lying directly on bed-rock. The visible remains of archaeological deposits cover a broad area of this sector and continue to the north of CV3/1 to the banks of the modern stream bed. This site is close to a water source and beyond the danger of rocks that fall or roll down from the high slopes to the south. It also offers access to the shoreline and it is from this direction that the majority of resources were targeted. The entire area is likely to be underlain with material dating from this early period and it is likely that this would be the area where older deposits lie.

The unit containing the earliest evidence (CV3/1/31) revealed the remains of a quantity of fish and shellfish. A significant proportion of fish remains were from small species (the majority being *roncacho* (*S. deliciosa*)). Such resources are difficult to catch on a line without very small hooks and difficult to spear in any quantity. As such, it is assumed that nets were used to capture them. Very small species (Engraulidae – sardines and/or anchovies) were also present in this unit. Such species could not be collected in such amounts other than by netting. Large fish are also represented in the early deposit. These may have been caught on hook and line but could have been caught in nets used for small fish, particularly as they would have been the prey for larger species. While shark remains were far more common in the Late Period trenches, some remains were found in the Archaic trenches CV1/3 and CV3/1 and the early units of CV2/1. This suggests that at least some shark were captured during the earlier periods of occupation. Whatever the case, the early fishers had the ability to capture a range of available fish species from the smallest to larger specimens.

In 1982 Llagostera developed a model based on his findings from La Chimba, to the south of Caleta Vitor. He suggested that the earliest coastal dwellers were hunter/gatherers and, over time, they developed techniques and technology that allowed them to capture larger prey – 'from marine gatherers, to early fisherman to late fishermen; from the seaside to later become deep-water specialists' (see Berenguer 2008).

Such a model does not completely satisfy the evidence found at Caleta Vitor. Those who resided at Caleta Vitor during the early Holocene had the expertise to capture large fish and had a well-established economy based on a wide range of marine resources. They worked co-operatively using nets to catch quantities of small fish. They harvested a range of molluscs available from the rocky shoreline, collecting them from the rocks or diving into the deeper waters. This evidence comes from the earliest units at Caleta Vitor (CV3/1/31). However, through time, the character of this evidence did not change significantly. Variations and fluctuations are evident but there was as much variation within individual trenches as there was between Archaic and Late Period trenches. Fluctuations that are evident were more likely the result of seasonal variation or vacillating environmental conditions (such as *El Niño*).

Mytilidae (mussels) provide a good example and collectively their remains were abundant at Caleta Vitor – from the oldest to the youngest trenches. Three species (*C. chorus, A. ater* and *P. purpuratus*) were identified and all are found along the west coast of South America. However, their abundance varies locally according to environmental conditions. The results of this investigation clearly revealed fluctuations in the abundance of individual mussel species throughout the entire period of occupation. However, in the majority of cases, where one species was abundant, the other two were not. The cause of such variation was likely due to fluctuations in water temperature - the result of *El Niño* cycles.

The evidence suggests that the diversity of marine resources was such that while one or two species may have been affected by *El Niño* events, alternate resource species were able to tolerate or even proliferate when the water temperature rose or if the upwelling reduced the amount of phytoplankton entering the food chain.

Cultural Shift at Caleta Vitor

The Archaic Period

The first settlers of Caleta Vitor brought with them a well-established economic regime able to exploit marine resources and their material culture reflects this. The first evidence of a cultural shift appears during this early period and is evident in changes in funerary practices. During the early periods of settlement within this region, the deceased were found to have been simply buried in an extended position. Signs of elaborate care and preparation of the body appear around 7500 years ago near Arica (Standen and Santoro 2004). The development of complex mummification procedures followed some centuries later, around 7000 years ago (Arriaza 1995a). The people responsible for the creation of these mummies became known as the Chinchorro

The Chinchorro economy was based on marine resources, to such an extent that Dillehay (2000) suggested that they probably represented the practitioners of the 'first true maritime economy' in South America. They had well-developed fishing strategies and a specialised tool-kit. The success of their endeavours is clearly evident in the extensive middens wherever they settled, including Caleta Vitor.

Evidence of fishing gear (hooks, line, sinkers, lures, points and *chopes*) found at Caleta Vitor and dated to the Archaic Period is similar in form to assemblages from Chinchorro sites in Arica and Camarones. Evidence of Chinchorro mummification practices was also recorded at Caleta Vitor (in CV1). This places them within a broader cultural milieu that extended along the coast from Ilo in southern Peru to Antofagasta in the central north of Peru (Arriaza 1995a, 1995b). The majority of the known Chinchorro mummies were found in Arica and Camarones where large burial grounds have been recorded. Caleta Vitor is located mid-way between Arica and Camarones. As such, it is not surprising to find Chinchorro burials there and one could expect to find numerous burials there, particularly within CV1. Caleta Vitor was likely to have been centrally located with the Chinchorro cultural setting and subject to any cultural shifts that evolved within it.

The Formative Period

The Chinchorro continued to mummify many of their dead until around 3500 BP when bodies begun to be placed in graves or tombs in a flexed position. This change in burial ritual is a dominant marker for the beginning of the Formative Period.

Evidence of agriculture was another marker that would indicate the transition into the Formative Period. Maize was one of the early crops domesticated in the region but not evidence of this plant was found at Caleta Vitor dating from the Formative Period. Cotton seed was found in CV2 in a unit dated to the Formative but this may have been a seed from a wild plant – a species known to have grown wild in this area.

Small quantities of camelid faecal pellets were found in CV2/1 and dated to the Formative Period. These are likely to have been from llama and may have been associated contact with highland groups and became more common as trading parties began to visit that part of the coast.

A major cultural shift was evident within CV4 where burials were marked with timber posts. Two graves within CV4 revealed that the deceased had not been buried in an extended position (typically Chinchorro) but were seated or flexed. CV4/3 also revealed evidence of techniques that were similar to Chinchorro mummification in that the cranium had been filled with ash, soil and vegetal material. While CV4/3 was not dated, bone from CV4/2 (a burial beneath a similar post) was dated to 2072-2422 cal BP – the Late Formative Period, Alto Ramirez phase and most likely contemporaneous with the *túmulo.* The burials at CV4/2 and CV4/3 were both associated with fragments of plain ceramics and simple basketware. The earliest ceramics found within a dated context came from CV2/27 and that unit falls within the date range 2300-2700 cal BP.

There was no evidence dated to this period that indicated a change in the economic focus of the occupants of Caleta Vitor.

The Middle Horizon

Burial practices continued to evolve gradually with later interments wrapped in textile bundles along with a range of grave goods that became more elaborate and/or exotic through time. Burials within CV2 were dated to the Middle Horizon through to the Late Period. These consisted of simple graves with the bodies wrapped in several layers of textile with an array of grave goods including ceramics, wooden implements, patterned textile bags (one example contained coca leaf and another had maize), leather sandals, feathers, miniature bow and arrow and hunting/fishing equipment.

Changes in the funerary practices and the appearance of more ceramics and elaborate textiles were indicative of significant cultural change. Evidence of domesticated plants and animals, including maize and camelids, also appear in this later period at Caleta Vitor, however there is no evidence to suggest that the sea was not the primary source of the local economic resources.

The Late Period

Agricultural products and domesticated animals were introduced to this region most likely between two to three thousand years ago. However, there appears to be little variation in the archaeological evidence of a new and emerging economy at Caleta Vitor that included domesticated plants and animals until relatively late. Maize does not appear in any abundance until quite late and camelid faecal pellets become more plentiful during the Late Period.

The presence of Inka style ceramics (e.g. *pucu* dishes) suggested at least some influence from this cultural group. However, as the evidence of Inka presence is scant this suggests little direct control led by the presence of an administrative body. Such control may have been centred inland, from the major *tambos* (trading stations) on the *Cápac Ñan* (Royal Road of the Inka) such as at Tambo Zapahuira or Tambo Belen, both situated in the Pre-Cordillera to the east or Arica and Caleta Vitor (see Carter & Santoro 2005).

The commingling of artefacts of Pre-Hispanic and European origin (items from the Bandelier collection, AMNH) within burials at Caleta Vitor indicate that traditional life-ways continued for some decades after the arrival of the Colonial Spanish. This suggests minor Colonial influence at this locale for some time after Arica was colonised and developed as a port.

Throughout the entire period of occupation, small fish remained a regular resource as did a common range of shellfish. Fluctuations in particular shellfish remains in the archaeological deposit are apparent, although there is an overall consistency in the total amount and type of remains recovered. Agricultural products appear to have been acting to supplement the economy, not supplant it.

Figure 14.1 contains a schematic diagram showing the temporal spread of evidence from the excavations at Caleta Vitor. The dates span the period from over 9000 years ago through to the Late Period. The apparent disjuncture between CV2/1 and CV4/6 is likely to be the result of trench selection and nothing more. The deposit at CV4/6 extends beyond the excavated units and the extent of the deposits at Caleta Vitor is such that this period is likely to be well-represented elsewhere.

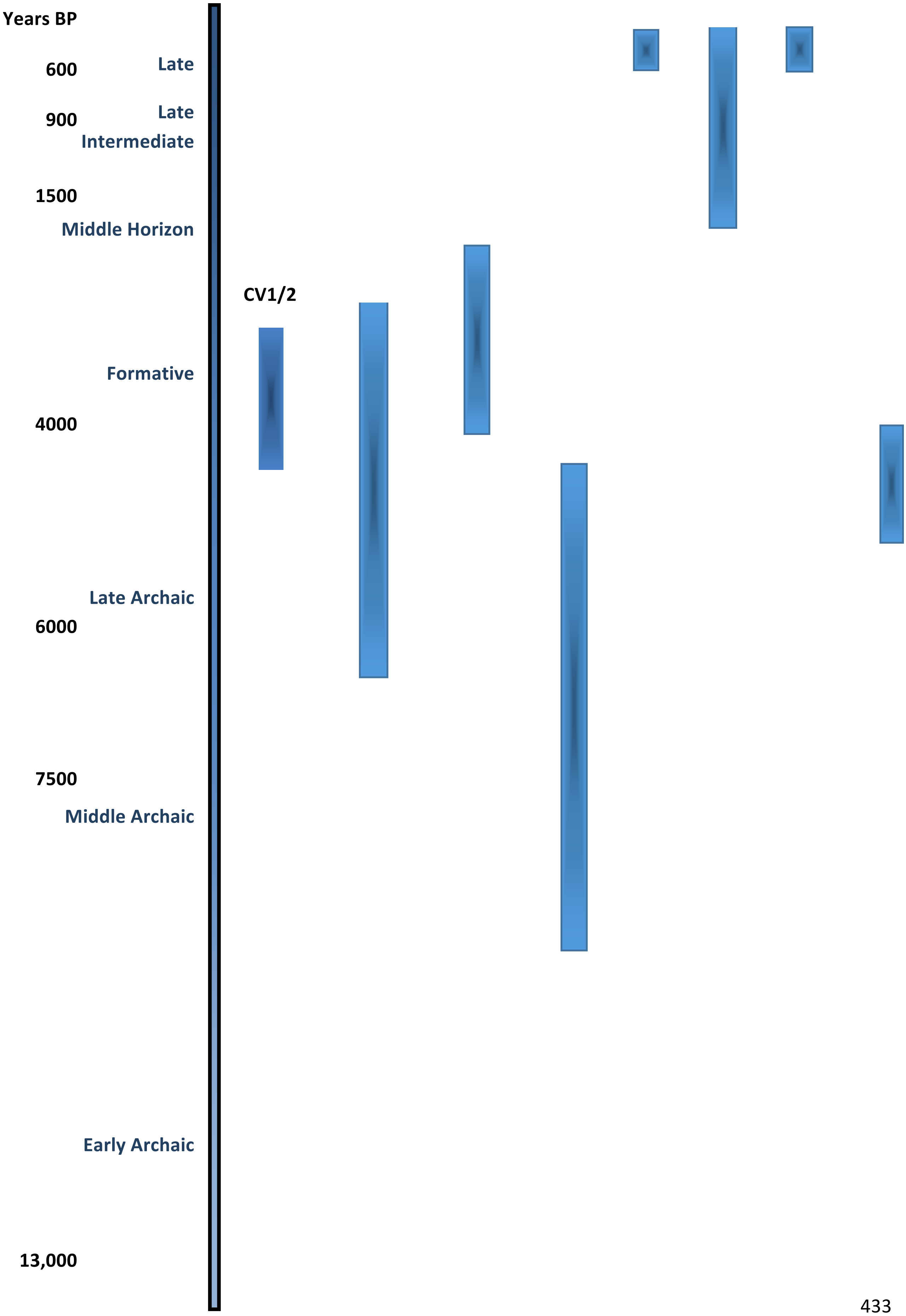


Figure 14.1: Schematic diagram showing temporal spread of dated trenches from Caleta Vitor.

A stable economy is predicated on the availability of resources to provide for the health and well-being of the local population. For a community to maintain their health, remain in one location and for an economy to be sustained, a range of resources must be regularly and readily available. Resources may vary seasonally but if they fluctuate significantly between seasons and storage is not a possibility, a community must be mobile, at least in part, to allow for hunting and/or gathering or trading over a broader geographic range.

The evidence at Caleta Vitor suggests that a portion of the community, if not all of it, dwelt permanently in the vicinity of the cove. The type of food remains deposited in local middens varied considerably. Through time, the local diet included a range of plant foods, both wild and cultivars, with evidence of evidence terrestrial fauna, particularly birds, with camelids and rodents, such as *cuy*, appearing during the Late Period. However, the bulk of the deposits within these middens are made up of marine resources including fish, shellfish and marine mammals. At least seven fish species and 10 shellfish species (molluscs, echinoderm and crustacea) whose remains were found in the middens attest to the availability of resources and amply demonstrate the stability and fitness of the local economy.

The range of resources is not simply the result of species richness but indicates also that a range of habitats was exploited via a broad range of procurement strategies. Shellfish were collected from the rocky shoreline and, to a lesser extent, along the beach; crustaceans were also caught along the rocks; divers collected molluscs from beyond the tidal line; anglers and hunters sought their quarry from watercraft, venturing some distance offshore as they did so; groups worked together to construct nets and then use them to capture large numbers of fish. The range of strategies was broad enough to allow almost every member of the community to become involved at some point. Women could collect shellfish from the shoreline without leaving their infants far behind, children could assist with such collection as could the older folk; whole families could be involved with the setting and retrieval of nets; and men could have hunted the larger game offshore.

Seasonal variation appears not to have had a dramatic impact on the ability of the local population to secure food. Longer term cyclical weather patterns, such as *El Niño*, may have, at times, impaired the availability of certain species. However, Caleta Vitor is located in such a position that if one set of resources diminished, it was replaced by another. There was no evidence to suggest that only minimal resources were available at any particular time. Impacts in some locations, particularly to the north of Caleta Vitor, in southern Peru, were more severe and may have caused populations to abandon sites, at least for a time. Southern Peru is not affected by the rain shadow caused by the Andes to the same degree as northern Chile. The areas to the north of Lake Titicaca are subjected to more severe flood events. During *El Niño* events the rise in sea temperatures is also greater in southern Peru than Chile.

The Nature of the Landscape at Caleta Vitor

In order to understand the prehistory of Caleta Vitor in a regional context, it is necessary to compare it with that of the neighbouring region to the north. One question arises; why did agriculture eventually become so important to the economy of the valleys immediately to the north of Caleta Vitor, when it was of limited importance in Vitor itself? To answer this question we need to examine some data from these valleys that lie close to the modern city of Arica.

Arica is now a city with sprawling suburbs. Early archaeological work on the middens located on the rocky shoreline to the south of the city revealed intensive occupation during the prehistoric period with indications that the economy was based on marine resources. Immediately to the north of El Moro, evidence of early occupation has been largely lost or at least covered by housing and commercial buildings. In response to the expanding city, in 2004, 2006 and 2008 I participated in archaeological surveys along sections of the coast to the north of the city. Two areas, Gallinazo Norte and Ponderosa, were found to contain evidence of intensive occupation during the Pre-Columbian period. These sites flank the Rio Lluta on the edge of the river terrace that adjoins the narrow coastal plain at the rear of the beach. The area of the plain immediately below the terrace now contains areas of wet-land and significant stands of vegetation including reed (*Typha* sp.), *juncos* (*Scirpus sp.*), horsetail (*Equisetum giganteum*), and shrubs like *chilca* (*Baccharis petiolata*) – the result of subterranean water being forced to the surface where it reaches the ocean.

Ponderosa, immediately to the south of the Rio Lluta, contains scattered ceramics, human remains and a number of looted tombs. Much of this site had been destroyed by the quarrying of diatomaceous earth. In fact, tombs recorded in 2004 had disappeared completely when the site was re-visited in 2008.

On the opposite bank of the river, Gallinazo Norte, is under the control of the Chilean Army and while it has been subject to military activities over the past century or so, a significant amount of archaeological material remains relatively intact. Like Ponderosa, the site was discovered via the presence of scattered ceramics and human remains on the surface. Several silos (*colcas*) were located along with tombs containing disturbed mummy bundles. Surface evidence suggests that there are a considerable number of tombs and/or grain silos across this terrace that are likely to be intact.

The remains of fish and shellfish were noted on the ground surface but there was no evidence of deep midden deposit. Pre-Columbian ceramics along with Colonial artefacts, possibly related to the War of the Pacific, were located on the surface and in silos and tombs and a quantity of maize was also found at the base of one silo. A bell-shaped, stone lined tomb contained the remains of a mummy. While disarticulated, the remains found in 2004 indicate that the body was placed in the tomb in a flexed, seated position, and wrapped in textiles. This mummy had been badly disturbed and was disarticulated. The cranium displayed signs of artificial deformation. Grave goods included a woven cane basket containing maize cobs and a *'chuspa'*, a woven textile bag, also containing maize cobs. A sample of bone taken from these remains returned a radiocarbon date of 635 ±30 uncalibrated years BP (human tooth, ANU27638), placing the burial within the Late Intermediate Period. Stable isotope levels suggest a terrestrial diet (-16.83 ±0.544 δ13C).

At this location, tomb construction required excavation to allow the placement of river cobbles to form a circular paved floor. The tombs were 'bell' shaped and it had a larger diameter at the based than the upper opening. The internal diameter at its base was over 1 m with the opening at the surface measuring 540 mm. Several other stone lined chambers were noted in this area but they consisted of straight sided chambers with the opening diameter the same as the base (approx. 1.4 m) and did not contain evidence of burials. The presence of maize cobs in one structure suggested these were used for storage.

Development to the east of Gallinazo Norte (the village of Chacalluta) did not enable the survey to determine the eastern boundary of the site. The collection of mummies from tombs at Chacalluta was recorded in 1851 (correspondence between George Duniam and the Australian Museum, 8 November 1851), so it is likely that this site extends well beyond the area surveyed.

A site known as the '*colcas*' (silos) is located ~5 km inland on the northern terrace above the Rio Lluta (pers. obs.). It contains a number (>20) of subterranean stone-lined silos, very similar in construction and topographic placement to those located at Gallinazo Norte.

Lluta 13 is site located on the slopes of the quebrada above the north bank of the Rio Lluta some 12 km inland. Lithic items found on the ground surface on the terrace below the slope indicated early occupation. I participated in excavations at that site in 2006 and 2008. Sixteen test pits were spaced across the sites at 5m intervals and established that the site covered at least 7000sqm. One trench was located within a house platform that was delineated by a line of river cobbles. The remains of hearths were located in several trenches.

An earlier survey, in 1999, showed that the sandy slope at Lluta 13 had clusters of river rocks, lithic flakes, marine shell and large fish bones scattered over much of the central part of the site. Concentrations of micro flakes indicate that knapping took place. Our test pits revealed successive layers of aeolian sand and ephemeral occupational lens from fishing, hunting and gathering coastal groups that camped there. A radiocarbon dating of a charcoal sample obtained from the bottom of centrally located test pit yielded a date of 3900±100 uncal BP (Beta 115430) with other dates ranging from the Late Archaic to the Late Period. Animal bones were common in association with hearths as well as spread through the deposit in other trenches across the site. Species included camelid, shellfish, crustacean, fish and birds. Crustaceans included unidentified crab and freshwater crayfish (*camaron*); and marine shellfish including *loco*, *almeja* and *cholga*. The remains of cultigens, including maize, cotton and chilli, were all excavated from the trench located within the house platform. Local plants, including *molle, algarrobo* and horse tail, were identified via fruit and seed remains found in three trenches. Santoro (2014, pers. comm.) has suggested that this site may have been transitional, containing evidence of the earlier hunter/gatherer/fisher phase that was shifting toward an economy supplemented, if not based, on agricultural produce during the late Archaic Period. Lluta 13 is also located adjacent to a Tiwanaku (Middle Horizon) Period cemetery.

A site known as Molle Pampa is located further inland (~18 km from the coast) and located on a bench above the Rio Lluta. Molle Pampa is an extensive site contains the remains of houses, tombs and a plaza delineated by stones brought up from the river terraces. Cultural material along with human and animal bone and plant remains are scattered across the site. The cultural material from this site has been associated with the Inka Period (C. Santoro, pers. comm.). Ceramics are indicative of the Inka style with small stylised llama appearing on many ceramics fragments. In 2008 I found a fragment of a *pucu* dish, identifiable by its stylised animal head and indicative of Inka style (see Bingham 1914: 266). Of note, camelid bone fragments were common across the site and suggests that camelid meat was part of the local economy. Maize cobs were seen on the site but the use of grain was indicated more so by the presence of numerous well-worn grindstones, often associated with house platforms.

There are numerous other similar sites along this section of the valley. From the coast at Gallinazo Norte to Molle Pampa, evidence suggests that the Rio Lluta was an agricultural centre, at least from the Late Intermediate Period but, as the evidence at Lluta 13 suggests, possibly earlier. This is in stark contrast to Caleta Vitor, where the presence of maize is obvious but not in the quantities observed along in the Lluta Valley. No silos have been located nor have any house remains. The village-like setting as found at Molle Pampa is not evident at Caleta Vitor, at least for some distance inland.

The Azapa Valley, which runs inland from Arica, contains a similar range of sites. There are numerous sites amongst the villages and farmlands but they are generally more disturbed than those in the Lluta Valley due to a greater intensity of modern agricultural activities. There are however, a number of sites containing the remains of villages and intensive occupation from the oldest site in the region at Acha, Formative period *tumúlos*, the *pukara* phase at the Pukara de San Miguel and the Alto Ramirez phase, Tiwanaku and finally the Late Period (Inka) (Rivera 2000).

Why did Caleta Vitor not develop along similar lines? There are likely to be a number of reasons. Firstly it is likely that the *quebrada* did not carry sufficient water to support intensive irrigation (it can today but that is with the benefit of mechanised pumps drawing subterranean water). The terraces flanking the stream in the Quebrada de Vitor are narrow and would not have supported broad areas suitable for cultivation, as are found along the Lluta and Azapa Valleys. Codpa, some 50kms inland, does support intensive agriculture and prehistoric terracing indicates that agriculture was developed in the past. Chaca, approximately 20km inland, also has a relatively broad floodplain and supports a greater intensity of cultivation today than does Vitor.

Another factor may be the nature of the coast line itself. The Rio Lluta enters the ocean across a sandy shoreline. An open sandy beach extends for 6 km to the south, near Arica town centre, and for at least 40 km to the north. It is not a sheltered beach and would not have been an easy location to launch boats nor to fish from. Surf clams (*macha*) were common along sections of this beach but a limited range of economically valuable shellfish species inhabit this shore line. Caleta Vitor contains a relatively short section of sandy shore with a rocky littoral to the north and south. Deep water lies just off-shore and the southern coast provides relatively sheltered water where boats could be launched and fishers would not have regularly faced surging waves. The coastline at Caleta Vitor - sandy beach and rocky littoral fronting deep water - provided a broad range of marine resources with far greater species richness than does a broad sandy shoreline.

The landscape at Caleta Vitor is similar to that found immediately to the south of Arica. The coast extending south from El Moro consists of a rocky shoreline at the foot of high cliffs. Deep water is relatively close to the shore and there are several sheltered coves within this area. There is a point ~6 km south of El Moro that provides some shelter when the seas are running from the south-west. The shoreline is accessible for some distance south of this point but the coastal terrace becomes very narrow in parts, broad enough for access but generally too narrow and rugged for settlement.

There has been some modern development (residential, recreational and industrial) along this section of the coast that has caused either the disappearance or disturbance of much of the archaeological deposit. However, Bird's investigation in 1943 contained sufficient results to show that extensive middens were located in this area. Even then, some were being targeted by developers for use as fill or simply removed to make way for new works. Bird's analysis of his excavated material did not go into great detail but there was sufficient to demonstrate that the middens there were similar in structure and composition as those at Caleta Vitor. This is hardly surprising as Caleta Vitor is located less than 30 km along the coast from this area and comprises much the same topographic setting.

The archaeological evidence from central Arica suggests that agriculture became a major economic component of those who had settled the local valleys. These communities became permanent and sedentary, established villages and serviced trade routes. There is a clear link with highland populations – as a likely source of the original cultigens as well as technological advancements such as the production of ceramics, textiles and metals.

Those living only a short distance away, the coastal population living on the very edge of the continent, continued with an economy based on abundant marine resources and supplemented with agricultural products. These two groups were culturally similar, probably dressed alike, performed similar rituals and had comparable burial practices. However, one group turned to the sea for their provisions and were thus a distinct sub-set within a broader population. That is not to say that their culture was static. The dynamics of human nature and contact with the 'other', those bringing goods from the highlands or seeking coastal produce, such as fish or guano, would have resulted in cultural exchange between these groups. It is highly likely that some highland traders made their homes on the coast and *vice versa*. However, many fishers and coastal communities chose to turn their backs on the land and not mix, in economic terms, with those who worked in the fields.

Ethnographic records relating to the Chincha 'kingdom' in south/central Peru, suggest that out of a population of 30,000 males, 6000 were merchants, 12,000 farmers and 10,000 were fishermen (Marcus et al. 1997: 6564). While goods were exchanged – fish and shellfish for grain and wool for shells, the Chincha maintained their own specialisation and while fishermen did not grow their own food, they did cultivate cotton for nets and reed for boats. A similar situation was also recorded further south, as far as northern Chile where 'settlements of fisherfolk in Mocquegua, Tacna and Arica and southward into the Atacama were established along the littoral zone and around the mouths of coastal river valleys forming particular villages under the authority of their own figurehead' (Zaro 2007: 163). The archaeological evidence from Caleta Vitor suggests that this particular political and economic scenario may have existed there. Ethnographic research may be able to take this discussion further.

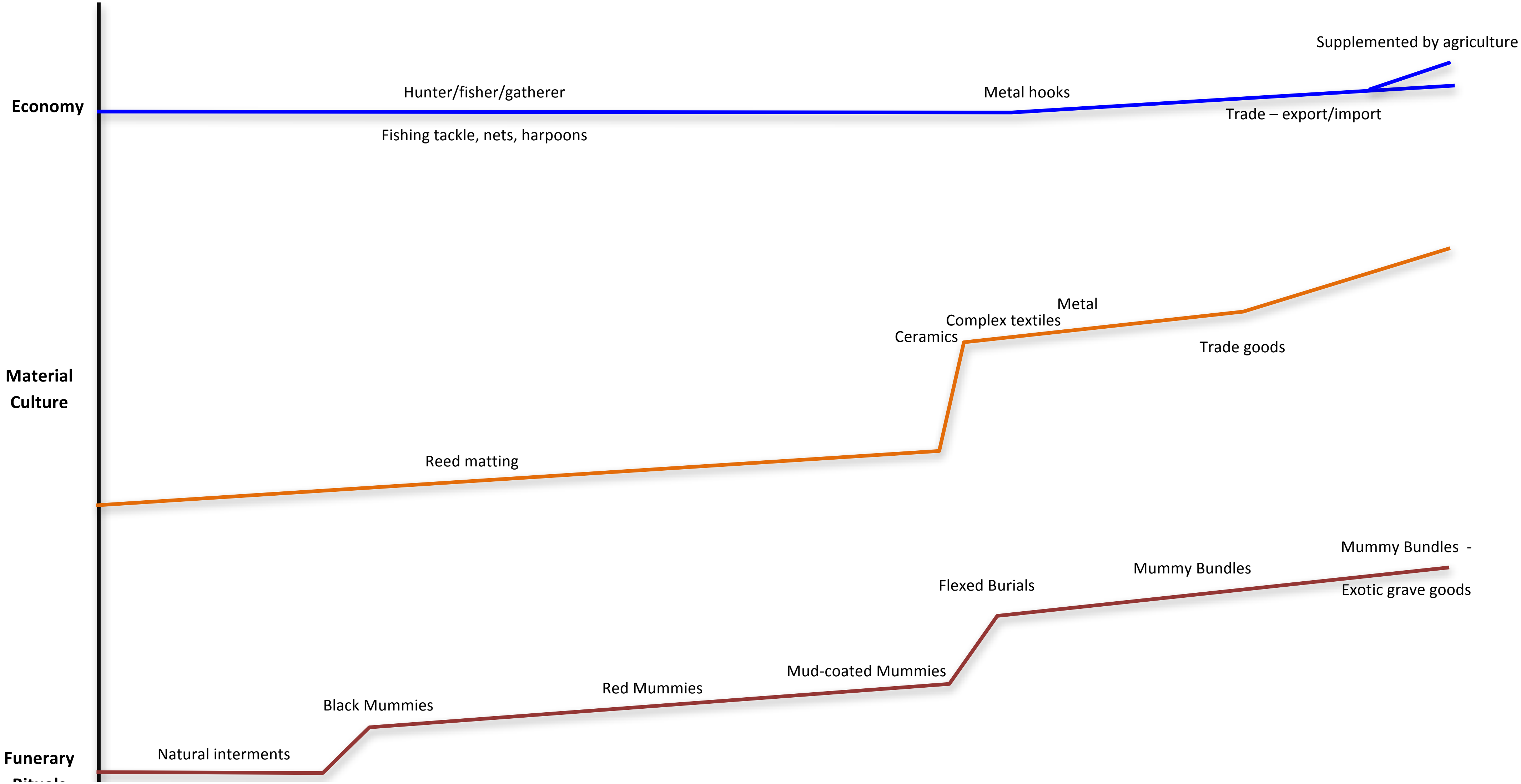
There is no evidence of highland/inland materials during the Archaic Period (9000-3500 BP) at Caleta Vitor. I believe that this lack of evidence along with the evidence of an early Holocene marine based economy supports, at least to some degree, the coastal migration theory – in terms of both the migration route and the economy of the original settlers. The evidence from coastal sites in North America dating from the late Pleistocene (particularly on the Channel Islands, California) indicated a well developed marine based economy and the ability to navigate some distance off-shore. While the distance between Caleta Vitor and these sites, there is no reason why the legacy of the early occupants of the Channel Islands could not have eventually made its way that far south. Furthermore, the waters off Caleta Vitor host a range of kelp species that helps support a diverse and flourishing biomass and tends to complement the 'Kelp Highway' hypothesis proposed by Erlandson et al in 2007.

Sites in southern Peru do contain material sourced from some distance inland but it may have been the result of a displaced community suffering the impact of *El Niño* events, events that are more severe to the north. Rising sea temperatures, reduced upwelling and flooding may have disrupted resource availability and forced the occupants to look elsewhere, at least for a time. This does not appear in the evidence at Caleta Vitor. The rain shadow effect of the Andes did not produce floods as severe as those that were recorded in central and southern Peru. The impact of increased water temperatures and reduced upwellings did not have as severe an impact in the south as it did in Peru and further north. The *El Niño* event of 1982-83 provides a good example - the sardine fishery of Ecuador suffered significantly; the impact in Peru was far less and the catch in northern Chile actually increased (Barber & Chávez 1986: 284).

Figure 14.2 contains a graphic depiction of the hypothetical trajectories of cultural developments at Caleta Vitor from 9000 BP until the arrival of the Spanish. This depiction highlights the relatively abrupt changes that occurred as funerary practices changed and new elements appeared with the material culture. The economic trajectory does not display similar change. It appeared 9000 years ago within a well-developed regime and this continued for several thousand years and then the improvements did not result in any profound change. A slight improvement may have occurred when metal hooks were introduced or following improvements to watercraft. There is no apparent change that corresponds with the arrival of agricultural products. The increased incidence of maize during the Late Period is matched by an increase in the deposit of fish and shellfish remains. Cultivated products were only supplementary to the main economy.

The residents of Caleta Vitor during the pre-Hispanic period were part of a longitudinal cohort, that is with connections running north/south, reliant on the sea not only for their basic necessities but also their sense of place and community. The Chinchorro funerary practices are a clear display of this early cultural phase. The development of a specific economy related to a particular environment did not mean that one occurred in place of the other or that they were mutually exclusive. The coastal fringe continued a tradition based on the sea while the highland/inland cohort relied on a completely different suite of resources. Local, cultural connections were initially via the coast, via walking trails or on watercraft. Later highland influence brought changes to the local material culture but did little for the economy – apart from providing a market for marine based resources.

The archaeological evidence from Caleta Vitor, particularly during the early, developing periods, clearly demonstrates the coastal connections – none more so than the funerary practices that appear on the coast and not inland. It is clear that there was cultural exchange between inland and the coastal populations – the changes in material culture and mortuary practices attest to that. The evidence of the presence of camelids indicated trade, via caravans, with inland populations. Did that contact and exchange include the entire economy? It appears not. Marine resources were favoured over agricultural products at Vitor and continued to be exploited and may have even an important trade commodity and driving force behind inland contact.


Economy
Hunter/fisher/gatherer
Fishing tackle, nets, harpoons
Metal hooks
Supplemented by agriculture
Trade – export/import
Material
Culture
Reed matting
Ceramics
Complex textiles
Metal
Trade goods
Funerary
Natural interments
Black Mummies
Red Mummies
Mud-coated Mummies
Flexed Burials
Mummy Bundles
Mummy Bundles -
Exotic grave goods

While those at Caleta Vitor certainly had contact with and/or traded with inland communities, their affinities lie with those groups who occupied similar environmental niches along the coast, particularly where the *quebradas* cut through the coastal range to the shore line. Those living in such locations were restricted in the range of the resources available to them, restricted in the range of their habitations (primarily by the presence of water), and focussed on maintaining a stable economy while developing it as techniques and technology improved.

The archaeological evidence available at Caleta Vitor is substantial and only a small portion is included herein – both in terms of geographic spread and in volume of material excavated. While far more detailed analysis could have been undertaken, temporal and financial constraints prevented this from occurring. However, more specialised research is on-going and includes the analysis of textiles (Tracy Martens, ANU); ceramics (Catherine Bland, Flinders University, South Australia); stable isotope analysis of human remains (Bianca Petruzzelli, Flinders University) and otoliths (Morgan Disspain, University of Adelaide).

While more general in nature, this investigation has shown that the early inhabitants arrived with a tool-kit and the techniques that allowed them to successfully exploit local resources. The economy was well established over 9000 years ago and persisted throughout that time. Over time, economic adaptation was minimal as there was no real need to modify it. Technological advances, such as metal hooks, improved watercraft and access to better fibres for fishing lines, may have resulted in more large fish being caught, fishing grounds extended and/or an increase in the range of target species, however the occupants of the settlement remained economically resilient.

Although the regional economy has changed greatly, many still rely on the sea for their livelihood. The resources that provide for this segment of the community differ little than those of the pre-Hispanic inhabitants; the techniques employed to harvest them are much the same; and the technological advances have been built on a tradition with little real change. Fish are still caught in nets and on hook and line; shellfish are collected along the coast - harvested by hand from sandy beaches, collected from the rocky shores or gathered from the sea floor by divers. Improved materials and equipment may have increased catch rates but a trend that began several thousand years ago continues unabated.

* * *

In retrospect, we can visualise the course of prehistoric life in Caleta Vitor as follows:

Over 9000 years ago, possibly as early as the Late Pleistocene, a small group of people explored the coast of what is now northern Chile. Much of the coastline was flanked by precipitous cliffs fronting open ocean and there few available sources of fresh water. When this group came upon what is now known as Caleta Vitor, they chanced upon a broad beach with an open gorge that incised the coastal range. An ephemeral watercourse flowed along the valley floor, several springs seeped from the valley sides. The water supported stands of vegetation including *algarrobo*, *molle*, *tomatillo,* cotton and various reeds. Sea-lions, penguins, otters and numerous sea-birds inhabited the rocky shoreline. Shoals of fish were revealed by feeding birds, sea-lions and dolphins. While the beach was washed by powerful waves, a headland to the south provided shelter where watercraft could land. This location was able to provide resources enough to sustain an economy that had its origins much deeper in the past – originating with the ancestors of these early settlers as they had migrated southward along the west coast of the Americas from the far north.

The economy of these early settlers was well developed when they arrived, all that was necessary was to adapt to this new landscape. The coastal desert extends well into southern Peru so the explorers moving south from that region encountered similar settings. Familiar resources were abundant, the majority commonly found where they had come from. All that was required was for the fishers, hunters and gatherers to become familiar with the new landscape and settle in. Exploration further afield, both inland and along the coast would have added to the resource base as well as maintaining contact with older settlements to the north, and newer settlements to the south. This enabled them to maintain a cultural base through the exchange of ideas, resources and people.

The first inhabitants of Caleta Vitor brought a cultural regime that was well established and that had evolved as they moved down the coast. They buried their dead in the manner that they were familiar with. The treatment of the deceased gradually became more complex as the simple, dehydrated bodies were altered and preserved in a complex process of mummification. The common practice of dealing with the dead provided a link between groups that eventually extended for some distance along the coast, both to the north and south. However, these common links did not extend inland – this was a coastal phenomenon.

This coastal population continued to live along this section of the coast for several thousand years with little apparent change to either their culture or economy. Around 3500 years ago explorers or traders from the inland made contact with the coastal group. They introduced ceramics, more complex textiles and domesticated plants and animals. Theirs was a different culture and economy based on farming and trading. This brought about a significant cultural shift at Caleta Vitor.

Over time, the population increased as did contact with highland polities. Caravans using llama to carry goods in and out from Caleta Vitor introduced exotic goods and carried out marine products. Technological advances included pottery and metallurgy which resulted in the development of local industry. Textiles became more complex during the Middle Horizon. Cotton was grown locally and textiles were woven on-site.

Despite these major cultural shifts, the economy remained clearly focussed on the sea. Indeed, if anything, the exploitation of marine resources increased – both to satisfy local demand and for trade. Deposition rates, based on dates from the Late Period 9CV4/1, CV6) increased substantially.

Until the Spanish arrived, to eventually cause great social upheaval, the economy that was initially established at Caleta Vitor required little modification. The simple techniques that they employed were efficient, the resources were at hand and, cooperatively, could be harvested by almost the entire population. Children could help their parents forage in the shallow sheltered waters of the *caleta*, older folk could assist with the processing and preparation of their food. Groups would have worked together to make nets and then use them to catch fish from the beach. Individuals dived from the rocky shore to collect shellfish, anglers and hunters took to the sea in watercraft to seek larger prey. The result of their actions lies in the extensive middens that spread over large areas at Caleta Vitor. These middens contain evidence of the broad range of resources that were available and included fish, shellfish, crustaceans, marine mammals and birds along with local plant species. The range and abundance of these resources does not appear to have fluctuated greatly nor diminished during the prehistoric period.

It is clear that social and ritual change along the coast was influenced by highland cultures. However, as far as the economy is concerned, it was likely that inland groups were motivated to come to the coast to acquire marine resources while the community at Caleta Vitor remained focussed on the sea and did not depend on trade goods coming from the inland.

Fluctuations in the environmental conditions, particularly those brought about during *El Niño* events, did not have a severe effect on the economy. Perhaps Caleta Vitor was beyond the reach of all but the most severe events, or perhaps it was the nature of the Humboldt Current in this particular area that allowed the nutrient levels to sustain resources and support a local economy with little or no disruption to the inhabitants. Caleta Vitor provided an Arcadian setting with resources sufficient to sustain their preferred economic base.

* * *

To conclude, I submit the following in answer to the questions initially proposed in this thesis:

I. *The gap in the archaeological record along this section of the coast;*

The archaeology at Caleta Vitor provided a significant quantity of material to ably demonstrate the continuum of early settlement along this section of the coast. The results of this investigation have attracted further on-going research and this is likely to continue for some time to come.

II. *The significance of the impact of El Niño events in this region;*

Caleta Vitor does not appear to have been unduly impacted by *El Niño* cycles in the past. Resource richness is such that the economy could withstand all but the most severe events.

III. *When the first people settled this region of South America and their migratory pathway;*

The first settlement of Caleta Vitor occurred at least 9000 years ago. I believe that the evidence complements the coastal migration theory.

IV. *The faunal composition, structure, and dynamics of the middens at Caleta Vitor;*

The middens at Caleta Vitor are extensive and are composed of the remains of a diverse and complex range of marine resources. They are indicative of intensive marine exploitation, focussing on a wide range of marine habitats – from the shore line and further out to sea.

V. *Whether the development of the local economy was an adaptive mechanism of early, more generalised hunter/foragers or if it was developed earlier, elsewhere and introduced by the first settlers?*

The first settlers of Caleta Vitor had a well-established marine based economy that had developed earlier – likely during the Late Pleistocene, developing as explorers moved southward along the coast from North America.

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