THE SHELL MIDDEN AT ANMYON ISLAND; A STUDY OF THE KONAM-RI SHELL MIDDENS, KOREA AND THEIR BROADER SIGNIFICANCE

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This thesis is concerned with the four Konam-ri shell middens dating from the Neolithic and Bronze Age on Anmyön Island, Korea. Various methods are used to interpret the middens.

Following a summary of Korean geology and natural environment, the present state of knowledge of Korean prehistory is reviewed, and the excavations on Anmyön Island are described. The artefacts and structures found in the middens are studied in order to locate the sites in the chronological and cultural context of Korean archaeology. The animal and plant remains are analyzed to reconstruct the past local environment, subsistence economy, technology and strategy of food preparation and to identify the function of the middens. Finally, C-14 dates are given to provide absolute date to the sites.

The subsistence economy of the Neolithic midden (A-2) could not be reconstructed due to extensive disturbance by farmers, however it is concluded that the subsistence economy represented by the Bronze Age middens (A-1, B-1 and 2) depended on farming with occasional exploitation of wild resources such as molluscs, mammals, fish, birds and wild plants. Despite the abundance of marine shells in the sites it is estimated that the role of shellfish in the total diet of people who formed the middens was not significantly important. The analyses of archaeological evidence and animal and plant remains recovered from the sites suggested that the Bronze Age middens were home-base sites occupied year-round. The Neolithic midden was dated
to about the 15th century BC and the Bronze Age middens somewhere around the 8th-5th centuries BC. Evidence from animal and plant remains indicated that the prehistoric local environment was generally similar to that of today.
INTRODUCTION

In Korea, many Neolithic and Iron Age shell middens have been found mainly along the south and west coast with some on the east. Some have been excavated and so far all such studies have emphasized chronology and cultural sequences. As Korean archaeology is a relatively new discipline, it has been of primary importance to attempt to set up a regional chronological framework in order to develop a basic framework for the prehistory of Korea. As a result there have been few attempts to reconstruct past environment and subsistence patterns which are very important factors in the understanding of prehistoric culture and human behaviour. In general these shell middens, except those on the west coast, contain well-preserved animal and plant remains which offer a great potential for reconstructing past environment and economies.

Bearing in mind these points, I will review the main approaches which have been adopted in shell midden studies, and their associated problems. As a case study, using some of these methods, I will attempt to reconstruct the subsistence patterns, past environment and the function of the midden represented by the Konam-ri shell middens on Anmyŏn Island, Korea.

1. A BRIEF REVIEW OF SHELL MIDDEN STUDIES

The term 'midden' comes from the Danish Køkkenmødding, kitchen midden for a refuse heap, and is still used in England for a farm yard manure heap. Shell middens were
formed by people exploiting molluscs as a food resource. They consist of food debris, above all mollusc shells, but may also include mammal bones, fish bones, plant remains, settlement structures, burials and various kinds of artefacts.

The earliest evidence of human exploitation of molluscs has been found at Palaeolithic sites such as Terra Amata in France (300,000 years ago) where small amounts of oyster, mussel and limpet shells were recovered (de Lumley 1972:37). The oldest shell middens found are in the coastal South African caves and open-air sites dated between 130000 and 30000 years ago (Volman 1978; Shackleton 1982). Shell middens appear world-wide during the Holocene when sea-levels stabilized at levels close to those of the present.

Shell midden studies have a long history, dating back to the mid-nineteenth century especially, in Denmark (Andersen and Johansen 1986). By the end of the last century, systematic excavations were begun at the Ertebølle shell midden in Denmark which became the type site for the latest phase of the Mesolithic of Northern Europe - the Ertebølle culture (ibid.).

**Quantitative approaches:** Quantitative approaches have been applied in midden studies to obtain information on the midden formation period, the total population involved in the midden and more recently ecological interpretations on the midden. The approaches are based on quantitative analysis of samples from midden sites.
Although quantitative studies of middens has long history, modern approaches were pioneered by California School of midden studies. In America, Nelson (1909) and Gifford (1916) first quantified the components of middens and estimated the duration of occupation of sites on the basis of midden samples. Cook (1946; Cook and Treganza 1950) estimated population size involved in the formation of a midden site using quantitative methods. The Nelson-Gifford-Cook tradition, usually referred to as the California School of midden analysis, has contributed to midden studies by pioneering quantitative methods in research.

Although the quantitative approaches to midden studies have proven valuable, three major factors weaken the results (Bailey 1983, Ceci 1984 and Waselkov 1987). These are pre-depositional factors such as variations in the productivity of intertidal and inshore habitats: discard behaviour affecting the location, accumulation rate and spatial distribution of shells: and post-depositional factors such as destructive agencies, for instance natural erosion, bioturbation and human disturbance. These factors may influence an entire midden, or be limited to certain parts and therefore must be considered when interpreting the content of a shell midden. However these data can be discovered by quantitative analysis of shell middens.

Studies on midden formation process: Studies on formation and post-depositional processes can lead to an understanding of midden context and the human behaviour
involved in midden formation. Ethno-archaeological studies can help us to understand shell midden formation and transformation through analogy. Perhaps the most important study of shell midden formation processes has been made by Meehan (1982) through her ethno-archaeological study in the Northern Territory of Australia. According to her the remains of shellfish consumed by the Anbarra people result in three types of sites: 'dinner-time camp', home-base and processing sites (ibid.:112-8).

A detailed examination of midden deposits may be also useful in the understanding of midden formation processes. For example, when Koike (1980:85-94) interpreted midden deposits, she tried to distinguish primary and secondary shell deposits by using clam shell (Meretrix lusoria) growth-line analysis: primary deposits consist of the shells collected in a particular season and retain their stratigraphic sequence of seasonal deposition; whereas, secondary deposits contain mixtures of shells collected at different seasons, suggesting that they include shells falling into the deposit from neighbouring deposits, which have been disturbed by natural or human agencies. She then tried to infer shell discard activities of the Jomon people by using the same growth-line analysis. The shell deposits within an abandoned Jomon dwelling pit in Natsumidei, for example, had a stratigraphic sequence of seasonal deposition, suggesting that the prehistoric Jomon people continuously used the depressions of abandoned pits or dwelling pits as refuse places. Although this method is very useful for interpreting midden contexts, it cannot
easily be adopted in the field because it requires much
time and financial resources to prepare sections of shells
for growth-line analysis. This method is also limited to
areas with distinctive seasonal variations in sea
temperatures allowing shells to develop distinct annual
growth-lines.

**Sampling methods:** Sampling methods and procedures are also
important in order to obtain proper data for the
quantitative analysis of middens. To get totally accurate
results, a site should be completely excavated to recover
all components, but total excavation, especially in the
case of a large site, is almost impossible due to lack of
time and finance. Consequently sampling methods have been
used. Column and bulk sampling methods have been adopted
to collect midden samples in a probabilistic or non-
probabilistic manner according to sampling strategies.
These include random or systematic sampling throughout
middens; stratified random sampling or stratified
systematic sampling (see Treganza and Cook 1948; Bailey
1975; Barz 1977 quoted by Bowdler 1983; Bowdler 1983;
Peacock 1983; Finlayson and Bellhouse. 1986; Waselkov 1987
for detailed procedures, advantages and drawbacks of each
sampling method). However none of these methods can ensure
of the recovering of rare components which may be unevenly
distributed through the midden.

**Environmental studies:** In recent years one of the aims of
shell midden studies has been to reconstruct past local
environments based on the animal and plant remains
recovered from midden sites. A study of the habitat preferences of individual shell species and their shell morphology, can provide information on past sea environmental conditions, and the areas from which shellfish might have been collected (e.g. Andrews et al. 1985). Several attempts have been made to infer mollusc gathering areas and past marine environments on the basis of shell morphology: e.g. using oysters (Kent 1988), limpets (Mellars 1978) and dogwhelks (Andrews et al. 1985).

In addition, the analysis of small organisms attached to shells provide additional information on the areas from which the molluscs were collected because many marine organisms have rather specific salinity ranges (Kent 1988:39). Five groups of epibionts, for instance, appear to be suitable to estimate of the habitat of oysters (ibid.): sponges in the genus Cliona, polychaete worms in genus Polydora, encrusting ectoprocts, boring bivalves and barnacles.

Reconstruction of subsistence patterns: A detailed study of changes in the distribution, abundance and size of individual shell species throughout the sequence of a midden can provide some information on changes in dietary preference, the technology used to collect shellfish, environmental changes, and the intensity of human exploitation of shellfish resources (Branch 1975; Voigt 1975; Shaw 1978; Glover 1986; Shackleton and van Andel 1986; Kent 1988)
It is impossible to reconstruct total subsistence patterns of any past human populations from shell midden studies alone because the information can never be complete. Several factors weaken the results of dietary reconstruction (Bailey 1975:47-8): these are differential preservation of food remains; different seasonal occupations; different food refuse discard behaviour; and unevenly distributed populations in the midden.

Shell middens contain various food remains in addition to molluscs and, due to relatively good preservation of molluscs compared to other food remains, the role of shellfish in the total diet of people can be overestimated. Recent workers have tended to interpret the role of shellfish as a supplemental resource (Bailey 1975; Meehan 1982; Buchanan 1988), whereas some earlier researchers such as Meighan (1969) saw molluscs as a major food resource, even a staple food at least on a seasonal basis.

If we try to estimate the role of shellfish in the total diet, it should be done on a seasonal basis, especially in areas such as the temperate coasts with seasonal variations in food availability, because there is a high possibility that shellfish can make great contributions to the diet for short periods and during lean seasons. Today in Korea, for example, shellfish is highly consumed from autumn to spring. In fact, the midden evidence from prehistoric Korea and Japan may reflect the important dietary role of marine resources including shellfish, although few middens in these areas have been
well studied from this perspective, these shells might be consumed during this period.

**Seasonality of shellfish collecting:** There are other factors which affect shellfish collecting: seasonal preference for particular shellfish species; the breeding cycles of various species; and natural variables such as red tides (Buchanan 1988).

Two techniques are used to infer the season of shellfish gathering using marine shells: growth-line analysis (Coutts and Higham 1971; Clark 1974; Koike 1980; Deith 1983; Rollins et al. 1987) and oxygen isotope analysis (Shackleton 1969 and 1973; Killing 1981; Deith 1983 and 1985; Godfrey 1988).

I have briefly reviewed various approaches involved in shell midden studies to give a theoretical and methodological background to this study of the Konam-ri shell middens. Although these approaches have been adopted by midden archaeologists to interpret midden sites, there has been a lack of synthetic study bringing them together for the interpretation of midden sites. If one of the purposes of archaeology is to reconstruct the past, any one of these approaches if adopted individually is insufficient to accomplish that purpose. Instead, a synthetic approach is required to interpret a shell midden more precisely on the basis of a study of not only artefact assemblages but also animal and plant remains in addition to these approaches which I have reviewed above.
I attempted to interpret the Konam-ri shell middens from this perspective.

2. AIMS AND STRATEGIES

My thesis aims to obtain information on the cultural sequences, the function of the middens, the past environments at the sites, the subsistence economy, and human behaviour involved in the formation of the Konam-ri shell middens.

In 1983, as a result of a field survey in the western coastal area of Korea Bronze Age shell middens were found on Anmyŏn Island (Kim 1983), indicating the possibility of obtaining valuable archaeological and environmental evidence. Because few Bronze Age shell middens had previously been discovered in Korea, it had been considered that Bronze Age people did not depend on shellfish. On the other hand, there have been suggestions that Bronze Age middens might have been covered by rising sea-levels. The discovery of the Konam-ri shell middens in 1983 offers opportunity to obtain archaeological and environmental evidence to examine these hypotheses.

There is an argument concerning the difference in midden composition between those on the south coast and those on the west coast of Korea. Very few animal bones have been recovered from shell middens on the western coast, compared to those on the south coast. The difference has been interpreted as reflecting either cultural differences related to food preferences between the two regions, or functional differences of those
middens. This will be examined on the basis of artefacts and animal and plant remains recovered from the Konam-ri middens.

Finally, my research also aims to obtain archaeological evidence to understand the prehistoric culture of the western Ch'ungnam area: the prehistoric archaeology of this region is not well known in comparison to other areas. The strategies for obtaining this information were as follows:

Firstly, the Konam-ri shell middens were excavated under the supervision of Sim Kwang-ju in 1988 and by myself in 1989 to recover cultural artefacts and non-cultural materials (the excavations were supported by the Hanyang University Museum, Seoul).

Secondly, several bulk and column samples were taken from the middens in order to analyze the midden components and to recover small components such as fish scales, land and marine molluscs, bones and plant remains.

Thirdly, samples for pollen analysis were also collected from the middens to reconstruct past environment at the sites.

Fourthly, artefacts were studied to understand the cultural sequences of the middens.

Fifthly, non-artefactual components such as molluscs, animal bones, plant remains were examined and analyzed in order to reconstruct the subsistence patterns and past environment represented by the middens.

Finally, the function of the middens was examined on the basis of data obtained by studies on artefacts and natural midden components.
The thesis consists of eight chapters. Chapter 1 provides a general introduction to the natural environment and prehistory of Korea. Chapter 2 describes the present natural environment and economy of Anmyŏn Island, and archaeological work there (with a detailed description of the midden excavations of 1988 and 1989). Chapter 3 deals with artefacts recovered from the middens. Chapter 4 contains quantitative analysis of the midden components. Chapter 5 deals with the animal remains recovered from the middens, including marine and terrestrial molluscs, mammals, birds, fish and so on. Chapter 6 discusses plant remains recovered from the middens. Chapter 7 provides the results of radiocarbon dates on shells and wood charcoal. Chapter 8 includes volumetric analysis and the estimation of the role of shellfish in the diet of people who formed the middens. Chapter 9 discusses the cultural sequences of the middens, based on results of archaeological analyses and radiocarbon dates, past subsistence patterns, environment and function of the sites. It ends by stressing the importance of this research for the prehistory of Korea.

Two excavation reports on the Konam-ri shell middens have already been published (Kim and An 1990; Kim and Sim 1990).
1. GEOGRAPHY AND PREHISTORY OF KOREA

1.1. GEOGRAPHY OF KOREA

Korea is a peninsula protruding in a north-south direction from the eastern part of the Asian continent, surrounded by the East Sea (Japan Sea) to the east, Yellow Sea to the west and South Sea to the south. It is located between 33°06'—43°01'N and 124°11'—131°53'E, has an area of about 221,000 square km (including the mainland and about 3,300 islands) and is about 300km wide and about 1,000km long.

Geologically Korea has various structural formations, ranging from the Pre-Cambrian to the Cenozoic (Table 1.1), but it is largely composed of Pre-Cambrian rocks such as granite and gneiss, and Mesozoic granite. It is believed that the Korean Peninsula reached its present shape after several geological events between the end of the Cretaceous and the early Paleogene (O. Kim 1987:13). The Tertiary sequences are distributed in a few basins along the east coast and in some areas in the west coast. The Quaternary alkali basaltic volcanic activities are confined to Mt. Paektu, the Ch'ugaryong Rift Valley in the north, and Ullúng and Cheju Islands off the south coast (ibid.).

The topography of Korea is rugged, consisting of about 70 per cent of mountainous terrain. However, the landscape is characterized by flat hills created by long periods of weathering and erosion (there has been little uplift since the Jurassic and Tertiary Periods (Lee et al. 1974:3)). As a result the landscape shows generally evolved forms of a mature stage. The average height of the
country is 482m and the highest mountain, Mt. Paektu, is 2,744m.

The peninsula is bisected by the Ch’ugaryŏng Rift Valley (Fig.1.1). The Valley, supposedly formed during the Bulguksa Disturbance of the Cretaceous Period, marks a major topographic contrast between the northern and southern part of the country: the northern part is generally higher with steep mountainous terrain (B. Kim 1987:7).

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<thead>
<tr>
<th>Geologic Time</th>
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<th>Igneous Activity</th>
<th>Tectonic Movement</th>
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Table 1.1 The major stratigraphic units and tectonic movements in Korea (from O. Kim 1987:14).
The peninsula also shows topographic contrast between the eastern and western zones by mountain ranges running in the "Korean direction" (north-south), such as the Nangnim and T'aebaek ranges. The eastern high mountainous area has very steep slopes running into the sea. Rivers and plains are poorly developed in this region. On the other hand, the western and southern parts have very gentle low hills, long meandering rivers and well developed alluvial plains along the rivers (B. Kim 1987: 7-9).

Fig. 1.1. Mountain ranges in Korea (from B. Kim 1987:8).
The coastline in the eastern part is generally steep and straight with a narrow continental shelf, while the southern and western coast have irregular shorelines forming small peninsulas, bays and islands. The contrast between the topographic features of the western and southern coasts and the eastern coast indicates an uplift of the eastern part of the peninsula and the submergence of the western part of the peninsula (B. Kim 1987:9-10). The high tidal range (up to 8.6m in Inch'on) of the Yellow Sea has developed broad tidal mudflats (which have been important for fisheries in this region since the prehistoric periods). Many prehistoric shell middens found in this area are composed of shells from the intertidal zones.

Korea has a humid East Asian monsoon climate. It has four seasons. Winter is cold and dry caused by the influence of the Siberian high pressure cell. The mean temperature during the coldest month in the winter (January) is between about 2.5°C and about −20°C. While summer is hot and rainy due to the influence of the Pacific high. The mean temperature during the hottest month in the summer (August) is between about 20°C-25°C. Spring and autumn are the seasons of transition from winter to summer monsoons and vice versa. The average annual temperature is about 2-14°C; the average annual temperatures in the southern coast and in the northern coast are about 14°C and about 8°C respectively, while in the Kaema Plateau it is about 2°C (Fig.1.2). The annual range of temperature between the hottest and coldest
months for Korea is about 21-44°C. The range of temperature is much greater in the north and in the interior than in the south and along the coasts (Kim 1973:32-4).

Fig. 1.2. Mean annual temperature (°C) (from Kim et al. 1973:381).
The average annual precipitation in Korea ranges from about 500–1,500mm. The amount of rainfall decreases from south to north. The rainfall pattern of Korea is characterized by a dry season from October to March and a wet season from April to September. About seventy per cent of the total precipitation falls between June and September.

Korean soils mostly derive from granite and gneiss which are the main land rocks of the peninsula as mentioned above. Light brown and sandy acid soils are common in the soils derived from granite, and clayey brown to red soils are common in the granite gneiss areas. Limestone-origin red soils are found in the areas of Kangwon and northern Hwanghae Provinces. Black volcanic soils are common in Cheju and Ullüng Islands, and northern Kangwon Province. Podozolic soils are also found in northern mountain areas. Artificial soils, such as cultivated—especially paddy—soils, have developed as a result of farming activities over long periods (Jeong et al. 1983: 30).

Owing to great variation in the natural environment, especially in temperature and rainfall, the modern vegetation in Korea can be divided into three major vegetation zones: warm temperate vegetation, cool temperate vegetation and subarctic vegetation zones (Yim 1968). The cool temperate vegetation zone is divided into three sub-zones: northern, central and southern zones. The southern coast and the offshore islands such as Cheju and Ullüng Islands, are regions where warm temperate evergreen
plants grow abundantly. Broad-leaved deciduous trees are predominant in the cool temperate vegetation zone of central part of Korea, while in the north and high mountain areas, many alpine plants grow (Fig.1.3).

Fig. 1.3. Vegetation map of Korea (from Yim 1968).
A: warm temperate forest zone. B: cool temperate forest, southern zone. C: cool temperate forest, central zone. D: cool temperate forest, northern zone. E: subarctic forest zone.
The fauna of Korea can be divided into two regions: Sub-Siberian and Sub-Chinese (Lee et al. 1974:16-7). The Sub-Siberian region occupies mountainous high latitude areas with a climate similar to that of the Amur River region. Animals in this region are related to those of Manchuria, mainland China, Siberia, Sakhalin and Hokkaido and include deer, roe deer, Amur goral, Manchurian weasel, brown bear, tiger, lynx, northern pika, water shrew, muskrat, Manchurian ring-necked pheasant and so on. The Sub-Chinese region is in a low latitude area with a mild climate and is inhabited by animals of the temperate zones such as black bear, river deer, mandarin vole, white-bellied black woodpecker, fairy pitta and ring-necked pheasant (Jeong et al. 1983:39).

1.2. QUATERNARY PALAEOENVIRONMENTS

The Quaternary palaeoenvironments of Korea have not been studied in detail. Although some very limited traces of the Pleistocene glaciers in the Korean peninsula have been detected (Yi 1973:51), generally speaking none of the larger continental glaciers seem to have extended to Korea during the Pleistocene Period. However during that period, sea level would have changed several times mainly due to the eustatic changes. The Yellow Sea did not exist due to the marine regressions during glacial periods (Park and Bloom 1984, and Bloom and Park 1985). The latest maximum regression was around 18,000 years ago when the sea level of the Yellow Sea was about -130m (Chang and Cheong 1987:3). As a result, during that time the Korean Peninsula was
connected to China across the Yellow Sea, allowing human and animal migrations. In addition, it is thought that there was also a land bridge between the Korean Peninsula and Japan, and that the Sea of Japan was once a lake (Fig.1.4).

Fig.1.4. Palaeocoastline (135-150m isobaths below the present sea level) around 18,000 BP (from Park 1987: 422).
There has been little study of the changes in the fauna and flora of the Korean Peninsula during glacial and interglacial periods, thus detailed palaeoenvironmental reconstruction is not yet possible. However, data have been accumulated, most of it recovered recently from Pleistocene archaeological sites, and has been studied with a view to environmental reconstruction, shedding some light on the Pleistocene environment of the Korean Peninsula.

Archaeological and palaeobiological evidence from the Lower Pleistocene Period has not yet been found (Yi 1988). Faunal remains of the following Middle Pleistocene period, especially in terms of the existence of extinct sub-tropical animals in Korea such as *Macacus robustus*, *Rhinocerotidae* and *Bubalus* sp., indicate that the temperature during that period was warmer than the present day (Bae 1989:2-4).

During the Upper Pleistocene Period it seems that the Sub-Siberian faunal region might have extended to the northern part of Korea (Bae 1989:5). Animals living in cold or warm conditions however have been found together or separately from sites formed during this period, possibly reflecting no significant differences of temperature between glacial and interglacial stages during the Upper Pleistocene Period (Pak 1983:176-9). Mixed deciduous and coniferous forests dominated by broad leaved deciduous species indicate generally warm temperatures (ibid.).

After the last glacial maximum of the end of the
Pleistocene Period, sea level rose worldwide due to the melting of the great ice sheets. It is believed that the sea level of Korea rose rapidly between the early Holocene and around 6,000-6,500 BP (Park 1969; Park and Bloom 1984; Bloom and Park 1985; Jo 1987). Subsequent changes in sea levels are, however, still open to question. The Sea of Japan has been relatively stable at the present sea level, with little fluctuations during the past 6,000 years (Jo 1987:174-8). There are two major interpretations on the trend of sea level changes of the Yellow Sea: one is that the sea level of the Yellow Sea has risen during the past 6,500 years, showing a smoothly rising curve (Park and Bloom 1984; Bloom and Park 1985); the other is that the sea level of the Yellow Sea rose above the present level at about 6,000 BP (Jo 1987:178-81). Some evidence of higher sea levels during that period has been suggested (Yoon et al. 1977; Chong et al. 1981; Sohn 1982; Yoon and Yi 1985; Chang 1988), but further detailed study with a large number of absolute dates is required to settle this controversial problem.

In addition to changes in sea levels, the changes in other factors of the marine environment such as salinity, temperature and wave rate, etc. are important because such changes may affect the availability of marine resources which people have exploited. Chang and Cheong (1987) have attempted to reconstruct the Holocene palaeoenvironments of the Middle Yellow Sea based on micropalaeontological analysis of cores obtained from the study area, and have provided invaluable light on the palaeoenvironmental
changes of the Yellow Sea during the Holocene. According to them, the palaeoenvironment of the Yellow Sea depends on influences of the open sea (Palaeo-Kuroshio Current). Strong influences of the open sea are noted during the Early and Middle Holocene, resulting in normal marine conditions with higher salinity and temperature than those of the present. Later, the influence of the open sea was reduced in the Late Holocene, resulting in hyposalinity as at present (Table 1.2). This study provides important data for reconstructing palaeo-marine environments, but the chronology of the stratigraphic zones (based on the distinct occurrence of particular species of benthic foraminifera) depends on the results of previous work (Taira 1979 and 1980) due to the absence of absolute dates and biostratigraphic indicators. Absolute dating is crucial to obtain more specific results.

Palynological studies may provide good evidence of palaeoenvironments. Oh (1976) has produced a pollen diagram from the study of the peat sediments at Pyōngtaek, Kyōnggi Province. The peat deposit, 110cm deep, is thought to be 3,000 years old, based on the hypothesis of a constant accumulation rate of the peat. According to Oh, the major pollen types are arboreal such as Ligustrum, Alnus, and Carpinus. Pinus and Abies increased from the bottom to the top of the deposit. Oh suggested that the past climate of the area might be cool and moist on the basis of the increase of Pinus and Abies. Although Oh's study is important, as the first work by a Korean dealing with pollen sequences for reconstruction of the past
<table>
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<tr>
<th>Age</th>
<th>Zone</th>
<th>Palaeoenvironments</th>
<th>Remains</th>
<th>Transgression</th>
<th>Palaeoenvironments</th>
<th>Years R OES</th>
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<td>mixed mid-latitude, temperate to subtropical</td>
<td>no</td>
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</tbody>
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Table 1.2. The schematic representation of stratigraphy and palaeoenvironments of the Middle Yellow Sea (from Chang and Cheong 1987:77).
environment of the study area, two major problems arise from his interpretation and should be pointed out. One concerns the dating of the peat deposit. He dated the peat sediment back to about 3,000 years, based on the data on peat accumulation rates presented by Flint and Gale (1958) and Arnold (1961). However the accumulation rate in different depositional environments will not necessarily be similar, and a constant accumulation rate in even the same peat deposit can not be assumed. Therefore his interpretation needs more careful re-examination with absolute dates. The other problem is how correctly he has identified the pollen types. Jo (1987:17-8) has pointed out that even if his dating is correct, no pollen evidence showing high frequencies of Abies and Carpinus in pollen diagrams during that period, has yet been found. Therefore the results presented by Oh should be re-examined with absolute dates.

A more recent pollen study on the sediments of the Youngnang Lake, Sokcho, Kangwon Province, shows much longer sequences with radiocarbon dates (Yasuda et al. 1980). The pollen diagram, covering the last 17,000 years, is divided into 6 pollen zones (Fig.1.5).

Zone I (17,000-15,000 BP): Abies, Pinus, Picea and Larix stage.
Zone II (15,000-10,000 BP): non-aboreal stage.
Zone III (10,000-6,700 BP): Quercus stage.
Zone IV (6,700-4500 BP): Pinus, Quercus and Artemisia stage.
Zone V (4,500—1,400 BP): Quercus, Pinus, Artemisia, Corylus, Ulmus and Juglans stage.

Zone VI (1,400 BP-present): Pinus and non-arboreal stage.

Meanwhile, Jo has presented more sub-divided pollen zones based mainly on cores bored in alluvial and peat sediments formed during the Holocene. These include peat sediments from Chumunjin, Kangwon Province, Pangŏjin, Kyŏngnam Province and Hwangdŭng, Chŏnbuk Province, and alluvial sediments from Pohang, Kyŏngbuk Province and Mankyŏng, Chŏnbuk Province (Jo 1987:134—53). He has two pollen zones, I and II, and sub-divides zone II into 3 sub-zones, IIa, IIb and IIc.

Zone I (10,000-6,000 BP): Quercus stage (warm).

Zone IIa (1,000—about 3—4,000 BP): Lower Pinus substage (cold or dry).

Zone IIb (about 3—4,000—2,000 BP): Pinus-Quercus sub-stage (warm or wet).

Zone IIc (2,000 BP—present): Upper Pinus substage (cold or dry).

He has also pointed out that the higher proportion of Pinus during last 6,000 years can be related to a sea level rise because Pinus is relatively better adapted to coastal sandy environments compared to broadleaf trees (ibid.:150). However, because his cores for the pollen diagram were recovered from only coastal areas, the interpretation needs to be compared with pollen diagrams.
Fig. 1.5. Pollen diagram of the Yongnang Lake (from Yasuda et al. 1980:12-3).
from inland in order to examine the certainty of the interpretation. Jo also suggested that the higher proportion of Pinus during the past 2,000 years may reflect secondary forests caused by human disturbances (ibid.:151).

1.3. THE PREHISTORY OF KOREA - A BRIEF OVERVIEW
Korea has a long tradition of human occupation beginning in the Lower Palaeolithic Period. The prehistory of Korea has been divided into the Palaeolithic and Neolithic Periods and the Bronze and Iron Ages, as in many other parts of the world. However, there is an absence of detailed studies on subsistence, economy, social structure and organization, and so on, in each period. Therefore, further study on these aspects is required to develop a better understanding of the prehistory of Korea for the future. The overall chronology of the prehistory of Korea is based on Kim (1986:268).

1.3.1 THE PALAEOLITHIC PERIOD (600,000-10000BP)
The earliest site known from the Lower Palaeolithic is Komunmoru, Sangwon, P'yöngnam Province. This cave site is reported to have produced crude stone tools such as choppers, bifaces and scrapers and animal fossils including Dicerorhinus kirchbergensis, Ursus arctos, Ursus spelaeus, Minomys sp. and Equus sangwonensis, all of which became extinct after the Middle Pleistocene (Kim and Kim 1974). The site has been dated to 600,000-400,000 BP, based on the fossil animal assemblages (Kim and Kim 1974; Lim 1984).
Sŏkchang-ri at Kongju, Ch'ungnam Province is the earliest Palaeolithic site in South Korea. According to Sohn (1972 and 1978a), the lower layers at locality I, produced unifacial chopper, chopping tool and scraper industries, all made of heavy quartzite, easily available in the locality, but no animal remains were recovered. The layers are thought to be Lower Palaeolithic.

The recent excavation in Chŏngok-ri at Yŏnch'ŏn, Kyŏnggi Province, is important because it has revealed an Acheulian-type handaxe industry including cleavers, choppers, chopping tools and scrapers, all made of heavy quartzite cores and flakes. The date of the site, from the Lower to Late Middle Palaeolithic Periods, however is controversial (Kim and Chong 1979; Clark 1983; Yi 1986; Bae 1989).

The lower layer of Kŭmgul cave site, Tanyang has produced Acheulian-type handaxes and choppers, with animal remains, and has been attributed to the Lower Palaeolithic (Yi 1981 and 1983; Sohn 1984 and 1985). In addition to these sites, cave sites in Turubong near Ch'ŏngju (Sohn 1983; Yi 1982 and 1983a), Chŏmmal in Chech'ŏn (Sohn 1978b), Yonggok-dong near P'yŏngyang, P'yŏngnam Province (Chon et al. 1986), Tohwa-ri and Shimgok-ri, Kangwon Province (Yi 1988) are reported to have Lower Palaeolithic industries. Remains of Homo sapiens have been discovered in the lower layers of Yonggok-dong, Taehyŏndong and Sŭngrisan (Tŏkch'ŏn) cave sites in North Korea.

In summary, the Lower Palaeolithic industry known from the Korean Peninsula consists mainly of choppers,
flakes, retouched river pebbles, and scrapers with few secondary retouching technology. Although proto-bifaces and Acheulian-type handaxes have been found from Chŏngog-ri and Kŭmgul, the stone industry from this period is generally crude (Bae 1989:7). Animal remains commonly found are Bos primigenius, Dicerorhinus kirchbergensis, Macacus robustus, Megaloceros flabellatus, Pseudaxis sp., Cervus elaphus, Panthera tigris, Sus scrofa, Ursus arctos, Ursus spelaeus and Vulpes vulpes, though distinctive regional differences are recognized (Bae 1989:3).

The Kulp'o-ri I industry (To 1964), the middle layers of the Sŏkchang-ri, the middle layers of the Chŏmmal cave (Sohn 1978b), the upper layers of Turubong caves No.2 and No.9 (Yi 1981 and 1983a; Sohn 1983), the lower cultural layer of Myŏng-ri (Choi 1983), the lower layer of Suyangge (Yi 1983b, 1984 and 1985) and the Sangmuryong-ri site, Hwach'ŏn are considered as Middle Palaeolithic. The Kulp'o-ri I industry included choppers, scrapers, cores, flakes and crude debitage and is thought to date about 100,000 BP (To 1964).

Remains of Homo sapiens were recovered from cave sites of the upper levels of Sŭngnisan (Tŏkch'ŏn) and Taehyŏn-dong in North Korea.

Kulp'o-ri Layer 2, the upper layers of the Sŏkchang-ri, the upper layers of Sŭngrisan (Tŏkch'ŏn), Suyangge and Ch'angnae sites are attributed to the Upper Palaeolithic. The upper layers of Sŏkchang-ri yielded obsidian scrapers, points, blade tools, end scrapers and gravers, and layer 11 contained an occupation floor which
was dated to 20,830±1,880 B.P. Tree trunks were used to build a shelter. The upper layer of Kulp’o-ri II contained choppers, chopping tools, scrapers and burins, all made of shale. A stone tool manufacturing site was discovered in level 5b of Suyangge with an Upper Palaeolithic industry (Yi 1983b). This site yielded bifaces, scrapers, points, adzes and etc., made mainly of shale, quartzite and porphyry. Dwellings were found at Ch’angnae, Chungwon near Suyangge. This site had choppers, piercers, side-, round- and end-scrapers and cleavers (Pak and Yi 1982).

Several human remains of Homo sapiens sapiens, were discovered at cave sites of Mandal-ri and Kümch’ŏn-ri in North Korea and Sangshi, Tanyang in South Korea.

1.3.2. THE MESOLITHIC PERIOD (10000-7000BP)
Mesolithic sites were only discovered very recently, although the possibility of the existence of sites has long been suggested (Choi 1974 and 1983). It had been thought that the Upper Palaeolithic peoples of Korea might have moved north following the retreating cold fauna, and that the Korean Peninsula had no human occupation until the arrival of Neolithic people in the fifth millennium BC (Kim 1981:26). Another possibility to account for the apparent absence of Mesolithic sites is that those in coastal areas might have been submerged by rising sea levels (Sohn and Han 1983:70).

Although subsistence patterns are not yet clear, several sites have produced microliths indicating the possible presence of Mesolithic technology: the upper
layer of Sŏkchang-ri (Sohn 1973:44), Sangnodae-do (Chang 1988), Imbul-ri (Ahn 1988), Tongsam-dong, submergence areas of Chuam Dam and elsewhere. Further study however is needed to understand the distribution, scale, technology chronology and subsistence patterns of the Mesolithic cultures in Korea.

1.3.3. THE NEOLITHIC PERIOD (8/7000-3000BP)

The term 'Neolithic' in Korea is used differently from western usage because food production from the beginning of the period is not clearly shown, as is also the case of the Jomon culture in Japan. In Korea, however, the Chūlmunt’ogi or Comb pattern pottery culture (Kim 1977:62) or Geometric pottery culture (Kim 1978:10) has been used synonymously with the term "Neolithic culture" to indicate the presence of ceramics and polished stone tools, even though the pattern of food production is not clear. The comb pattern pottery of Neolithic Korea has been thought, since Fujita’s argument (1930), to derive from the 'kammkeramik' of Northeastern Eurasia. However, it has recently been challenged by new archaeological discoveries such as the Osan-ri dwelling sites which have produced early Neolithic pottery, dated to sixth millennium BC (Im and Kwon 1984). Im has argued (1982 and 1983), based on the radiocarbon data, that the comb pattern pottery of Neolithic Korea might be an independent development, and the beginning of the Neolithic of Korea is thought to be around 6,000 BC.

The Chūlmunt’ogi culture can be divided into three
regional groups based mainly on the shape of pottery: the west coast, south coast, and east coast regions. The west coast sites, clustering around the Taedong River in the north and the Han River in the south, are characterized by pottery with incised decoration of bands of dots and of comb-patterns or herring-bone patterns, and with a V-shaped body. This type of pottery is represented by sites at Kungsan-ri and Chit'ap-ri in North Korea, and Amsa-dong and Misa-ri in South Korea. Three evolutionary phases of comb pattern pottery in this region have been suggested based on changes in decoration zones. There is a three-zone type (mouth, body and bottom) which changes to a two-zone type (mouth and body), finally to one-zone type (mouth only) (Im 1984).

The South coast region is characterized by pottery with a rounded base and dominated by applique decorations, thumb-impressions, thick geometric patterns and in the later period, double rims. In this region, another type of pottery is found from the early period, which is flat-bottomed without or with limited surface decoration on the upper portion of vessels. The sites producing these kinds of pottery, are shell midden sites at Tongsam-dong (Pusan), Suga-ri (Kimhae) and Sangnodae-do (Tongyông).

In the east coast region, the ceramics are flat-based and dominated by pottery decorated only on the rim or the upper half of the body with applique and incised, pinched and stamped patterns. Sites represented are Sŏp'ohang, Kulp'o-ri, Unggi and Osan-ri, Yangyang. Pottery from Osan-ri shows some cultural contact with the northeast coast,
represented by Sŏp’ohang, and with the south coast, represented by Tongsam-dong (Kim 1981:29-30).

The overall chronology of the Korean Neolithic is still difficult because of a lack of absolute dates and because of uncertain cultural connections between different regions and the distinctive regional variations, although several attempts have been made (Choi 1977; Im 1983 and 1984; Kim 1986; Miyamoto 1986; So 1985; Kohara 1987).

Dwellings have been discovered at Kungsan-ri, Kŭmt’an-ri, Chit’ap-ri, Hogok-dong, Sŏp’ohang and Sejuk-ri in North Korea, and at Amsa-dong and Osan-ri in South Korea. All are basically pit dwellings which show gradual changes in shape and size, and can be divided into two phases (C. Kim 1987). Dwellings in the early period are circular or almost circular, and about 15 square meters in size, while in the late period they are mostly square or rectangular and are 20-30 square meters in size. According to reconstructed house shapes based on the distribution of post holes, early houses might have been conical, while later ones might have been ‘matbae or ujinkak’ (central ridge pole supported by central poles) in shape.

Early dwellings have a central hearth, while later dwellings have a hearth to one side, allowing a more functional division of space (C. Kim 1987).

Subsistence patterns of the Neolithic Period have not been studied in detail. The Korean Neolithic is generally explained as having a broad spectrum subsistence pattern such as fishing, hunting, collecting and possibly some
cultivation (Nelson 1982:114-6). The distribution of sites, with dwellings along the rivers and shell middens along the coastal regions, may reflect partly their subsistence pattern.

No evidence of Early Neolithic cereal cultivation has yet been found, but the early layers of shell midden sites such as Tongsam-dong, Sangnodae-do, Sŏp’ohang have produced the bones of land and sea mammals, fish bones and molluscs indicating hunting, fishing and gathering.

During the Middle Neolithic, primitive cultivation of millet and possibly root crops seems to have begun (Choe 1990). A large quantity of charred millet (Panicum miliaceum or Setaria italica), farming tools such as stone sickles, and stone and deer antler hoes have been found at Chitap-ri in North Korea (Kim 1978). Similar farming tools to those of Chitap-ri have also been found in the dwelling sites at Kungsan-ri in North Korea and Amsa-dong in South Korea, indicating farming activities in this period.

During the Late Neolithic, cultivation of rice and buckwheat in addition to millet has been suggested (Choe 1990:6), but no evidence of cultivation of such cereals has been found. The pollen evidence from the peat deposit at Kahŭng-ri, Muan, shows abundant Oryza type pollen from a depth of six meters below the surface, which is assumed to date to 3,500 BP (Yasuda et al. 1980:5-8 and 17). The date, however, lacks certainty because it is based on the radiocarbon date of the upper layer (1500±90 bp) and on a constant accumulation rate of the peat sediments, which cannot be assumed. Solving all the problems of the
Neolithic subsistence patterns requires more data and further detailed study.

1.3.4. THE BRONZE AGE (3000-2300BP)

From around the beginning of the first millennium B.C. new pottery types appeared replacing the Chūlmun pottery. The new pottery types are generally plain (Mumunt'ogi) without, or with very limited, decoration. This change has been interpreted as a result of migration of new tribes, a Yemaek Tungusic population, from Manchuria into the Korean Peninsula (Kim 1981:30-1).

It is still unclear when bronze implements began to be produced in Korea, however the occurrence of plain pottery has generally been accepted to indicate the Bronze Age, because it is often associated with bronze, although plain pottery has been found far more often without bronze artifacts.

The plain pottery is the main pottery type with burnished red- and black- potteries throughout the Bronze Age in Korea. The plain pottery has very distinctive regional variations, so called top-shaped (P’aengihyŏngt’ogi), Misong-ri type, Konggwi-ri type, rim-perforated (Kongryŏlmunt’ogi) pottery in North Korea and Karak-ri type, Chŏmt’odaet’ogi, Songguk-ri type in South Korea, named according to pottery shapes and names of sites producing pottery of typical shapes.

In the northwest of the Korean Peninsula, top-shaped pottery with a wide double mouth, an extended body and a small base, is characteristic. This type of pottery has
often been found with a jar which is sometimes called 'modified top-shaped' pottery because it has a long neck above a top-shaped body. This pottery type spread into the southern part of the peninsula, producing modified types such as the Karak-ri type pottery.

Rim-perforated pottery has small holes at regular intervals below the rim. This type of pottery has been found in the northeast area of the Korean Peninsula. However, it spread over all the peninsula except the northwest area during the Bronze Age.

The pottery types of the southern part of the Korean Peninsula developed on the basis of the influences from the northwest and northeast pottery traditions, producing pottery types such as Songguk-ri type, Chŏmt'odaet'ogi, Kolagarit'ogi, etc.

Bronze production in Korea is considered to be related to the bronze industry of the Liaoning-Liadong area of China because the Liaoning dagger (Pip'ahyŏng donggŏm), the prototype of the Korean dagger (Sehyŏng donggŏm or Slender type dagger), has been found in Korea. For example, a recent find from a stone cist coffin at Songguk-ri, Puyŏ, revealed a Liaoning-type bronze dagger and a bronze chisel, along with a polished stone dagger, arrowheads, perforated beads and two comma-shaped jades. In addition to daggers, bronze implements discovered in Korea include mirrors with crude or fine geometric decoration, axes, bells, belt hooks, horse armour and plaques.

Stone tools, mostly polished, were still used during
the Bronze Age; they include axes, adzes, chisels, arrowheads, daggers and semi-lunar-shaped knives.

A variety of burial forms appeared during the Bronze Age, represented by dolmens, stone cists, pit graves and jar burials. Several possible origins for the dolmens of Korea have been suggested (introduced in Choi 1984:62-5). However, the dolmens of Korea are generally thought to be an indigenous invention in the Korean Peninsula during the Bronze Age (Choi 1984:65 and Kim 1986:31). Dolmens discovered in Korea can be divided into three types: the capstone and the northern and southern types (Kim 1986:30-1). The capstone type (Kaesŏkshik), regarded as the earliest form is distributed throughout the peninsula and developed into the other two types. The capstone type consists of a large flat capstone on the ground and a subterranean cist covered by the capstone. The southern type (Kidanshik) consists of a huge block of stone supported by several small stones. One or more stone cists or burial pits are generally found below the ground surface. This type is distributed throughout southern Korea, mainly in the coastal region. The northern type, which is in the shape of a table, consists of a large flat capstone raised on several supporting slab stones, forming a burial chamber above the ground. This type is distributed mainly in northern Korea, spreading into the Han River.

Stone cists are also a widely distributed burial form in Korea, Manchuria and Siberia during the Bronze Age. It has been thought that this burial system spread from
Siberia throughout Manchuria into Korea (Kim 1986:31). A stone cist was generally built of several stone slabs. However stone blocks were also used, developing a chamber-shaped burial which was a dominant burial system from the Bronze Age to the historical period (ibid.).

Dwellings during this period are mostly rectangular but there are several square or circular. The most common size is 20 square meters, just suitable for a family of four or five, followed by 50, 30, 40 and 60 square meters (Kim 1976:102-3). Dwellings mostly have one hearth, but two hearths are also frequently found, all to one side of the house. The hearths are mostly circular or oval with few square or rectangular ones. The hearths are usually surrounded with stones or clay. In addition, flat stones were added inside a hearth surrounded with stones. The houses may have been built in a 'ujingak' or 'matbae' style according to the layout of postholes (Kim 1976).

The existence of agriculture in the Korean Peninsula during this period is now beyond question. Discoveries of semi-lunar-shaped polished stone knives at many sites might indicate harvesting crops. In contrast to the previous Neolithic Period, evidence of millet cultivation has been found, and cereal cultivation during the Bronze Age became diversified including foxtail millet, broomcorn millet, barnyard grass, sorghum, soybean, red bean and rice (Ji and Ahn 1983). Bones of domestic dog and pig are also reported from several sites in North Korea.

The Hŭnam-ri dwelling sites, Yŏju, revealed carbonized rice (*Oryza sativa*), barley (*Hordeum sativum*),
sorghum (Andropogon sorghum) and foxtail millet (Setaria italica) (SNUM 1978). These dwelling sites have been dated to 3,210±70 BP, 2,920±70 BP and 2,620±100 BP, however it was believed that the sites might belong to the early first millennium BC in terms of cultural artefacts. The Songguk-ri dwelling sites, Puyŏ, yielded a lump of charred rice grain, dated 2,665±60 BP and 2,565±90 BP (NMOK 1979, 1986 and 1987).

In North Korea, the Namgyŏng dwelling sites, near P'yongyang, are reported to have rice, foxtail millet, broomcorn millet, sorghum and soybean (Kim and Sok 1984). This discovery is important, indicating that rice was already cultivated in North Korea (39° N) during the Bronze Age dated to about 10th century BC (Kim and Sŏk 1984). In addition, several other sites are reported to yield crop remains including Hogok-dong and O-dong in northeast Korea though without rice.

It is worth noting that few shell middens formed during this period, have been discovered. This aspect has been considered to indicate that people of the Bronze Age, compared to people of the Neolithic period, did not depend on marine foods. There has been another suggestion that middens in this period might have been covered by a rise in sea level. However, as there is no evidence of significant sea level changes during the Bronze Age and afterward, this interpretation is unlikely. In the context of this argument, the discovery of the Konam-ri shell middens is very significant because they demonstrate marine resource exploitation in the Bronze Age and also
because they shed light on the possibility of more discovery of Bronze Age shell middens elsewhere. Further discussion about this will be presented in following chapters.

The date of the beginning of the Iron Age in Korea is not yet certain. According to Kim, Won-yong (1986:33), iron implements began to reach Korea from China from the third century BC. During this period however bronze implements were still used. The slender bronze daggers which are thought as a developed form of the Liaoning type, crude-pattern mirrors (Chomungyōng), and other ceremonial items have been frequently found in burials with black burnished pottery and iron weapons. Stone-lined burials, pit burials and jar-coffins are the most common type of burials, while dolmens were still built in some areas. In addition, wooden chamber tombs (Togwang-mokgwakbun) began to be used around the second century BC (Kim 1986:34). A new type of pottery with a stamped pattern (Kimhaeshik) seems to have been produced from about the end of the Early Iron Age, although this is not still certain.

By the start of the Christian era, Korea had entered a full iron-using stage (Kim 1986:35). During the end of the Early Iron Age and the following the Protohistoric Period (Wonsamguk shidae), huge shell middens reappeared mainly along the southern coast region, for example Hoehyon-dong and Puwon-dong in Kimhae, Nük-do in Samch’ŏnpo, Cho(Jo)-do and Tongnae in Pusan, Sŏngsan and Ungch’ŏn in Ch’angwon, Kungok-ri in Haenam, Yangsan and
Kosong. This abrupt appearance of huge middens might reflect an increase of population and commercial exploitation of shellfish during that period, although these aspects have not been studied. Further detailed study on animal and plant remains recovered from those sites can be used to infer these aspects.
2. EXCAVATIONS AT THE KONAM-RI SHELL MIDDEN SITES, ANMYŌN ISLAND

My purpose in this chapter is to give a general introduction to the present environment and economy of Anmyōn Island. In addition, I will look briefly at the archaeological work which has been carried out on the island. A field survey performed in 1983 gave general background information on prehistoric sites, while the excavations of 1988 and 1989 gave specific information on the shell middens at Konam-ri in terms of the cultural sequences, past economy and environment of the sites. More detailed information on the excavations can be obtained in Kim and An (1990); Kim and Sim (1990).

2.1. THE PRESENT ENVIRONMENT AND ECONOMY OF ANMYŌN ISLAND

ENVIRONMENT

Anmyōn Island lies just off the central west coast of the Korean Peninsula between latitudes 36°24'N and 36°37'N, and longitudes 126°10'E and 126°27'E (Fig. 2.1). It was originally a small peninsula attached to the main peninsula before being artificially made into an island. This happened during the Chosŏn Dynasty Period in the 17th century, when a channel was cut at Ch'akhang (located at the top of the island) in order to facilitate sea transportation (Anmyŏn-ŭp 1986:7; CHM 1974:170). The island remained cut off from the main peninsula until the construction of the Anmyōn Bridge in 1970 reconnected them once more (Anmyŏn-ŭp 1986:7).

At present the island's total area is 87.96 square
kilometers: it is 6km wide and 22km long. Geologically the island is composed of the Sŏsan Group of mainly Pre-Cambrian quartzite and quartz schist rocks (Kim et al. 1971:9-10).

The island has a rugged topography even though 60 percent of the island is less than 50m above sea level. The highest mountain is Kuksa-bong in Shinya-ri (97m) followed by Kuksa-bong in Ch'anggi-ri (95m). The ria-type coastline, which is 181.8 km long, has been modified in recent years by reclamation work. Therefore during the prehistoric period the coastline was more irregular than it is at present. Due to high tidal fluctuations, a wide tidal mud flat developed around the island. This was important to fisheries on the island in the past and remains so today, allowing access to rich marine resources.

Fig. 2.1. Distribution map of the Konam-ri shell midden sites.
No direct records of climate are available for Anmyŏn Island itself; however, the data from Sŏsan city nearby provides a detailed record (CMO 1982). Records for the Sŏsan area show an annual average temperature of about 11.6°C, average temperatures for the warmest months (July and August) around 24.1 to 24.8°C, and for the coldest months (January and February) around −0.8 to −1.9°C. Annual average precipitation is 1089.7mm. This annual pattern of rainfall shows a marked seasonal variation: in the dry season (from November to March) rainfall is between 313 to 432mm, and in the wet season (June to August) between 2,339 and 2,622mm.

The present forest vegetation of the island consists mainly of Pinus with some Quercus, although field investigations on the vegetation of the island show it to contain 107 plant families and 503 species (CHM 1974:100). Early 20th century records show that there were dense Pinus woodlands on the island (Hayashi:1933).

The fauna of the island is basically similar to that of the south-western part of the peninsula, belonging to the Sub-Chinese region. The main fish available to fishermen around the island are sharks, rays, flatfishes, shrimps, etc. Marine molluscs such as oysters, venus clams and abalone shells and sea slugs are also abundant. These, together with seaweeds, are still important to the fishermen of the island.

**ECONOMY**

Despite being an island with rich marine resources, a large part of the economy is devoted to farming. According
to Anmyŏn-üp (1986), of the 3,469 households on the island, 2,499 (74.9%) are based on farming, 222 (6.4%) on fishing and 648 (18.7%) on other activities. However 1,900 (54.8%) are involved in harvesting and collecting seaweeds and oysters as an additional way of earning during the winter period. It is interesting to note that in the early 20th century the records on the economy for the island show that the economy was heavily dependent on farming, despite rich marine resources being available around the island. It was suggested that the reason for this phenomenon was that the terrestrial resources of the island were rich enough to support the population without the need for them to be involved with the dangers of fishing (Hayashi 1933:23—4). Therefore major commercial fishing was carried by fishermen from outside the island at that time.

2.2. PREVIOUS ARCHAEOLOGICAL RESEARCH

FIELD SURVEY

In 1983, the Hanyang University Museum surveyed the Island as part of a project investigating prehistoric culture in the western coastal area of Korea, and discovered prehistoric and early historic period sites including thirteen shell middens on Anmyŏn Island (Kim 1983). The survey revealed archaeological materials such as pot-sherds from the Neolithic Period to the Three Kingdoms Period, stone implements and many species of shells, suggesting the possibility of the existence of prehistoric sites from the Neolithic Period to the Iron Age, and the
early historic period, including prehistoric shell midden sites.

EXCAVATIONS

Two of thirteen shell middens discovered during the field survey in 1983 were excavated in December 1988 and in September and October 1989 by the Hanyang University Museum. They were named midden complex A and B (Kim and An 1990; Kim and Sim 1990) (Fig.2.1-2). The sites are located at Konam-ri, in the southern part of Anmyŏn Island. The local residents call the village 'Kamnamu-gol', Persimmon-tree village, due to the plentiful number of persimmon trees. The sites lie on hills (about 25-27 meters above sea level) extending southwest (Midden Complex A) and westward (Midden Complex B), about 1.5km from the present coastline. However, before land reclamation work they would have been very close to the sea.

The general aims of the Anmyŏn Island project have already been discussed in the Introduction. To expand on this, the campaigns at the Anmyŏn Island focused on obtaining information on the following points:

1. The cultural sequences of the middens.

2. Subsistence patterns; evidence of farming activities and of seasonal exploitation of food resources.

3. Quantifying midden deposits and food resources in order to reconstruct the subsistence economy and diet, and to estimate population sizes and the length of time of midden formation period.
Fig. 2.2. Aerial photograph of the Konam-ri shell midden sites (●).
4. To examine the midden components in order to determine whether different components reflect either functional differences, or cultural differences between different regions. For example, middens on the south coast of Korea contain many animal bones, while those in the west coast area contain very few bones. The reason why this could be so has been interpreted in two ways either cultural or functional as suggested above.

5. Evidence of past environment at the sites.

2.2.1. EXCAVATION PROCEDURES

A grid system, of 3 by 3 metre squares, leaving 1 meter baulks, was laid out over the sites to allow examination of many stratigraphic profiles (Fig.2.3-5). The midden deposits were separated into individual layers according to differences in composition, density, colour of the deposits and artefact types. The position of finds such as artefacts, bones and plant remains were recorded using the three-dimensional method.

Column and individual bulk samples of midden deposits were collected to obtain data on midden components. Column samples were designed to obtain detailed information on vertical changes in midden components. The size of column was 25 by 25 cm. Each column was removed in sub-samples (spits), each of 5 cm depth.

Column samples were only taken from middens B-1 and B-2. They were basically collected in a systematic way. Before the excavations the location of column samples was positioned at the north-east or south-west corner of the 1 by 1 metre squares lying diagonally north-east to south-
west within 3 by 3 metres excavation squares (see Fig. 2.4-5). After removing the surface soil from the excavation squares, however, it was found that some of column samples did not contain the main thickness of shell deposits. In this case the samples were either not taken at all, or were taken from other positions within the excavation squares (e.g. column samples No. 8 and No. 9 on Fig.2.4 and column sampl No. 14 on Fig.2.5). In addition, two more column samples (No. 1 and No. 5) were taken from the baulks where the shell deposit was thickest and the preservation condition of the shells was relatively good.

Bulk samples (approximately 40 x 40 x 5 cm) were collected from some areas in the excavation squares during the excavations and from each of the shell layers in the baulks after completion of the excavations of the squares.

Fig.2.3. Plan of the excavation squares and the middens A-1 and A-2 (modified from Kim and Sim 1990:34, see Fig.2.6 for sections).
Fig. 2.4. Plan of the excavation squares (A-D and control pit) of midden B-1 and structures (modified from Kim and An 1990:17, more figures in section 2.2.3).
The purpose of collecting the samples was to obtain data on the components of each shell layer, and on the overall composition of the midden deposits, based on large samples.

In addition, during the excavation in 1989, dry sieving with 3mm mesh sieves was carried out to obtain small fragments of artefacts and animal and plant remains which can easily missed during trowelling. The sieving method facilitates the identification of small remains among shells of midden deposits. This practice resulted in more material being recovered than that recovered in the campaign in 1988.

Fig. 2.5. Plan of the excavation squares (A–C) of midden B-2 and dwelling 3 (modified from Kim and An 1990:19, more figures in section 2.2.3).
2.2.2. MIDDEN COMPLEX A (Fig.2.3 and 2.6-8)

The midden complex A consists of two shell middens located at the lower slope of a hill. These were excavated in 1988 and named A-1 and A-2 from the north to the south. Before excavation work began, middens A-1 and A-2 were thought to be a single midden deposit; however, during the excavation work it became clear that they were two middens belonging to two different time periods as they were producing different artefact assemblages (Kim and Sim 1990).

A. MIDDEN A—1 (based on Kim and Sim 1990)

The surface of the upper layer of the midden has been disturbed by farming activities. The midden was circular in outline and measured about 12 meters in diameter, varying in thickness with deposits up to 50cm. The midden was centred around pits B-1 and B-2, showing dense shell accumulation and the greatest depth of midden deposit. The deposit became gradually thinner as it approached the perimeter of the midden. This midden contained plain pottery and various kinds of Bronze Age artefacts, indicating that the site dated from that time.

B. MIDDEN A-2 (based on Kim and Sim 1990)

This midden was found to the southwest of midden A-1, being only one metre apart from midden A-1 below the surface soil. It was discovered however that the lower part of the shell layer of midden A-2 extended north, running below the shell layer of midden A-1 (see Fig.2.3 and 2.6). Most of the midden deposits had been destroyed by farming activities. This was especially true at the
southern part of the midden which had been cut into in the making of a stepped field. This resulted in the spreading of midden materials into the field south of the site. The surviving area of the midden was estimated to be about 10 x 3m and semi-oval in outline. The midden consisted mainly of oyster shells and some venus clams, and produced Neolithic comb pattern pottery (confirming that formation of midden A-2 preceded that of A-1).

C. STRATIGRAPHY (Fig.2.6-7)
The stratigraphy of middens A-1 and A-2 was recorded together due to their very close proximity. The stratigraphy was relatively simple, consisting of a main shell layer and several subsoil layers.

Layer 1 is the uppermost humus soil layer, dark brown, 15-20cm thick and containing shells scattered by farming activities.

Layer 2 is a very dense shell layer, consisting mainly of oyster shells with little soil matrix. This layer appeared from whole excavation squares, with especially deep shell profile in squares B-1 and B-2 becoming thinner toward the edges of the midden. The uppermost part of this layer, which was partly disturbed by ploughing, consisted of densely-packed shells while the lower part of the layer in some squares showed a higher proportion of soil matrix.

Layer 3 was a sandy clay subsoil beneath layer 2 and seemed to be related to the prehistoric land surface immediately preceding the period of midden occupation; it was dark brown and 20-30cm thick. This layer contained
Fig. 2.6. Section (N-S) throughout middens A-1 and A-2 following wall face of squares as shown in Fig. 2.3 (from Kim and Sim 1990:39).

Fig. 2.7. Section (E-W) of middens A-1 and A-2 following wall face of squares as shown in Fig. 2.3 (from Kim and Sim 1990:39).
both plain and comb pattern pottery.

Layer 4 was a blackish brown humus soil layer, 10–20cm thick, and appeared mainly around square C-2. This layer overlay layer 6, producing Bronze Age plain potsherds and Neolithic comb pattern pottery.

Layer 5 was a Neolithic phase with comb pattern pottery, and consisted of densely-packed shells (mainly oysters and venus clams).

Layer 6 was a brown sandy soil layer, 20–30cm thick, underlying layer 3 and extending beneath shell layer (layer 5) of midden A-2. This layer produced Neolithic comb pattern pottery, indicating that it was related to the Neolithic cultural layer.

Layer 7 was a yellowish brown subsoil, 30–50cm thick, mainly found in squares C-1 and C-2.

Layer 8 was a yellowish weathered bedrock, appearing at depth from 30–40 to 120–140cm below the surface soil.

D. STRUCTURES (Fig.2.8)

Three pit structures were discovered at squares B-3 (pit structure No.1) and C-1 (pit structures No.2 and No.3). Pit structure 1 is cut into layer 3, and possibly layers 4 and 8, and was filled with shells of layer 2, indicating that it might have been made during the Bronze Age (see Fig.2.7). It was 1.5m in diameter and 50cm depth and located inside square B-3. It was semi-circular and extended beyond the west wall of square B-3. Its exact size and shape were not clear however.

Pit structures 2 and 3 are cut into layer 8 and underlay layers 6 and 7 (Fig.2.8), indicating that they
were dug during the Neolithic Period. The part of pit structure 2 visible in square C-1 was semi-circular in shape: it measured 85cm in diameter and 40cm in depth. It continued into the north face of square C-1. This pit structure was filled with yellowish brown soil matrix (layer 7) from which Neolithic comb pattern potsherds were recovered.

Pit structure 3 was rectangular, measuring 97 x 63cm, and was about 22cm deep. It was filled with the yellowish brown soil of layer 7. The function of these three pit structures was uncertain due to lack of clear evidence, but they might be to storage pits. Similar pit structures were found beneath Neolithic midden deposits at Tongsamdong, Pusan (Sample 1974).

Fig.2.8. Plan of pit structures in excavation square C-1 of midden A-1 (from Kim and Sim 1990:48).
2.2.3. MIDDEN COMPLEX B (based on Kim and An 1990)

This consists of six small shell middens along the slopes of a hill located about 250 metres south of shell middens A-1 and A-2. Two of them, located at the easternmost point on the slope, were excavated in 1989 and named midden complex B-1 and B-2 from east to west. These middens produced Bronze Age artefacts, indicating a Bronze Age formation of the middens.

Part of these midden deposits may have been disturbed by farming activities. The southern slopes of the middens have been cut into, and the scatter of midden deposits on the surface around the sites make it difficult to define their exact limits prior to excavation. A local farmer informed us that the area around Midden Complex B had recently been made into fields by removing trees from the area.

A. MIDDEN B-1 (Fig.2-4 and 2.9-11)

The remaining main area of the midden measured about 13 x 7.5 meters, and was semi-oval in outline. The midden centre was in the area of square B, showing the thickest and widest distribution of midden deposits with a high density of shells and a relatively high concentration of artefacts. The midden became gradually thinner and narrower at squares A, C and D, and faded out at the eastern part of square A and the western part of square D.

STRATIGRAPHY (Fig.2.9-11)

The midden was divided into thirteen stratigraphic layers,
including the surface and bedrock or pre-cultural layer (Fig.2.8-10, see also 2.4).

The uppermost, layer 1, was a greyish-brown humus soil, varying in thickness from 10-20 cm. This layer has been disturbed by recent agricultural activities.

Layer 2 was a grey mixed shell layer, consisting mainly of clams and broken oysters. This layer appeared in the northeastern part of the control square.

Layer 3 was a greyish-brown mixed shell layer with much soil matrix and appeared in the southeast of square B and the northeast of the control square. It consisted mainly of oysters and clams.

Layer 4 was a grey humus-mixed shell layer, spreading into the southwest of square B, the north of the control square and into square C with a variable thickness of up to 60 cm.

Layer 5 was distributed at the southwest of square A, the southeast of square B and the northeast part of the control square. It contained much soil matrix with crushed shell and fragments of charcoal. A hearth (No1) was found at the bottom of this layer.

Layer 6 was a dense shell layer, consisting mainly of oysters. This layer appeared at the western part of square A, throughout square B, the eastern part of square C and part of the control square. It was up to 70 cm thick and contained a relatively large number of artefacts.

Layer 6-1 was a brown sandy soil layer, distributed in a very limited area of square B within layer 6.

Layer 6-2 was a green sand lens which appeared in
layer 6 at the northwestern corner of square B.

Layer 7 appeared in the control square below layer 5, and consisted of a brown soil with a low number of shells.

Layer 8 was a dense layer of mostly oyster shells, appearing in the western part of square C and in the eastern part of square D.

Layer 9 was the greyish-brown subsoil, sloping gradually southwestwards. This layer might have been the prehistoric land surface during the period of the midden formations.

Layer 9-1 was a yellowish-brown soil lens appearing within layer 9. This layer was basically the same as layer 9, with less organic material which may be the reason why there is a difference in colour.

Layer 10 was a dark brown soil layer, appearing below layer 9 at the southern part of square C. It contained comb-pattern potsherds.

Layer 11 was a greyish-brown shell layer with charcoal, ash and soil matrix and was found at square D on the floor of dwelling No.2.

Layer 12, found below layer 9 of the south section of square D, revealed comb pattern potsherds. This layer might be related to layer 10 in square C, although it was not continuously connected.

Layer 13 was the pre-cultural red subsoil or bedrock of the bottom-most layer.

STRUCTURES AND FEATURES (Fig.2.4 and 2.12-4)

Two dwelling pits 1 and 2 were found just beneath midden B-1 (Fig.2.12-3).
Fig. 2.9. Sections of the faces of control pit at midden B-1 (from Kim and An 1990:35).
Fig. 2.10. Sections of the faces of excavation squares at midden B-1 (from Kim and An 1970:36).

Fig. 2.11. Sections of the faces of excavation squares at midden B-1 (from Kim and An 1970:37).
Dwelling 1: It was rectangular in plan and measured about 4.7 x 3.1 meters (Fig.2.12). The depth of the pit was about 56cm at the north wall and about 10cm at the south wall, due to the sloping land surface from the north to the southwest. A single pit hearth, measuring 70cm in diameter and 10cm in depth, was found beside the centre of the floor and was filled with ashes and charcoal. The bottom of the hearth and the area near the hearth were fire-hardened. Around the hearth there were concentrations of broken potsherds, arrowheads and deer antlers indicating that it may have been central for activities such as food preparation and toolmaking, etc. An L-shaped drainage channel on the floor was uncovered along the east and north walls of the dwelling. It was filled with ashes, charcoal and soil matrix and measured about 10-20cm in width and 3-6cm in depth. Twenty holes of various sizes, irregularly distributed, were found in the floor and outside the walls. Some holes near the south wall, distributed at right angles to it, might relate to an entrance structure. Judging from the amount of charcoal on the north wall and floor, this dwelling might have been abandoned due to a fire.

Dwelling 2: It is located about 4m west of dwelling 1 (Fig.2.13). It was dug into the prehistoric land surface sloping from the north to the southwest and was L-shaped in section. The depth of the pit from the prehistoric land surface was about 40cm in the north, becoming shallower toward the south wall. However the depth at the south wall
was not certain, perhaps because the south wall was built on the same level as the land surface at that time. It is rectangular in plan, measuring about 3.5 x 2.4 metres. An oval-shaped pit hearth, measuring 70 x 80cm with a depth of about 10cm, was found just west of the centre of the floor. A hole 10cm in diameter and 7cm in depth was uncovered in the centre of the hearth, and a fire-fractured stone was found east of the hole in the hearth. Several scattered holes were also discovered in the floor and

![Diagram of dwelling 1 and pit structure](image)

**Fig. 2.12. Plan of dwelling 1 and pit structure beneath midden B-1 (from Kim and An 1990:40).**
outside walls. One big hole located about 45cm west of the hearth was possibly used as a storage pit. An L-shaped drainage structure, similar to that found at dwelling 1, was also uncovered along the north and east walls, measuring 4-10cm in width and 2-6cm in depth.

**Pit structure:** It was found about 60cm southwest of dwelling 1 (Fig.2.12). The pit was oval and measured 190 x 150cm. The depth of the pit was about 40cm at the north wall and became shallower to the south. It ran along the south limit on the same level as the surface of the subsoil because the subsoil tilted from the north to the south. It was filled with ashes, charcoal, and shells in soil matrix from top to bottom. The bottom of the pit, hardened by fire, was red. Small pot sherds were recovered from the ash layer. The function of the pit was not clear; perhaps it was used as a fire place associated with dwelling 1.

**Fireplaces:** Two open fireplaces were found between dwelling 1 and dwelling 2 (Fig.2.14, see also Fig.2.4) and in an area above the south wall of dwelling 1. Open fireplace 1 was discovered at the upper part of the subsoil (layer 9) in excavation square C. Its traces spread to an area of 2m in diameter. The area was hardened by fire and revealed burnt red soil and charcoal. Burnt shell and bone fragments were found between the charcoal, indicating perhaps shellfish cooking or barbeque activities. About 30 stones were concentrated at this
Fig. 2.13. Plan of dwelling 2 beneath midden B-1 (from Kim and An 1990:45).

Fig. 2.14. Open fireplace 1 beneath midden B-1 (from Kim and An 1990:54).
place. This fireplace might have been used before the shell deposits formed in pit 3, because one of two pieces of a broken ground stone was found down the slope, below shell layer 4, about 180cm south of the other piece found at the fire place.

The traces of hearth 2 spread above the eastern part of the south wall of dwelling 1 to the north-east corner of the control pit, below layer 5. It might have been used during the period of midden formation after the abandonment of dwelling 1 because it spread above the south wall of dwelling 1.

B. MIDDEN B-2 (Fig. 2.5 and 2.15)
Midden B-2 is located on the lower slope, about 20 meters west from midden B-1. The remaining main area of the shell midden was estimated to be about 13m x 5.6m, appearing generally semi-oval in outline. The midden centre was the area around the baulk left between squares A and B, revealing the thickest (up to 70cm) and widest distribution of midden deposits. The midden deposits became thinner approaching the southeast of square A and the southwest of square B, and faded out afterwards.

STRATIGRAPHY (Fig. 2.5 and 2.15)
The stratigraphy of shell midden B-2 consisted of 8 layers including the surface and the lowermost non-cultural layer (Fig. 2.14, see also Fig. 2.4).

The uppermost layer, layer 1, was a dark brown humus soil. Within it was midden material disturbed by farming. It was about 20cm thick.
Layer 2 was relatively dense shells in a blackish brown matrix (sandy clay soil). It consisted mainly of oyster shells. The thickness of this layer was about 30 cm.

Layer 3 was a highly dense shell layer in a little soil matrix. It appeared at the western part of square A, the eastern part of square B and the area of the north walls of both pits. The oysters were bigger than those of layer 2, at the north area of both squares there was a concentration of top shells. The thickness of this layer was up to 30 cm.

Layer 4 appeared at the southeast corner of square A and consisted of dark humus soil with some oyster fragments.

Layer 5 was a subsoil uncovered below the midden layers. This layer might have been the prehistoric land surface during the occupation period of the midden and the dwelling occupation associated with layer 9 of midden B-1.

Layer 6 was a black humus layer below layer 5 and was discovered in the section of the south face of square B. It was 5-15 cm thick.

**STRUCTURE (Fig. 2.16)**

**Dwelling 3:** It was found beneath midden B-2 (Fig. 2.16). It was estimated to have been about 4.1 m x 2.8 m, and was almost rectangular in shape. The dwelling penetrated the subsoil sloping from the north to the south. The depth of the pit was about 65 cm in the north wall, becoming shallower to the south wall. The trace of the south wall was not clear and it was thought that it might have been
Fig. 2.15. Sections of the faces of excavation squares at midden B-2 (from Kim and An 1990:38).

Fig. 2.16. Plan of dwelling 3 beneath midden B-2 (from Kim and An 1990:49).
on the prehistoric land surface. An oval-shaped pit hearth was uncovered slightly south of the center of the floor. It measured about 80 x 50cm, and penetrated the floor to about 10cm in depth. It was filled with ash. A lump of charred millet seeds was uncovered at the north-eastern corner of the house, and wood charcoal, possibly remains of burnt posts or roofing materials, was also found on the north wall. This house might have been abandoned due to fire, judging from the wood charcoal, charred millet and heat-hardened floor.
3. ARTEFACTS

This chapter deals with the artefacts recovered from the midden sites and the structures found beneath them. The purpose of the analysis is to understand the content and dynamics of prehistoric culture in this region. Due to the large quantity of artefacts found at the Konam-ri sites, it is difficult to deal with every individual find. Instead of doing this, samples of diagnostic items will be discussed. More detailed information on finds can be found in Kim and Sim (1990) and Kim and An (1990).

Artefacts will be dealt with briefly on the basis of materials, individual site and structure for convenience, instead of layer by layer of each site because no great difference between layers was noted.

3.1. ARTEFACTS FROM MIDDEN A-2 (based on Kim and Sim 1990)

3.1.1. COMB PATTERN POTTERY

A total of 630 comb pattern pottery sherds were recovered, but no complete pot was recovered. These sherds consist of 86 (13.6%) rim fragments, 538 (85.4%) body fragments and 6 (1%) base fragments. The rim sherds are almost all vertical (Fig.3.1.1—2), while the bases are round, indicating typical U-shaped comb pattern pottery (Fig.3.1.3—5).

Most of the rim sherds and about 65% of the body sherds have geometric patterns. The patterns can be roughly divided into three main groups. The first group has spaced, horizontal rows of vertical or inclined lines made with a comb-like implement (Fig.3.1.1—2). These
impressed or incised lines usually appear near the top of the body or at the rim. The second group has impressed dotted lines (Fig.3.1.6). This pattern also usually appears near the top of the body or at the rim. The third group has an incised herringbone pattern, made by using a comb-like implement (Fig.3.1.7). This pattern frequently appears on the body, however it also appears on some of the rim sherds, reflecting a feature of late Neolithic comb pattern pottery. Most of the herringbone pattern sherds have a crude irregular incised shallow lines, with only traces of the pattern. These features are also characteristic of late Neolithic comb pattern pottery. In addition to these three main patterns, several irregular geometric designs were also found. The fabric of the pottery is clay and tempered with fine quartz grains, mica, felspar, etc. The sherds are dark brown or red brown and from 0.4-0.8cm thick.

Fig.3.1. Comb pattern pottery and polished stone tools from midden A-2 (from Kim and Sim 1990).
3.1.2. STONE IMPLEMENTS

Two polished stone adzes were discovered from layer 6 (Fig.3.1.8-9). They have an oval cross section and a biconvex blade, all made of mudstone. One was 8.4cm long, 2.9cm wide and 2.0cm thick (Fig.3.1.9). The other was 7.8cm long, 3.6cm wide and 2.0cm thick (Fig.3.1.8).

3.2. ARTEFACTS FROM MIDDENS A-1, B-1 AND B-2 (based on Kim and An 1990 and Kim and Sim 1990)

3.2.1. POTTERY

A. PLAIN POTTERY

A great number of broken plain pottery sherds were recovered including two substantially complete vessels from midden A-1 (Fig.3.2.1-2), two from midden B-1 (Fig.3.2.3-4) and one from midden B-2 (Fig.3.2.5). Fig.3.2.1-2

Fig.3.2. Plain pottery from middens A-1, B-1 and B-2 (from Kim and An 1990; Kim and Sim 1990).
are shallow bowls with a flat base and a straight flaring body. Fig.3.2.3 is a bowl-shaped vessel with a flat base and straight flaring body. Fig.3.2.4 is a jar-shaped vessel with a flat base, globular-shaped body and a constricted and almost straight neck. Fig.3.2.5 is a small dish with a flat base and short out-curving body.

**RIM SHERDS**

Remaining pottery included rim, body and base sherds. The rim sherds can be divided into two main groups, deep flowerpot-shape (type I) and jar-shape (type II) vessels, assuming shapes based on bases and rims recovered. Type I can be further divided into in-curving (a) or straight (b) rims. This rim type can be divided into subgroups according to the presence (1) or absence (2) of notched stripes on the rim. Type II can be divided into rims with a short out-curving or straight neck (a), or with a relatively long straight neck (b: about 5cm in length). This type can also be sub-divided into sub-groups according to the presence (1) or absence (2) of notched stripes on the rim. Though these rim sherds can be divided into yet more subgroups according to small variations of detail, this has not been attempted in this thesis which is primarily concerned with organic remains. In some cases, it was difficult to classify sherds into groups a and b of types I and II; however, I attempted to classify them to the closest subgroup. The classification of rim sherds can be summarized as follows:
I. flowerpot shape
   a. constricted: 1. with notched stripes (Fig. 3.3.1)
      2. without notched stripes (Fig. 3.3.2)
   b. straight: 1. with notched stripes (Fig. 3.3.3)
      2. without notched stripes (Fig. 3.3.4)

II. jar shape
   a. short neck (straight or out-curving):
      1. with notched stripes (Fig. 3.3.5)
      2. without notched stripes (Fig. 3.3.6)
   b. long neck: 1. with notched stripes (Fig. 3.3.7)
      2. without notched stripes (Fig. 3.3.8)

Fig. 3.3. Plain pottery rim types (from Kim and An 1990).
Midden A-1: Among 70 rim sherds recovered from the midden and dealt with in Kim and Sim (1990), 64 rim sherds can generally be classified into the eight typological subgroups divided above (some rim sherds were classified into different group types from the classification by Kim and Sim, 1990). The remaining rim sherds were too small to allow classification, or were unique such as one double rim sherd. The frequency and proportion of each type are given in Table 3.1.

| SITE Layer | Type I | | | | Type II | | | | | | No (%) |
|------------|--------|---|---|---|--------|---|---|---|---|---|---|---|
| A-1 2/3/4 | 2/3/4 3 | | 7 | | 1 | | 0 | | 12 | | 14 | | 6 | | 13 | | 64 | | 4.7 | 10.9 | 1.5 | 12.5 | 18.8 | 21.9 | 9.4 | 20.3 | 100 |
| (%) | 4.6 | 10.2 | 13 | 46.3 | 7.4 | 6.5 | 3.7 | 4.6 | 3.7 | 100 |
| B-1 1 | 1 | | 4 | | 2 | | 1 | | 1 | | 3 | | 2 | | 1 | | 1 | | 16 | | 14.8 | | 19.4 | | 8.3 | | 26 | | 24.1 | | 3 | | 2.8 | | 1 | | 0.9 | | 15 | | 13.9 | | 1 | | 0.9 | | 7 | | 6.5 | | 4 | | 1 | | 1 | | 0 | | No | | 5 | | 11 | | 14 | | 50 | | 8 | | 7 | | 4 | | 5 | | 4 | | 108 | | 4.8 | 11.1 | 15.9 | 47.6 | 7.9 | 11.1 | 1.6 | 63 | 100 |

| B-2 1 | 2 | | 3 | | 4 | | 7 | | 22 | | 3 | | 7 | | 46 | | 73.0 | | 3 | | 1 | | 3 | | 1 | | 1.6 | | 9 | | 14.3 | | No | | 3 | | 7 | | 10 | | 30 | | 5 | | 7 | | 1 | | 63 | | 4.8 | 11.1 | 15.9 | 47.6 | 7.9 | 11.1 | 1.6 | 63 | 100 |

I. IIB?: those fragments missing the rim among IIB type.
II. SCP: shell layer in the control pit.
III. ?: other.

Table 3.1. The frequency and proportion of plain pottery rim sherd types from middens A-1, B-1 and B-2.
Midden B-1: Approximately 108 rim sherds were recovered. The frequency and proportion of each type are given in Table 3.1 for comparison. As can be seen from this, type IB1 was the most abundant rim type among those recovered from midden B-1, and is followed by IB1 and IA2 types. The remaining types are less frequent. It is worth noting that type I are mainly found in earlier layers (layer 6 and 9), while the appearance of type II generally increases in later layers (layer 3, 4 and 5). This fact would reflect some process of change in pottery types (see Chapter 8).

Midden B-2: Approximately 63 rim sherds were recovered and had basically the same attributes as those recovered from midden B-1 except for the absence of types IIA1 and IIA2. The frequency and proportion of each type are given in Table 3.1. As can be seen from Table 3.1, type IB2 is the most abundant among those rim sherds recovered from midden B-2, and is followed by types IB1, IIB2 and IA2. This is a similar pattern to the rim sherds found in midden B-1.

BASES

About 80 bases were recovered from midden A-1, 75 from midden B-1 and 50 from midden B-2. They are all flat, although small variations are observable (mentioned in Kim and An 1990:74). Base diameters vary from 5.9 to 11.5cm in midden A-1, 7.8 to 14.3cm in midden B-1 and 6.2 to 13.0cm in midden B-2.
GENERAL CHARACTERISTICS

The fabric of the plain pottery is of clay tempered with quartz grains. The vessels had been fired in the open air at a relatively high temperature, being yellowish or reddish brown, and some of them had a greyish spot on the outer or inner surfaces. Inner or outer surfaces were treated by a wet hand, brushing or beating with paddle implement techniques.

However there was a difference in the paste between the jar (IIB type) which had a relatively longer neck than the others. The paste of IIB type pot sherds is very fine and greyish or yellowish brown, with a temper of fine quartz grains. This indicates a special selection of fabric and temper for the vessels. The difference in the shape and paste between IIB type and the other types may be related to the different functions of the vessels. The deep flowerpot type pottery made from relatively coarse fabric might be a cooking pot, while IIB type might have a storage function. Some of the pot sherds of IA and IB and IIA contained burnt materials, possibly food remains, inside the sherds.

B. RED-BURNISHED POTTERY

Midden A-1: 186 red burnished pottery sherds were recovered, in addition to four complete vessels (Fig.3.4. 1-4). The complete vessels have a general a bowl shape with a flat base and constricted rim.

Among the 186 remaining sherds, 51 (27%) are rim sherds and of these 51, 26 can be classified into rim
sherds of three main vessel types: bowl (type I which are basically similar to those complete vessels mentioned above) with a constricted or straight rim; or jar with a short neck and wide mouth (type II, Fig.3.4.5-6), or with a long and narrow neck and mouth (type III, Fig. 3.4.7-8). Eleven (42.3%) specimens are type I, 9 (34.6%) type II, and 6 (23.1%) type III. Based on the complete vessel, it can be suggested that types I and II might have had flat bases while type III had a round base. Among the specimens, Fig.3.4.8 has the typical shape of red-burnished pottery with a globular-shaped body, constricted out-curving neck and rim, and possibly a round-shaped base although the base was broken. This type of pottery has been discovered from Bronze Age burials. The vessel shown in Fig.3.4.7 has a relatively straight neck and a body with the maximum body diameter at the lower part of the body. This type of pottery was found at the Songguk-ri dwelling sites in Puyŏ (possibly occupied at the same period as the Konam-ri shell middens A-1, B-1 and B-2, see Chapter 8). This indicates cultural contact between the Konam-ri sites and the Songguk-ri sites.

Twenty five bases were recovered from the midden and can generally be classified into three types: type I flat bottom connected to a body without constriction (Fig.3.4.9); type II flat bottom with constricted or straight sides (Fig.3.4.10-1); and type III round bottom (Fig.3.4.12-3). Among the 25 base sherds, 5 (20%) sherds are type I, 25 (72%) type II and 2 (8%) of type III. Type II is similar in shape to the plain pottery discovered at the site.
Midden B-1: Red-burnished pottery sherds including rim sherds of ten vessels and four bases, were recovered. The rim sherds are a straight rim type of a bowl-shaped pot and a constricted rim type of a jar-shaped pot with an out-curving neck or a short straight neck (Fig. 3.4.14). All bases were flat except a roundish one (Fig. 3.4.15).

Midden B-2: Red-burnished pottery sherds, which include the rim sherds of eight vessels and a base, were recovered. The rim sherds include the straight rim type of a possibly bowl-shaped vessel and the rim type of a jar-shaped vessel with a straight neck (Fig. 3.4.16). In addition, a vessel of a typical red-burnished pottery shape was found, with a globular body, a long neck and an out-curving rim (Fig. 3.4.17). Although the base of this

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Fig. 3.4. Red-burnished pottery from middens A-1, B-1 and B-2 (from Kim and An 1990; Kim and Sim 1990).
vessel is missing, it may be assumed to have been round as those of this typical shape tend to be.

The red-burnished pottery recovered from Konam-ri shell middens A-1, B-1 and B-2, is made of fine clay paste tempered mainly with fine quartz, mica and felspar. The outer surface of the vessels and the inner surface of the necks are red-painted and are burnished with a implement. One specimen has red paint mixed with mica on the outer surface. The remaining inner surface is smoothed by techniques such as wet hand or brushing, etc., and were yellowish or reddish brown in colour.

3.2.2. POTTERY IMPLEMENT

In addition to pottery vessels, one disk-shaped pottery spindle whorl was recovered from midden B-2 (Fig.3.5.1). The central hole is vertically perforated from one side. The clay fabric is brown and tempered by sand grains as those of plain pottery.

3.2.3. STONE IMPLEMENTS

A. ARROWHEADS

A total of 34 polished arrowheads were uncovered from midden A-1, 40 from midden B-1 and 16 from midden B-2. Almost all of them were broken, indicating that they were discarded into the shell middens because they had been damaged. Most of them are stemmed and had a diamond body cross section (Fig.3.5.2-3), although some variations are recognizable in detailed shape (including some with a
Among the 34 specimens recovered from midden A-1, 29 (85%) are made of schist, four (12%) of slate and one (3%) of sandstone, showing a preference for a particular raw material. Among 40 specimens recovered from midden B-1, 27 (67.5%) are made of schist, nine (22.5%) of slate, three (7.5%) of phyllite and one (2.5%) of sandstone. And among 16 recovered from midden B-2, eight (50%) specimens were made of slate, four (25%) of phyllite and four (25%) of schist. According to a geologist (Yoon-kyu Kim, personal communication) these raw materials are all available in Anmyon Island.

B. AXES
Nine stone axes were discovered (Fig.3.5.6-8). Five of these were found in shell layer 2 of midden A-1 and layer 3 beneath the shell layer (Fig.3.5.6-7), while the remaining four were from layer 6 of a Neolithic cultural layer (Fig.3.5.8). Most of them might have been in the process of manufacture, showing chipped irregular edges and surfaces, although the possibility of actual use cannot be excluded. They are made of granite gneiss, with one exception which is made of granite.

C. ADZES
Ten polished stone adzes were recovered from midden A-1 (Fig.3.5.9), three from midden B-1 (Fig.3.5.10) and four from midden B-2. They are flat on one side and rounded on the other, and are oval in cross section. Most of them have
a blade on the flat side. Fig.3.5.10 is possibly made of schist and has two ground parallel lines on one side of the blade; one line extends to the blade and the other to the upper portion of the side. This adze might also have been used as a grinding stone to make stone tools such as arrowheads, or for sharpening blades.

In addition, five broken grooved adzes were found: three from midden A-1; one from B-1 (Fig.3.5.11); and one from midden B-2. One of them (Fig.3.5.11) has an oval cross section with a groove on the upper portion of one side. Most of the upper portion is missing.

D. GROOVED STONE TOOLS

Fourteen stone implements with central grooves on both flat sides were recovered from midden A-1 (Fig.3.5.12-3) and two from midden B-2. Most of them have large bi-grooved centres (made by percussion techniques) on both flat sides, however, some of them have 3 or 4 depressions on 3 or 4 sides (Fig.3.5.13). They are mainly made on pebbles: six of them are made of sandstone, four of quartzite, two of granite gneiss, two of steatite, one of granite and one of quartz. Most of them have traces of chopping on the margins and three of them showed a trace of grinding in addition to chopping, indicating that they were multi-function tools. These tools might have been used for tool-making or for opening shells.

Most of the gastropod shells recovered from the middens have perforated body whorls (Fig.3.6). It seems that these broken body whorls might be related to the
Fig. 3.5. Pottery spindle whorl and stone tools from middens A-1, B-1 and B-2 (from Kim and An 1990; Kim and Sim 1990).

Fig. 3.6. Perforated rock shells (Rapana venosa) recovered from midden A-1.
extraction of flesh from the shells and these types of stone tools might be used for that purpose.

E. KNIVES

Six polished triangular- or semi-lunar-shaped stone knives were discovered from midden A-1. Two of these are triangular in shape with two perforated biconical holes (Fig.3.5.14-5). One of these has an alternative blade on both side (Fig.3.5.14). The other has a blade on one side (Fig.3.5.15).

F. OTHERS

Midden A-1: Nine polished stone chisels, three pebble hammerstones and fragments of polished stone implements such as three daggers, a grinding quern and a rubbing pestle were recovered. Several chipped stone implements, some of which might have been used and others in the process of manufacture, were also discovered.

Midden B-1: Three hammerstones, three grindstones, a polished stone chisel (Fig.3.5.16), a stem portion of a polished stone dagger, a fragment of a mace head, a broken polished dagger-shaped stone implement and a polished saw-shaped stone implement (possibly used as a grindstone) were found. In addition, fifteen other stone implements, including chipped ones, were also recovered. These might have been either those in the process of manufacture, or waste flakes remaining from the tool-making process.

Midden B-2: Two pointed parts of two broken polished daggers, two broken disc-shaped spindle whorls, two
grindstones, a quartz crystal point and several chipped or unfinished stone implements were also recovered.

3.2.4. JADE ORNAMENT

A comma-shaped ornament was found from midden B-1 (Fig.3.7.1). It is made of green jadeite and is almost rectangular in cross section with a biconical-shaped hole perforated from both sides. It is 1.6cm long, 0.6 cm wide and 0.35cm thick.

3.2.5. ANTLER AND BONE IMPLEMENTS

One deer antler object was discovered from midden A-1 (Fig.3.7.2) and six from midden B-1 (Fig.3.7.3-8). Most of them are nearly oval or diamond-shaped in cross section. They are well ground all over and might have been used as arrowheads, spearheads or points.

Ten needles were recovered from midden B-1 and one from midden B-2 (Fig.3.7.9-11). They are well polished and generally oval in cross section. Five of them are made of the tail spines of rays and the others of bones or deer antler. Most of them have an eye conically or bi-conically drilled from one or both sides. One complete specimen is 4.2cm in length and 0.2cm in diameter (Fig.3.7.9). The wide end is square and very thin but there is no eye.

Two fish-hooks were found in midden B-1 (Fig.3.7.12-13). They are made from the tusks of wild boar and are well ground. The complete one is a J-shaped one-piece fishhook without a barb and is 3.2cm long and 1.6cm wide (Fig.3.7.12). The hook-shaft is rectangular in cross
section and the hook-bend is round. The line might have been attached in the middle of the hook-shaft as this point is slightly grooved to prevent the line from slipping off. The other fish-hook is broken. Its shape may have been similar to that of the complete one. The middle part of the straight body was also depressed perhaps to fix the line more securely on the hook.

Two bone points were discovered from midden B-1. One is ground around the pointed area (Fig.3.7.14). The other is ground totally, however the upper portion is missing (Fig.3.7.15).

Several worked bone and antler objects were recovered from middens B-1 (Fig.3.7.16-21). Among these one antler tip shows use; it has a flattened ground area at one end and an irregular shape at the other (Fig.3.7.21). The other objects were either unfinished objects or debitage remaining from the bone tool manufacture.

In addition, a broken ground tail spine of a ray was discovered from midden B-2.

3.2.6 SHELL IMPLEMENTS

Midden A-1: A shell sinker was discovered (Fig.3.7.26). It is made from a clam (Meretrix lamarcki) perforated at the umbo area, allowing it to be attached to the net.

Midden B-1: Three shell objects were recovered. One is made of a limpet shell (Fig.3.7.22). The apical area is removed and ground, making a wide hole. The natural exterior surface and the lower edge of the shell are also ground. It is 3.2cm in diameter. The others are made of
olive shells. The apical area of the shells is perforated and ground and the denticile is also ground. One of them is 2.4cm long (Fig.3.7.23).

**Midden B-2**: Two shell objects were recovered. One is made of ark shell, *Tegillarca granosa* (Fig.3.7.24). The portion of the central part has been removed and ground, and the outer edge and exterior surface were ground. The other object is made of ark shell, *Scapharca broughtorii* (Fig.3.7.25). Although it is broken, the remaining part includes the umbo area and part of the dorsal and anterior margins. It is like a bracelet in shape. The teeth under the umbo, and the surface as well as the edges, are ground.

![Fig.3.7. Jade, shell, bone, tusk and deer antler objects from middens A-1, B-1 and B-2 (from Kim and An 1990; Kim and Sim 1990).](image-url)
3.3. ARTEFACTS FROM DWELLING 1 (based on Kim and An 1990)

3.3.1. POTTERY
Two complete vessels were recovered (Fig. 3.8.1-2). These are deep flowerpot-shaped vessels, each with a flat base and a straight rim. They are made from a clay fabric mixed with sand grains and are fired at a relatively high temperature. They are reddish or dark brown in colour. The surface of these vessels are smoothed by using a wet hand or brush. They have U- or V-shaped notched stripes at irregular intervals on the rim. In addition to these two vessels, a number of body fragments of plain pottery were recovered.

3.3.2. STONE IMPLEMENTS
Three fragments of polished arrowheads were discovered (Fig. 3.8.3-4). These are made of schist, and are diamond-shaped in cross section. A polished adze (Fig. 3.8.6), a hammerstone (Fig. 3.8.5), two broken grindstones and one rubbing stone (Fig. 3.8.7) were discovered.

In addition, one schist polished arrowhead, one broken felsite grindstone and one fragment of a sandstone rubbing stone (Fig. 3.8.8) were found from the deposited soil layer on the floor of the house.

These stone implements from the dwelling site have the same features as those recovered from the midden sites.

3.3.3. ANTLER AND BONE IMPLEMENTS
Two willow-leaf-shape deer antler implements were found (Fig. 3.8.9-10). They are well polished and nearly oval in
cross section. They might have been used as arrowheads or spearheads. In addition to these two willow-leaf-shape antler implements, two deer antler implements, possibly arrowheads or spearheads (Fig.3.8.11-2), as well as one bone drill (Fig.3.8.13) were discovered from the deposited soil layer on the floor of the house. The arrowhead is stemmed and diamond-shaped in cross section, with similar features to the stone arrowheads.

Fig.3.8. Artefacts from house No.1 beneath midden B-1 (Kim and An 1990).
3.4. ARTEFACTS FROM DWELLING 2 (based on Kim and An 1990)

3.4.1. POTTERY

Six plain pottery sherds, all body fragments, were recovered. As they are small fragments, with the same features as other plain pottery sherds, they have been excluded from a detailed study.

3.4.2. STONE IMPLEMENTS

A broken polished arrowhead and a saddle quern were discovered. The flat quern discovered leaning against the east wall is made of sandstone (Fig. 3.9.1).

Three polished arrowheads (Fig. 3.9.5) and three drill-shaped quartz crystal implements (Fig. 3.9.2-4) were discovered from the soil deposited on the floor of the dwelling.

3.4.3. ANTLER AND BONE IMPLEMENTS

One bone and two antler objects were discovered from the deposited soil layer on the floor of the dwelling (Fig. 3.11.6-8). Among these antler objects, one is bipointed, well polished, and an oval in cross section (Fig. 3.9.7).

![Fig. 3.9. Artefacts from house No. 2 beneath midden B-1 (from Kim and An 1990).](image)
The other is broken, but it might have been similar in shape to the former (Fig.3.9.6). The bone object is pointed on one side (Fig.3.9.8) although the pointed part is broken. It is partly polished along both long edges, and oval in cross section.

3.5. ARTEFACTS FROM DWELLING 3 (based on Kim and An 1990)

3.5.1. POTTERY

A number of plain pottery vessels were recovered, including two complete specimens. These two specimens are deep flowerpot-shaped vessels made from a clay fabric and tempered with sand grains (Fig.3.10.1-2). One (Fig.3.10.2) has irregularly notched stripes on the rim. The surface of the vessels is treated by wet hand and brushing techniques. In addition, two flat bases, two rim sherds and several body sherds were recovered. Among these one base is red-painted and treated by brushing techniques (Fig.3.10.3).

From the soil layer on the floor of the dwelling, a number of plain pottery sherds were discovered including a bowl-shaped vessel (Fig.3.10.4), bases and rims. It is worth noting the location of the sherds of one of the vessels (Fig.3.10.5): they were found in layer 5 (the prehistoric land surface beneath midden B-2), in the deposited soil layer of dwelling 3 and in layer 9 (the prehistoric land surface beneath midden B-1) of midden B-1. This might indicate that dwelling 3 was used and abandoned before midden B-1 formed.
3.5.2. STONE IMPLEMENTS

A polished arrowhead (Fig.3.10.6), a saddle quern (Fig.3.10.9) and two grindstones (Fig.3.10.7-8) were discovered from the dwelling site. The arrowhead is diamond-shaped in cross section and made of schist. The quern is made of sandstone and is 42.5cm long, 21.8cm wide and 6.6cm thick. In addition to these, a grindstone and a chipped stone implement were also found in the deposited soil layer above the floor of the house.

3.5.3. ANTLER IMPLEMENTS

A broken antler drill, oval-shaped in cross section, was uncovered. It is well polished, making one pointed end (Fig.3.10.13). In addition, three other antler objects were recovered. Among these one antler tip shows traces of use on the pointed end (Fig.3.10.10). The remaining two antler objects are made out of the beam or tine of deer antler (Fig.3.10.11-2). One end of these objects is carved with a stone tool; the scratches made by this tool can still be seen, and the object might have been abandoned while in the process of manufacture.

Fig.3.10. Artefact from house No.3 beneath midden B-2 (from Kim and An 1990).
3.6. ARTEFACTS FROM PIT STRUCTURE AND OPEN FIRE-PLACES
(based on Kim and An 1990)

From the pit structure and open fire-places, a number of plain pottery and red-burnished pottery sherds including a jar-shaped vessel (Fig. 3.11.1), were discovered. These have the same features as other pottery sherds recovered from the middens and dwellings. The jar-shaped red-burnished pot sherd was recovered from open fire-place 1. The maximum body diameter is at the lower part of the body and from that point it curves inwards, to give a constricted neck. It is made of a fine clay paste mixed with fine sand grains and has a wall thickness of about 0.6cm. The outer surface is red-painted and burnished and the inner surface is a yellowish-brown in colour.

Two pieces of a broken grindstone were discovered (Fig. 3.11.2). One was from open fire-place 1 and the other was from the surface of the subsoil (layer 9) beneath the shell layer (layer 4). As the latter piece was discovered 1.8m south of the other part, this would indicate the fire-place was used before shell layer 4 formed. It is made of sandstone and shows grinding traces on one flat side.

Fig. 3.11. Artefacts from open fireplace No.1 beneath midden B-1 (from Kim and An 1990).
3.7. SUMMARY

The characteristic features of the artefacts recovered from the sites can be summarized as follows:

Looking at pottery first, the comb pattern pottery sherds recovered from midden A-2 are similar in patterning methods and the paste used to those of the final stage of this pottery type from the western coast of the Korean peninsula. The patterns applied are crude and simple, and the clay fabric is close to that of Bronze Age plain pottery (on visual observation). The pots are generally fired at high temperatures, producing fine and hard vessels.

There are two main groups of plain pottery: deep flowerpots (type I) and jars (type II). The former group is the type common in the early plain pottery phase in the central western area of the Korean Peninsula, discovered in earlier dwelling sites such as Hŭnam-ri (SNUM 1973, 1974, 1976 and 1978), Yŏksam-dong (Yi 1986:33), Hyuam-ri (NMOK 1990) and so on. The latter group was also found at these same sites and the Songguk-ri sites (NMOK 1979, 1986 and 1987). However the assemblages of type II vessels recovered from the Songguk-ri dwelling sites differ from the above three sites (Hŭnam-ri, Yŏksam-dong and Hyuam-ri) with the absence of stripes on the rims (except one example: the specimen recovered from passgeway 21). This difference may be related to chronological sequences between the sites. Songguk-ri sites are thought to belong to a later period than the above three sites (see Chapter 8).
In the plain pottery assemblages from the Konam-ri sites, midden A-1 contain more type II pottery sherds than middens B-1 and 2 (see Table 3.1). This may indicate a time gap between these sites; midden A-1 seems to be slightly later than middens B-1 and 2.

Red-burnished pottery consists of bowls and jars. This pottery recovered from the Konam-ri sites is similar to that of the Songguk-ri sites in terms of assemblages and shapes.

Various stone, bone, antler and shell objects were recovered from the sites and are summarized in Tables 3.2 and 3. This may relate to different functions and usage of each object. The functions of these objects can be divided into several groups: hunting tools such as arrowheads and spearheads; fishing tools such as fish-hooks, spearheads and a net sinker; farming tools such as triangular- or semi-lunar-shaped knives and grooved adzes; tools for daily use and wood-working such as axes, chisels, adzes, drills, needles, daggers, spindle whorls, hammerstones, grindstones, rubbing stones, saddle querns and so on; and ornaments such as comma-shaped jade and shell objects.

Finally, the fact that these various kinds of objects were recovered from the midden in association with plenty of food debris, such as shells, animal bones and cereals (discussed in Chapters 4 and 5) may indicate that the middens were home-base sites rather than simple shellfish processing ones which producing mainly shells.
<table>
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<td>B-1</td>
<td>B-2</td>
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Table 3.2. List of stone and jade objects found from the Konam-ri shell middens and houses.

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</thead>
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<td>B-1</td>
<td>B-2</td>
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</table>

Table 3.3. List of bone, antler and shell objects found from the Konam-ri shell middens and houses.
4. THE ANALYSIS OF THE MIDDEN COMPONENTS

In this chapter, the non-artefactual midden components will be described and analyzed. The purpose of doing this is to obtain information on the composition of the middens. The information can be used to reconstruct midden formation processes and past subsistence patterns and environment.

To obtain the information, the midden components will be studied quantitatively, using bulk and column samples of the midden deposits. The relative proportions of the major midden components will be generally described in this chapter. Among the components, molluscs, animal and human bones and plant remains will be studied in detail in the following chapters.

4.1. METHODS

4.1.1. SAMPLING

Midden samples were collected to estimate the components of the middens. Bulk samples (40 x 40 x 5cm) of each shell layer were collected from the remaining baulks and some areas of the excavation squares. In addition, column samples (25 x 25 x 5cm) were taken from several areas of the middens (see Fig.2.4-5 for the location of the samples). Rare shell species were collected individually by hand during the excavation process. Because bulk and column samples were obtained from limited areas of the middens, one can not assume that these samples included all rare shell species.
The samples used in this midden analysis were chosen from the collected bulk samples. Time pressure forced me to select samples because it took about one week to analyze each sample. Samples were chosen to represent each of the shell layers of the middens, and in regard to the preservation condition of shells. The locations where the samples were taken from are as follows:

**Midden A-1**: Four samples from layer 2 of the midden were analyzed: one from the south wall of square B-3; two from the north wall of square C-1; and one from the west wall of square C-2.

**Midden A-2**: Three samples were used: one from the upper part and two from the lower part of the north wall shell layer of square D-3.

**Midden B-1**: Eleven samples were analyzed: one from layer 3 of the east wall of square B; two from layer 4 of the south walls of squares B and C; two from layer 5 of the east wall of square B; two from layer 6 of square B and its east wall; one from layer 8 of the west wall of square C; two from layer 11 of square D; and one from layer 12 of the south wall of square D.

**Midden B-2**: Four samples were analyzed: two from layer 2 of square A and its west wall and two from layer 3 of the square B and its east wall.
4.1.2. LABORATORY PROCEDURES

The following procedures for the component analysis of the midden deposits were applied to each collected bulk sample:

1) Samples were brought to the laboratory and dried in natural conditions.

2) Each dried sample was weighed. The samples ranged in weight from 4.5 to 6.5kg. When more than two samples were collected from each layer, their mean value was calculated and used in the midden component analysis.

3) Preliminary sorting: bigger items such as shells, pebbles and pottery sherds were separated to avoid damage to the shells during the wet sieving process. The bigger shells were washed using a gentle stream of tap-water with a soft brush to remove the soil matrix. During this process, the washed soil was passed through 3mm and 0.5mm mesh sieves from top to bottom to obtain small shell fragments, small marine and land molluscs (which were possibly mixed with the soil matrix) and bigger sediment particles for analysis.

4) Dry-sieving: the remaining materials of the midden samples were dry-sieved at first with 0.5mm mesh sieve. About 50g of midden components which had passed through the sieve were collected from each sample. These subsamples of fine midden materials smaller than 0.5mm were used for estimating a pH value and fine shell proportion in the fine soil matrix smaller than 0.5mm particle size.

5) Wet-sieving: the remaining midden materials after dry-sieving were wet-sievied using 3mm and 0.5mm sieves.
6) The midden components remaining on the sieves were dried separately according to their individual sieve size.

7) The coarse fraction larger than 3mm was sorted into several categories and weighed according to materials such as sediment particles, molluscs, bones, artefacts and charcoal. The residue smaller than 3mm was not sorted into the same categories because it would have been very difficult to do so by eye. Only small marine and land snails were picked out from the remaining midden material (between 0.5mm and 3mm) using a binocular microscope.

8) The sorted midden materials of each sample were weighed.

9) In order to estimate the proportion of shells and sediment smaller than 3mm about 50g of items smaller than 3mm was taken from the unsorted midden material of each sample. The subsample of soil matrix with fine shell fragments was weighed and soaked in 10% hydrochloric acid to dissolve the shells from the matrix. This process was repeated until the reaction between the shells and the hydrochloric acid finished. The remaining sediment was dried and weighed to estimate the ratio of shell weight to sediment weight in each sample. The subsamples of soil matrix with fine shell fragments smaller than 0.5mm which were obtained in the process of dry-sieving (stage 4), were analyzed using the method mentioned above.

10) The proportion of individual midden components in each sample was estimated based on data obtained from the procedures set out above.

11) Shells retained in the 3mm sieves were sorted into
individual species and weighed to estimate the proportion of individual shell species in each sample: to reconstruct dietary preferences and the prehistoric environment, and to identify shell collecting areas (see section 5.1). In addition, small terrestrial and marine molluscs were sorted into individual species and were counted to study the terrestrial and marine environment of the prehistoric period and to reconstruct marine shell collecting behaviour (see sections 5.1 and 5.2).

12) Finally, measurements of the pH value of the soils were made, using a soil pH meter. Dried 10ml samples of soils obtained by dry-sieving (stage 4) were mixed with distilled water, making 20ml of soil paste. The soil pastes were stirred for several minutes. The pH values of the soils were then measured.

4.2. RESULTS

4.2.1. MIDDEN COMPONENTS

The results of the analysis of the midden components show that the middens consisted mainly of shells with some soil matrix and with other materials such as potsherds, flakes of stone tools, and the remains of bone and charcoal. The relative proportions of the components and pH values of each midden are given in Table 4.1 and Fig.4.1.

Midden A-1: The midden was composed of 85.2% of shells with 4.4% of gravels, 9% of soil and 1.4% of other materials.
Midden A-2: The upper shell layer consisted of 78.6% of shells, 16.7% of gravels, 4.5% of soil and 0.2% of other materials, while the lower shell layer of the midden consisted of 82.4% of shells, 13.5% of gravels, 4% of soil and 0.1% of other materials. The relatively high proportion of small stones in these two layers may have been due to oysters which were brought into the sites having been attached to a rock substrate (Fig.4.2).

Midden B-1: The shell compositions of the midden varied according to the shell layers, ranging from 20.7% to 86.9%. This variation is probably related to the formation process of the midden: layer 6 could have accumulated at a faster rate than others; especially the higher soil

<table>
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<th>SHELL (%)</th>
<th>SOIL MATRIX (&lt;3mm)</th>
<th>OTHER (%)</th>
<th>TOTAL (%)</th>
</tr>
</thead>
<tbody>
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<td>2</td>
<td>7.65</td>
<td>85.2</td>
<td>4.4</td>
<td>9.0</td>
<td>1.4</td>
</tr>
<tr>
<td>A-2</td>
<td>UPPER</td>
<td>7.75</td>
<td>78.6</td>
<td>16.7</td>
<td>4.5</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>LOWER</td>
<td>7.78</td>
<td>82.4</td>
<td>13.5</td>
<td>4.0</td>
<td>0.1</td>
</tr>
<tr>
<td>B-1</td>
<td>3</td>
<td>7.94</td>
<td>64.6</td>
<td>11.1</td>
<td>23.7</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>7.96</td>
<td>57.5</td>
<td>11.6</td>
<td>30.1</td>
<td>0.8</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>8.06</td>
<td>43.0</td>
<td>9.0</td>
<td>47.9</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>7.95</td>
<td>86.9</td>
<td>3.2</td>
<td>9.2</td>
<td>0.7</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>7.91</td>
<td>85.2</td>
<td>5.5</td>
<td>9.1</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>8.03</td>
<td>28.9</td>
<td>14.3</td>
<td>56.7</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>7.96</td>
<td>20.7</td>
<td>18.5</td>
<td>60.7</td>
<td>0.1</td>
</tr>
<tr>
<td>B-2</td>
<td>2</td>
<td>7.96</td>
<td>67.8</td>
<td>8.6</td>
<td>23.3</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>7.97</td>
<td>91.1</td>
<td>1.8</td>
<td>6.7</td>
<td>0.4</td>
</tr>
</tbody>
</table>

Table 4.1. The relative proportion (%) of the midden component weight of the Konam-ri shell middens (based on bulk samples collected from shell layers of the sites).
The relative abundance of the midden components of the Konam-ri shell middens (based on data from table 4.1).

Fig. 4.2. Oyster shells attached to gravel substrate.
proportion of layer 11 and 12 may suggest a slower formation speed compared to the others. It was noted that in layer 5 of midden B-1, there was a difference between my field observation and the result of analysis of a sample in terms of shell component estimation. During the excavation, layer 5 was observed as a layer with a very low shell component. Although it is relatively low compared to the others, the result of analysis of sample collected from the layer still showed 43.0% of shells. This might be related to the sampling error because of the thinness of the layer.

Midden B-2: Layer 2 of the midden consisted of 67.8% of shells, 8.6% of gravels, 23.3% of soil and 0.3% of other materials, while layer 3 showed the highest shell proportions (91.1%) among the midden layers with 1.8% of gravels, 6.7% of soil and 0.4% of other materials.

In summary, the analysis of midden components showed that the shell layers of middens A-1 and A-2 and main shell layers of midden B-1 (layer 6 and 8) and B-2 (layer 3), were composed of around 80% of shells, indicating that these shell layers have accumulated at a faster rate than others. This interpretation is also supported by better preserved shell conditions recovered from these layers and by a smaller number of land snails (see section 5.2), compared to those recovered from other layers: if a shell layer accumulated at a slower rate, there would be a higher chance that land molluscs lived on the surface compared to a layer which accumulated faster.
4.2.2. MEASUREMENTS OF pH VALUES

The result of the soil pH test showed that the pH values of the soil components of shell layers of the middens ranged from 7.65 to 8.06. At these levels shells and animal bones can be relatively well preserved compared to the more acid soil outside the shell middens. The pH values of the soil layers beneath the shell layers ranged from 7.13 to 7.47 in middens A-1 and 2 and from 8.03 to 8.10 in middens B-1 and 2. The alkaline condition of the soil samples beneath the midden layers might be due to dissolved calcite from the shells penetrating down into the soils.
5. ANIMAL REMAINS

5.1. MARINE MOLLUSCS

5.1.1. SHELLFISH COLLECTING BEHAVIOUR AND ENVIRONMENTAL INFORMATION

The distribution of marine molluscs depends on the physical and chemical conditions of the sea such as salinity, temperatures, substrate, depth, topography of the coastal areas, etc. (Matsushima and Ohshima 1974:137). Because of this we can deduce where shellfish were collected in the past and the coastal environment at that time. The overall feature of shellfish collecting behaviour and the coastal environment in which shellfish collecting might have been carried out can be reconstructed by species identification of the shells recovered from middens and by studying their habitats. Because the shell species recovered from the middens were selected by humans for food or as ornaments, they may not represent a picture of all of the species to be found near the sites. In addition, some may have been consumed offsite. Therefore there is a possibility of a bias in the reconstruction of the coastal environment based solely on shell species recovered from sites. A study of the habitats of molluscs in order to reconstruct the coastal environment is still a valid method to use because the shells found were almost certainly collected not far from the sites and can provide information on the coastal environment.

A. LARGE MARINE MOLLUSCS

The molluscs species recovered from the Konam-ri shell
middens and their habitats are given in Tables 5.1—2 (based on Habe and Kosuge 1967; Hokuryukan 1973; Matsushima and Ohshima 1974; Esaka 1983; Yoo 1986). The shell species listed in the tables are those which might be collected for consumption or raw materials for shell artefacts. Among these identified species, some species, which were not included in the column and bulk samples due to their rarity, were collected by hand during the excavation and are marked with a ‘*’ in the tables.

As can be seen in Tables 5.1—2, only marine shells were exploited. There is a difference in species assemblages between the middens. Middens A—1, B—1 and B—2 are of a later period than midden A—2 and show more diversity in shell species exploited. This might suggest that people of a later period collected more diverse shellfish resources than those of the earlier period.

There is however a possibility of a bias in recovering the shell species exploited because the surviving area of midden A—2 was small in comparison to middens A—1, B—1 and 2.

The shellfish collecting areas can be inferred, based on the habitats of the shells recovered from the middens. As can be seen in Tables 5.1—2, the habitats of the shells can be divided into three groups:

A: Intertidal zones,
B: Intermediate group inhabiting from intertidal to shallow water (i.e. sub-tidal).
C: Shallow water.

The shell species of group A were abundant in the middens
<table>
<thead>
<tr>
<th>GROUP</th>
<th>SPECIES</th>
<th>A-1</th>
<th>A-2</th>
<th>B-1</th>
<th>B-2</th>
<th>HABITAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Batillaria cumingii</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
<td>intertidal zones facing open sea, sandy mud bottoms</td>
</tr>
<tr>
<td></td>
<td>Cerithidea rhizophoratum</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
<td>intertidal mud flats</td>
</tr>
<tr>
<td></td>
<td>Cerithideopsilla diadjanensis</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
<td>intertidal zones, sandy mud bottoms</td>
</tr>
<tr>
<td></td>
<td>Chlorostoma argyrostroma lischkei</td>
<td>++</td>
<td></td>
<td>+</td>
<td></td>
<td>intertidal, rocks</td>
</tr>
<tr>
<td></td>
<td>Lunella coronata corensei</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
<td>intertidal, rocks</td>
</tr>
<tr>
<td></td>
<td>Ocenebra japonica</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
<td>intertidal, rocks</td>
</tr>
<tr>
<td></td>
<td>Thais clavigera</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
<td>intertidal, rocks</td>
</tr>
<tr>
<td>B</td>
<td>Acmaea pallida</td>
<td></td>
<td></td>
<td>+#</td>
<td></td>
<td>from intertidal to shallow water up to 20m, rocks</td>
</tr>
<tr>
<td></td>
<td>Lunatia fortunei</td>
<td></td>
<td>+#</td>
<td>+#</td>
<td></td>
<td>from intertidal to shallow water up to 30m?</td>
</tr>
<tr>
<td></td>
<td>Rapana venosa</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
<td>from intertidal to shallow water up to 20m, sandy mud bottoms</td>
</tr>
<tr>
<td></td>
<td>Siphonalia cassidaeformis</td>
<td></td>
<td></td>
<td>+#</td>
<td></td>
<td>from intertidal ? to shallow water up to 50m, sandy bottoms</td>
</tr>
<tr>
<td>C</td>
<td>Diplomeriza evoluta</td>
<td>+#</td>
<td></td>
<td></td>
<td></td>
<td>shallow water, sandy bottoms</td>
</tr>
<tr>
<td></td>
<td>Neverita didyma</td>
<td>+#</td>
<td></td>
<td>+#</td>
<td></td>
<td>shallow water, sandy bottoms</td>
</tr>
<tr>
<td></td>
<td>Nordotis discus</td>
<td></td>
<td>+</td>
<td>+</td>
<td></td>
<td>shallow water up to 20m</td>
</tr>
<tr>
<td></td>
<td>Oliva mustelina</td>
<td>+</td>
<td></td>
<td>+#</td>
<td></td>
<td>shallow water from 5m to 30m, fine sandy bottoms</td>
</tr>
<tr>
<td></td>
<td>Semicassis persimilis</td>
<td>+#</td>
<td></td>
<td></td>
<td></td>
<td>shallow water up to 20m, sandy bottoms</td>
</tr>
<tr>
<td></td>
<td>Umbonium costatum</td>
<td></td>
<td>+</td>
<td></td>
<td></td>
<td>shallow water, sandy bottoms</td>
</tr>
<tr>
<td></td>
<td>Volutharpa ampullacea perryi</td>
<td></td>
<td></td>
<td>+#</td>
<td></td>
<td>shallow water from 20m to 60m, sandy mud bottoms</td>
</tr>
</tbody>
</table>

+: present, #: not present in samples.

Table 5.1. Marine gastropods recovered from the Konam-ri shell middens showing their habitats.
<table>
<thead>
<tr>
<th>GROUP</th>
<th>SPECIES</th>
<th>A-1</th>
<th>A-2</th>
<th>B-1</th>
<th>B-2</th>
<th>HABITAT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Crassostrea gigas</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>intertidal, rocks, muddy sand or muddy gravel bottoms</td>
</tr>
<tr>
<td></td>
<td>Cyclina sinensis</td>
<td>+$</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>intertidal, sandy mud bottoms</td>
</tr>
<tr>
<td></td>
<td>Gomphina veneriformis</td>
<td>+</td>
<td>+$</td>
<td>+</td>
<td>+</td>
<td>intertidal near open sea, sandy bottoms</td>
</tr>
<tr>
<td></td>
<td>Mactra veneriformis</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
<td>intertidal, sandy or muddy bottoms</td>
</tr>
<tr>
<td>A</td>
<td>Meretrix lamarki</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
<td>intertidal near open sea, sandy bottoms</td>
</tr>
<tr>
<td></td>
<td>Mya arenaria oonoai</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
<td>intertidal in brackish water, muddy bottoms</td>
</tr>
<tr>
<td></td>
<td>Sinnovacula constricta</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
<td>intertidal in brackish water, muddy bottoms</td>
</tr>
<tr>
<td></td>
<td>Tapes philippinarum</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
<td>intertidal, sandy mud bottoms</td>
</tr>
<tr>
<td></td>
<td>Notochione jedoensis</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td>intertidal, sandy bottoms</td>
</tr>
<tr>
<td>B</td>
<td>Mytilus coruscus</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
<td>from intertidal to shallow water up to 20m, rocks</td>
</tr>
<tr>
<td></td>
<td>Tegillarca granosa</td>
<td>+</td>
<td>+</td>
<td>+$</td>
<td></td>
<td>from intertidal to shallow water up to 10m, sandy or muddy bottoms</td>
</tr>
<tr>
<td></td>
<td>Atrina pectinata japonica</td>
<td>+$</td>
<td></td>
<td></td>
<td></td>
<td>shallow water up to 20m, sandy mud bottoms</td>
</tr>
<tr>
<td></td>
<td>Chlamys farreri</td>
<td>+$</td>
<td></td>
<td></td>
<td></td>
<td>shallow water, rocks</td>
</tr>
<tr>
<td>C</td>
<td>Ostrea denselamellosa</td>
<td>+$</td>
<td></td>
<td></td>
<td></td>
<td>shallow water from 5m to 20m, rocks</td>
</tr>
<tr>
<td></td>
<td>Scapharca broughtonii</td>
<td>+$</td>
<td></td>
<td></td>
<td></td>
<td>shallow water from 10m to 40m, muddy bottoms</td>
</tr>
</tbody>
</table>

+: present, #: not present in samples.

Table 5.2. Marine bivalves recovered from the Konam-ri shell midden showing their habitats.
(see Table 5.4 and Fig.5.4), indicating a high dependence of intertidal shellfish collecting activities. This feature was noted in all of the middens. This may be explained by the high tidal fluctuation which exists in this region (FRDA 1979) and which brings wide intertidal areas allowing shells of group A to grow there.

It can be recognized that there are differences of shell species assemblages of different habitat groups between the sites (Table 5.1—2). Midden A—2 consisted of nine shell species of group A and two of group B with an absence of species of group C. Midden A—2 consisted of fewer species of group B and C compared to middens A—1, B—1 and B—2. This may indicate that the people who formed middens A—1, B—1 and B—2 carried out their shellfish collecting activities in broader coastal areas than those of the earlier midden A—2. And they may have acquired knowledge about shellfish inhabiting the shallow waters. Shells of the shallow water species however are rarely recovered from the middens and the reason for this may be related to the difficulty in searching for and collecting them. Because they live below low tide and can only be collected by diving, they are unlikely to have occurred much. Today it is still common for shells such as Atrina pectinata japonica, Notochione discus, Mytilus coruscus and Scapharca broughtonii, to be collected only by divers. Therefore it may require more effort to collect the shell species of groups B and C than to those of group A.

Because the shell species of group A generally inhabit in shore areas, they were easily accessible at low
tide to the people who formed the middens, thus resulting in a high frequency rate of these shell species in the midden deposits. Assuming that the sea level during the midden formation period was similar to that of the present day, intertidal zones may have been very near the sites possibly within several hundred meters. It may be worth noting that among group A molluscs, species such as oysters (*Crassostrea gigas*), gapers (*Mya arenaria oonogai*), razor clams (*Sinnovacula constricta*), creepers (*Cerithidea rhizophorarum* and *Cerithideopsilla djadjariensis*) and so on are most abundant in brackish waters, living in the innermost bay and therefore easily collected by the people who formed the middens.

It is possible that the reason for the highest proportion of oysters among these shells recovered from the sites might be related to their habitats. Therefore it is likely that the wide intertidal mud flats were very close to the sites, allowing prehistoric people easy access to them. On the other hand this can be interpreted from an economic point of view: i.e. energy input and output. In collecting oysters, compared to other shells, one does not need much effort to search them out because they are exposed on the surface during the low tide, allowing people to collect them easily. Also an individual oyster produces much more flesh compared to other shell species living in intertidal zones. Another possible interpretation can be made in terms of food preferences, i.e. oysters were considered tastier than other shell species. A relatively small amount of gapers and razor
clams were recovered from the sites. This may be related to either the food preferences of the people or availability in the coastal environment at that time. Among group A species, creepers (Batillaria cumingii) and venus clams (Gomphina veneriformia and Meretrix lamarcki) do not tolerate estuarine conditions. It may have been necessary to go out of the bay area to collect these shells. Today the open sea is located about 1.5km west of the sites (Fig.5.1).

The presence of sandy shore species from the open sea may be useful in estimating the shellfish collecting boundary. Today the rocky and sandy shore is located about 1.5km west from the sites, facing the open sea (Fig.5.1). Assuming the coastal environment during the midden formation period was similar to that of the present, it is possible that the people who formed the middens went to the coastal area about 1.5km west of the sites to collect the shells which inhabited the sandy shore near the open sea.

The type of coastal environment in which shellfish collecting activities may have been carried out can be inferred from a detailed study of shell habitats. As can be seen from Tables 5.1-2, the habitats of shell species recovered from the middens can be divided into several groups based on the type of bed: mud, sand, sandy mud, rock and so on. These bed types may reflect the past coastal environment of shellfish collecting. The middens consisted of shells inhabiting a full range of bed types from the muddy bed and rocky shores of intertidal zones to
Fig. 5.1. The location of the Konam-ri shell middens.
that of the sandy shore near the open sea. This indicates that during the midden formation period sandy shore, rocky shore and muddy intertidal flats were near the sites, although it is possible that sandy and rocky shores were further from the sites than muddy shores (as mentioned above).

From the early 20th century map of the area one can see that muddy intertidal zones were very near to the sites, in fact within several hundreds meters (Fig. 5.2). The rice field area located west of the sites (made by land reclamation work in the 1970's) used to be wide muddy intertidal flats (see Fig. 5.1). Therefore it is probable

Fig. 5.2. Map showing the early 20th century coastline around the Konam-ri shell midden sites (from Chosen Sotokubu 1919).
that in premodern times they were muddy intertidal flats.

The shell species recovered from the sites are still common in this area today, perhaps indicating that no large-scale marine environmental changes have occurred since the midden formation period. It is possible that the difference in shell species composition between midden A-2 of the Neolithic Period and middens A-1, B-1 and 2 of the Bronze Age may reflect different food preferences between different groups of people, Neolithic people preferring turban shells (Lunella coronata coreensis) compared with the population of a later period (this will be discussed in detail later).

B. SMALL MARINE MOLLUSCS

Small marine molluscs were recovered and identified. The species consisted mainly of gastropods and a few bivalves. I believe they were accidentally picked up with bigger shells which were collected for food or as raw materials for shell objects. However, these small marine shells are useful in helping to interpret shell collecting and carrying methods, and the coastal environment.

The identified species and their habitats are given in Table 5.3 (based on Habe and Kosuge 1967; Hokuryukan 1973; Matsushima and Ohshima 1974; Esaka 1983; Yoo 1986). As can be seen from Table 5.3, identified small marine shell species are mainly those inhabiting intertidal zones with some species inhabiting shallow water, similar to the habitats of these species exploited as food.

Among these, oyster spat may indicate that shells,
### Table 5.3. Inedible small marine molluscs recovered from the Konam-ri shell middens showing their habitats.

<table>
<thead>
<tr>
<th>GROUP</th>
<th>SPECIES</th>
<th>A-1</th>
<th>A-2</th>
<th>B-1</th>
<th>B-2</th>
<th>HABITAT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Alvania (alvania concinna</strong></td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td>intertidal, seaweeds</td>
</tr>
<tr>
<td></td>
<td><strong>Assiminea estuaria</strong></td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td>intertidal</td>
</tr>
<tr>
<td></td>
<td><strong>Batillaria cucinari</strong></td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td>intertidal near open sea, sandy mud bottoms</td>
</tr>
<tr>
<td></td>
<td><strong>Batillaria multifora</strong></td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td>intertidal or estuary areas, sandy mud bottoms</td>
</tr>
<tr>
<td></td>
<td><strong>Pedevina bicircle</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>intertidal, rocks</td>
</tr>
<tr>
<td></td>
<td><strong>Bittium craticulatum</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>intertidal, rocks?</td>
</tr>
<tr>
<td></td>
<td><strong>Cerithidea rhizophorius</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>intertidal, muddy bottoms</td>
</tr>
<tr>
<td></td>
<td><strong>Collisella neocid</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>intertidal, rocks</td>
</tr>
<tr>
<td></td>
<td><strong>Crassostrea gigas</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>intertidal, rocks or hard sandy mud bottoms</td>
</tr>
<tr>
<td></td>
<td><strong>Dendropoma maximus</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>intertidal, rocks</td>
</tr>
<tr>
<td></td>
<td><strong>Dif脈a picta</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>intertidal, seaweeds</td>
</tr>
<tr>
<td></td>
<td><strong>Dialum stric</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>intertidal, seaweeds</td>
</tr>
<tr>
<td></td>
<td><strong>Gyrosca parallela</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>intertidal, sandy bottoms between rocks</td>
</tr>
<tr>
<td></td>
<td><strong>Littorina brevicula</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>intertidal, rocks</td>
</tr>
<tr>
<td></td>
<td><strong>Littorina striata</strong></td>
<td></td>
<td></td>
<td></td>
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<td>from intertidal to shallow water, sandy mud bottoms</td>
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<td><strong>Dunkerte shigayae</strong></td>
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<td></td>
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<td>shallow water, sandy bottoms</td>
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<tr>
<td></td>
<td><strong>Umbonium costatum</strong></td>
<td></td>
<td></td>
<td></td>
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<td>shallow water, sandy bottoms</td>
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</table>

117
especially oysters, or marine resources living in similar conditions to that of oysters could have been collected just after the spawning season of oysters. However it has to be assumed that oyster spat were alive when they were collected with other marine resources. It is known that oysters spawn between June and July in Korea (Yoo 1986: 121). Although growth rates of spat may depend on the conditions in which they grew, spat can grow about 1cm per month in suitable conditions (Kent 1988:5). The spat recovered from the sites included those which were less than 5mm in length indicating that they might have been collected during the summer. In many cases oyster spat settle on other larger oyster shells, so that their presence can also indicate summer collecting of oysters. In fact spat attached to larger oyster shells were recovered from the midden deposits. However I have not been able to identify whether the spat were alive or not when they were collected. Methods to distinguish if this was the case have been suggested (Kent 1988:60).

It is interesting to note that some gastropods in the sites, such as Alvania (alvania) concinna, Diffalaba picta, Dialad strita and Stenotis cariniferus typically inhabit seaweeds, thus indicating indirect evidence for seaweed exploitation. These shells could have been accidently brought to the sites with seaweeds collected as food items from the intertidal zones.

Today a number of seaweeds are used as important food resources and are consumed all year round in Korea. Wild or cultivated seaweeds, such as brown seaweed (Undaria
Pinnatifida), laver (Porphyra sp.) and kelp (Laminaria sp.) and so on are collected or harvested in the proper season of the year, dried under natural conditions and stored for later use.

Bell (1981) suggested that ethno-historical evidence showed seaweed exploitation was important and that archaeological evidence could be found. It is interesting to note that he found barnacles, tiny shells of Mytilus sp. and Littorina sp. with other inclusions of modern seaweeds which were collected for experimental work by himself. These three kinds of inclusions with seaweeds identified by him were also found from Konam-ri middens. Among these inclusions, barnacles recovered from the middens might also relate to oyster shells collected for food resources. Because barnacles commonly live on oyster shells (Fig.5.3), it may be inferred that most barnacles recovered from the middens were introduced to the midden sites with oysters.

Fig.5.3. Barnacles inhabiting oysters.
Although direct evidence of seaweed exploitation has not been found from the sites due to their softness in structure (Bell 1981), its exploitation by the people who formed the Konam-ri shell middens may be inferred based on the small marine shells inhabiting the seaweeds.

It is also possible to deduce the type of shell collecting and carrying activities which occurred, based on the small-shell species. Among these, some might have been carried onto the sites because they were attached to larger shells. For example oysters and mussels can be brought into the sites attached to larger shells. True limpets, Colisella heroldi, normally live on rocks in intertidal zones but they can also be found on oyster shells (as noted during field work on Anmyŏn Island). This suggests that they may have also been accidentally carried onto the sites on oyster shells.

Other small-shelled species, especially those living in sandy mud or muddy bottoms, may have been brought into the middens, with their sedimentary materials, at the time when the larger shells inhabiting these habitats were exploited. It can be assumed then that those exploited shells were brought onto the sites with their sediment materials still attached to them.

5.1.2. ANALYSIS OF THE INDIVIDUAL PROPORTION OF SHELL SPECIES AND DIETARY PREFERENCES

The proportion of individual shell species among the shell components of each midden was estimated to obtain data on dietary preferences and shellfish collecting behaviour,
based on collected midden samples. Before analyzing the samples, it is necessary to assume that the samples are representative of the total midden components in terms of the proportions of different shell species.

The proportion of individual shell species was estimated by weight. Although it has been pointed out that the individual method is a more accurate estimate of the actual meat amount represented by the shell samples in comparison to the weight method (Coleman 1966:57), I chose the weight method to estimate the proportion because the weight method, I think, may produce a more reasonable and direct result than individual counting.

Two reasons for this can be suggested. The first is that midden deposits can contain small shells which might not contribute to the diet. If these small shells were counted, then the figure for meat weight based on shell weight to meat weight ratios is likely to be overestimated. A good example of this was observed during the field work on Anmyŏn Island in 1989 and 1990: small oyster shells less than 3cm (sometimes even 4cm) which attached themselves to the surface of larger oyster shells were disregarded by the local people. Thus they remained unopened despite being collected with the larger shells which were eaten. These unconsumed small shells may offset to some extent the bias involved in the weight method due to the weight loss by leaching processes (Bailey 1975:51). Because the processes may result in a low figure for the meat weight due to the loss of the shell weight, when we calculate the meat yield based on the ratio between shell

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and meat weights. The second reason is that many broken hinges were found in each samples, but there is no way to confirm whether the shellfish were consumed or not. Therefore the weight method seems to me to be a more reliable way to estimate the flesh content of shells than individual counting, especially when dealing with fragmentary archaeological shells.

The results of the analysis based on the weight method are given in Fig. 5.4 and Table 5.4.

Midden A-1: oysters constituted 80.1% of the samples, venus clams (Tapes philippinarum) 12.7%, rock shells (Rapana venosa) 5.8% and other shells 1.3%.

Midden A-2: In the lower shell layer of the midden, shell components consisted of 92.1% of oysters, 4.2% venus clams, 2.1% turban shells (L. coronata coreensis), 1.6% rock shells (R. venosa) and 2.1% other shells.

Oysters were still the most important dietary item in the upper layer of the midden but their proportion decreased to 68.8%, while venus clams and rock shells increased to 29% and 2.2%, respectively. The decrease of oysters in the total shell components may indicate an over-exploitation of the shells, resulting in the reduction of the size range of the shells (see section 5.4). It is possible that oysters decreased due to over-exploitation during the earlier period, the people who formed midden A-2 replacing them with venus clams.

It is worth noting the proportion of turban shell (L.
<table>
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Table 5.4. The relative proportion of shell species in the Konam-ri shell middens.
Fig. 5.4. The relative frequency of marine shells recorded from bulk samples from the Konam-ri shell middens.

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<tr>
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<th>A-2 UPPER</th>
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<td>C. argyrostroma lischkei</td>
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(%) 0 50 100 150 200 250 300 350 400 450 500 550 600 650 700 750 800 850 900 950 1000
coronata coreensis) in the upper layer of the midden. Although the proportion of the sample was only 2.1%, it may indicate that the shells were preferred by the people who formed the midden. During the excavations it was noted that this species was recovered much more frequently from this midden than from the later middens of A-1, B-1 and 2.

**Midden B-1:** It can be seen from the main shell layers of the midden, i.e. layers 3, 4, 6 and 8 that there are shifts in the proportion of different shell species. Oysters contributed a significant amount, constituting 77.92% and 89.4% in layer 6 and 8 in an earlier phase of the midden formation period. However, the importance of the oysters decreased in layers 3 and 4 in the later phase, being replaced mainly by venus clams. This shift may be because of size reduction resulting from over-exploitation of the oyster shells in an earlier phase (see section 5.1.3).

The possible preference for venus clam (C. sinensis) by Neolithic people recognized in midden A-2, can also be seen in layer 12 of this midden.

**Midden B-2:** The shell deposit consisted mainly of oysters with smaller amounts of rock shells (Thais clavigera and R. venosa), venus clams (T. philippinarum), creepers (C. rhizophorarum) and others throughout the midden.

Looking at the overall shell composition of the middens it can be summarized that oysters, venus clams and two species of rock shells were preferred. There is a
small difference in the main shell species components between the Neolithic midden A-2 and the Bronze Age middens A-1, B-1 and 2. Neolithic people may have collected more venus clams (C. sinensis) and turban shells (L. coronata coreensis) compared to those of the later period. The Bronze Age people seemed to prefer rock shell (T. clavigera) compared to those of the Neolithic Period.

Today oysters are the most common shell species consumed by Koreans. According to the records of Anmyŏn-ŭp (1986:51), venus clams (T. philippinarum) and oysters are widely cultivated as well as seaweed (laver), sea slugs, abalone shells and various species of fish. These two species of shells have been cultivated for commercial purposes in the coastal areas of the island.

5.1.3. OYSTER SHELLS

Oyster shells were studied in more detail than other shells because they were the most abundant throughout the middens. Analysis of the size distribution of the shells was undertaken to examine the possibility of oyster over-exploitation. In addition, collecting and opening methods and collecting season were studied to infer human behaviours involved in exploiting oysters.

A. ANALYSIS OF THE SIZE DISTRIBUTIONS

The analysis of size shows the size structure of a population at particular times. The structure varies according to many factors such as the intensity and frequency of predation including human exploitation and the abundance, growth rate and reproduction strategies of the species involved. In addition, it can be dramatically
changed in short term by disease and environmental change.

Human exploitation is one of main factors that affect the structure of mollusc populations. It has been demonstrated in a number of present day short term ecological studies that one of the results of human exploitation is the removal of the larger individuals which are more desirable foods items and provide a better return for collecting time. Exploited populations therefore tend to have a lower mean size and usually a narrower size range with a greater proportion of smaller size classes. Unexploited populations tend to have a higher mean size and larger size range. If all the reproductively mature specimens are removed then local extinction could result but this is rarely the case. Usually, unless the species is particularly rare sufficient number of younger i.e. smaller mature specimens remain to provide larvae for recruitment although very few animals will reach maximum size. Obviously abundant free spawning species will survive exploitation better than rare species. It has also been demonstrated that populations can recover relatively quickly in the absence of exploitation.

Archaeologists have observed that some exploited species show a reduction in mean size over time and at least, the individuals collected at the time of initial occupation of the site tend to be larger than those collected during later occupation. This has been interpreted as evidence for over-exploitation.

Growth rate is the speed at which molluscs developed towards maturity and requires information on the age and
maturity of individuals in the population at particular
towards maturity and requires information on the age and
times. It is possible to obtain some information on growth
rate in archaeological samples if complete individual
specimens can be aged by growth-line analysis and maturity
can be established by some predictable morphological
feature such as thickening of aperture as well as overall
size. Growth rate can be affected by many environmental
factors such as changes in salinity, temperature,
turbidity, etc. as well as predation. Usually it is
impossible to link changes in growth rate to single causal
factors.

METHODS
Oysters often are irregular in shape influenced by the
growing conditions making it difficult to compare oyster
sizes from different locations. However, oysters from the
Konam-ri sites would probably have been gathered from same
collecting areas, which would have produced similar
shapes. Therefore analysis of the size distributions of
the shells is still useful for investigating the intensity
of oyster exploitation in the past.

In order to analyze the size distributions of oyster
shells, oyster valves were distinguished as left and right
valves. The maximum width and maximum length of the left
valves were measured (the reason for this is that the
outer edge of right valves is very soft and easily broken,
which might produce an error in measurements). As
mentioned earlier, left valves smaller than 3cm were
excluded from the size analysis.
<table>
<thead>
<tr>
<th>SITE LAYER</th>
<th>NO</th>
<th>MEAN</th>
<th>MEDIAN</th>
<th>STDEV</th>
<th>MIN</th>
<th>MAX</th>
<th>Q1</th>
<th>Q3</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-1</td>
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<td>161</td>
<td>6.20</td>
<td>5.90</td>
<td>1.44</td>
<td>3.3</td>
<td>11.2</td>
<td>5.3</td>
</tr>
<tr>
<td>A-2 (UPPER)</td>
<td>119</td>
<td>4.99</td>
<td>4.90</td>
<td>0.93</td>
<td>3.2</td>
<td>8.9</td>
<td>4.5</td>
<td>5.5</td>
</tr>
<tr>
<td>A-2 (LOWER)</td>
<td>106</td>
<td>5.26</td>
<td>5.25</td>
<td>0.86</td>
<td>3.0</td>
<td>7.9</td>
<td>4.7</td>
<td>5.8</td>
</tr>
<tr>
<td>B-1</td>
<td>4</td>
<td>77</td>
<td>5.20</td>
<td>5.20</td>
<td>1.16</td>
<td>3.0</td>
<td>8.3</td>
<td>4.5</td>
</tr>
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<td>B-1</td>
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<td>82</td>
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<td>6.40</td>
<td>1.70</td>
<td>3.1</td>
<td>11.9</td>
<td>5.4</td>
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<tr>
<td>B-1</td>
<td>8</td>
<td>132</td>
<td>5.74</td>
<td>5.70</td>
<td>1.15</td>
<td>3.0</td>
<td>8.6</td>
<td>4.9</td>
</tr>
<tr>
<td>B-2</td>
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<td>40</td>
<td>5.84</td>
<td>5.45</td>
<td>1.71</td>
<td>3.0</td>
<td>11.2</td>
<td>4.9</td>
</tr>
<tr>
<td>B-2</td>
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<td>67</td>
<td>5.89</td>
<td>5.90</td>
<td>1.46</td>
<td>3.2</td>
<td>9.7</td>
<td>4.7</td>
</tr>
<tr>
<td>B-2</td>
<td>3</td>
<td>68</td>
<td>6.32</td>
<td>6.30</td>
<td>1.73</td>
<td>3.0</td>
<td>10.7</td>
<td>5.4</td>
</tr>
</tbody>
</table>

Table 5.5. The length of oysters (left valve) recovered from the Konam-ri shell middens.

Fig. 5.5. Size frequency distribution of left oyster valves from sample 1 from the upper layer of midden A-2.

Fig. 5.6. Size frequency distribution of left oyster valves from sample 2 from the lower layer of midden A-2.
Fig. 5.7. Size frequency distribution of left oyster valves from sample 3 from layer 2 of midden A-1.

Fig. 5.8. Size frequency distribution of left oyster valves from sample 4 from layer 4 of midden B-1.

Fig. 5.9. Size frequency distribution of left oyster valves from sample 5 from layer 6 of midden B-1.

Fig. 5.10. Size frequency distribution of left oyster valves from sample 6 from layer 8 of midden B-1.
Fig. 5.11. Size frequency distribution of left oyster valves from sample 7 from layer 11 of midden B-1.

Fig. 5.12. Size frequency distribution of left oyster valves from sample 8 from layer 2 of midden B-2.

Fig. 5.13. Size frequency distribution of left oyster valves from sample 9 from layer 3 of midden B-2.

Fig. 5.14. Boxplot of the size distribution of left oyster valves recovered from the Konam-ri shell middens (using data from Fig. 5.5-13).
possible to analyze changes in the size distributions of oysters through the midden sequence because bulk samples were collected from the middle point of sections of excavation squares and no column samples were collected.

Midden B-1: A small reduction in the size of oysters throughout the layers of midden B-1 was noted. In layer 4 of midden B-1 (Fig. 5.8), oysters are generally smaller than earlier layers, layers 6 (Fig. 5.9), 8 (Fig. 5.10) and 11 (Fig. 5.11): oyster size from layer 4 ranges between 3.0 and 8.3 cm and has a mean value at 5.2 cm; Layer 6 has a mean value at 6.4 cm with a wide range between 3.1 and 11.9 cm; layer 8 has a mean value at 5.7 cm and shows a relatively narrow distribution ranging between 3.6 and 8.6 cm; and layer 11 has a mean value at 5.8 cm. Layer 4 contained more Venus clams than other layers (see section 5.1.2).

It is useful to test whether size differences between the samples are significant in statistical terms. A one-way analysis of variance gives a value of \( F \) of 10.46 (with 3 and 327 degrees of freedom). This is statistically significant at the 0.1% level, and so the variation in the size distributions between the shell layers is highly significant. The difference in the size distributions between layer 4 and layer 6 is especially great. Layer 4 has not only more than 1 cm smaller mean size but also fewer shells bigger than 8 cm compared to layer 6.

This might be related to size reduction of oysters due to intensive human exploitation. Intensive and
continual human exploitation of larger shells would result in a reduction in size range of the shells.

**Midden B-2:** Size reduction of oysters in the later sequence of middens is also recognized in midden B-2 (Fig.5.12-13). The size distributions of oysters in layer 3 (Fig.5.12) is generally larger than that of layer 2, having a mean value at 6.3 cm. Layer 2 had a mean value at 5.9 cm. The reduction in maximum size from 10.7 cm to 9.7 cm, may reflect a more significant change. The intensive selective collecting of larger shells may result in the reduction in maximum size of the shells. Therefore, the size reduction in the upper layer of the midden may also reflect human exploitation of oysters although the possibility of environmental changes cannot be excluded. However no other significant evidence for environmental change has been obtained and thus the possibility that this reduction is due to natural causes alone is remote. The shell species assemblages throughout the layers indicate a constant marine environmental condition.

A one-way analysis of variance provides a value of $F$ of 3.034 (with 1 and 133 degrees of freedom). This is statistically significant at the 10% level.

A 'boxplot' Fig.5.14 drawn by the Minitab program, facilitates comparison of oyster size distributions. The sample numbers are listed on the left. The horizontal axis represents the length in centimeters. The "I" shows the positions of the 25th (lower quartile) and 75th (upper
quartile) percentiles. The "+" indicate the positions of the medians. The brackets "( )" are the 95% confidence intervals for the median. The lines beside the hinges (I) show the size distribution of oysters of individual sample. The symbols of "*" or "o" represent probable or definite outliers. If any individuals are more than one and a half times the interquartile range, they are marked with "*", and if they are more than three times, they are marked with "o".

Oyster size distributions between the sites can be compared from Fig. 5.14. Samples No. 1 and No. 2 from midden A-2 have more generally smaller mean values and fewer shells larger than 7.5 cm. If environmental condition is disregarded, it may be related to human exploitation of the shells. Samples No. 3 from layer 2 of midden A-1, No. 5 from layer 6 of midden B-1 and No. 9 from layer 3 of midden B-2 have generally larger mean values and more shells larger than 8 cm in length, indicating more abundant oyster resources compared to other midden formation periods represented by other samples.

A F value of 14.98 (with 8 and 843 degrees of freedom) indicates statistically significant variation at the 0.1 % level. This significant variation is especially attributed to samples No. 1, No. 3 and No. 5.

Column samples

In addition to bulk samples described above, three column samples, sample No.2 of midden B-1 and No.10 and No.14 of
midden B-2, were analyzed to examine oyster size distributions (see the location of the column samples on Fig. 2.4-5). These column samples were chosen for size analysis of oysters for several reasons. Firstly, it was confirmed that column sample No. 2 belonged to layer 6 of midden B-1 and No. 10 and No. 14 to layers 2 and 3 of midden B-2, which allowed me to examine detailed changes in shell sizes through the midden profiles of each layer. Secondly, these column samples were taken from thick shell deposits within the middens, which provided more subsamples, allowing me to analyze in more detail any changes in the size of oysters. Finally, these samples contained relatively well-preserved shells which allowed me to obtain suitable numbers of shells for the analysis of oyster size distributions.

Column No. 2: This was taken from layer 6 of midden B-1 and consisted of 14 sub-column units. As shown earlier, layer 6 was the thickest main shell layer of the midden. As a result of the oyster size measurements from the column, the size distributions for sub-column units of the column does not show a significant change throughout the column sequences, with means fluctuating between about 6.2 and 7.4 cm and interquartiles ranging between 5.1 and 8.7 cm (Table 5.6 and Fig. 5.15-29). Because there is no significant size reduction of oysters in the later column samples was recognized, it can be inferred that oyster resources during the formation period of layer 6 were relatively good, although shells longer than 11 cm were only recovered from the lower column samples.
A value of F of 2.594 (with 13 and 784 degrees of freedom) is statistically significant at the 0.5 % level. This significant variance ratio is especially attributed to sub-samples No. 8 and No. 9. It can be concluded that there was no continuous size reduction of oysters during the formation period of layer 6, and it may indicate that human exploitation of the shells was not so significant as to cause a progressive reduction in the size of shells during the formation period of layer 6.

**Column No.10:** Oyster size distributions showed a small reduction in size when the bottom unit (No.5) is compared to the uppermost one (No.1) of the column (Table 5.7 and Fig.5.30-35). Sample No. 5 has a mean value at 6.7 cm and ranges between 3.3 and 12.9 cm, while sample No.1 has a mean value at 5.5 cm and ranges between 3.4 and 9.5 cm with shells rarely larger than 7.5 cm. Although little fluctuation in the size distribution was visible, no significant change in the size of oysters was noted from the column belonging to layer 2 of midden B-2.

A F value of 4.18 (with 4 and 218 degrees of freedom) indicates that this is statistically significant at the 0.5 % level. The variance is especially great in sub-samples No. 1 and No. 5. Therefore it can be concluded that there was a general reduction in the size of oysters through the profile of layer 2 of midden B-2.

**Column No.14:** Oyster size distributions also showed no significant change throughout the column sequences except the uppermost sample (No.1) (Table 5.8 and Fig.
Fig. 5.36-42). Sample C14-1 has a mean value at 5.4 cm. The distribution ranges between 3.4 and 9.2 cm with few shells larger than 7.5 cm. Other samples have mean values between 6.1 and 6.7 cm.

A $F$ value of 4.2 (with 5 and 267 degrees of freedom) indicates that the variance between sub-samples is statistically significant at the 0.1% level. This variance is especially attributed to sub-samples No. 1 and No. 6, indicating a distinctive reduction in the size of oysters through the shell layer.

**GENERAL INTERPRETATION**

When considering oyster size distributions throughout the Konam-ri shell middens based on data mentioned above, some interpretation can be made. Although no distinctive differences in oyster size distributions can be observed between the sites, there are small variations. Oyster sizes from midden A-2 are generally smaller than those from layers of other middens with lower mean values and rare shells larger than 7.5 cm. The smaller oysters in midden A-2 may reflect more intensive exploitation of the species from this site compared to the other middens of the later period (A-1, B-1 and 2), possibly causing the increase of venus clams to supplement the oyster shells in the upper layer of the midden (see Chapter 4).

The role of shellfish in the diet was possibly more important during the formation period of midden A-2 than that of the other middens because agriculture was less developed during that period. Environmental factors
Table 5.6. The length of oysters (left valve) recovered from column sample No.2 taken from the Konam-ri shell midden B-1.

<table>
<thead>
<tr>
<th>SITE SAMPLE NO</th>
<th>MEAN</th>
<th>MEDIAN</th>
<th>STDEV</th>
<th>MIN</th>
<th>MAX</th>
<th>Q1</th>
<th>Q3</th>
</tr>
</thead>
<tbody>
<tr>
<td>C2 - 1</td>
<td>6.84</td>
<td>6.80</td>
<td>1.60</td>
<td>3.6</td>
<td>9.6</td>
<td>5.90</td>
<td>8.25</td>
</tr>
<tr>
<td>2</td>
<td>6.52</td>
<td>6.50</td>
<td>1.63</td>
<td>3.1</td>
<td>10.9</td>
<td>5.55</td>
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<td>3.2</td>
<td>9.9</td>
<td>5.90</td>
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<td>3.1</td>
<td>10.1</td>
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<tr>
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<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>6.35</td>
<td>6.20</td>
<td>1.41</td>
<td>3.4</td>
<td>9.5</td>
<td>5.43</td>
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<tr>
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<td>6.45</td>
<td>6.50</td>
<td>1.40</td>
<td>3.6</td>
<td>10.2</td>
<td>5.28</td>
<td>7.10</td>
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<td>7.21</td>
<td>7.30</td>
<td>1.97</td>
<td>3.3</td>
<td>12.8</td>
<td>5.80</td>
<td>8.20</td>
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<td>7.38</td>
<td>7.10</td>
<td>1.80</td>
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<td>6.05</td>
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<td>6.70</td>
<td>1.69</td>
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<td>1.70</td>
<td>3.4</td>
<td>10.2</td>
<td>5.50</td>
<td>8.30</td>
</tr>
<tr>
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<td>6.24</td>
<td>6.35</td>
<td>1.54</td>
<td>3.3</td>
<td>11.8</td>
<td>5.08</td>
<td>7.08</td>
</tr>
<tr>
<td>14</td>
<td>6.45</td>
<td>6.40</td>
<td>1.94</td>
<td>3.2</td>
<td>13.0</td>
<td>5.15</td>
<td>7.30</td>
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</tbody>
</table>

Fig.5.15. Size frequency distribution of left oyster valves from column sample (C) 2-1 from midden B-1.

Fig.5.16. Size frequency distribution of left oyster valves from C2-2 from midden B-1.
Fig. 5.17. Size frequency distribution of left oyster valves from C2-3 from midden B-1.

Fig. 5.18. Size frequency distribution of left oyster valves from C2-4 from midden B-1.

Fig. 5.19. Size frequency distribution of left oyster valves from C2-5 from midden B-1.

Fig. 5.20. Size frequency distribution of left oyster valves from C2-6 from midden B-1.
Fig. 5.21. Size frequency distribution of left oyster valves from C2-7 from midden B-1.

Fig. 5.22. Size frequency distribution of left oyster valves from C2-8 from midden B-1.

Fig. 5.23. Size frequency distribution of left oyster valves from C2-9 from midden B-1.

Fig. 5.24. Size frequency distribution of left oyster valves from C2-10 from midden B-1.
Fig. 5.25. Size frequency distribution of left oyster valves from C2-11 from midden B-1.

Fig. 5.26. Size frequency distribution of left oyster valves from C2-12 from midden B-1.

Fig. 5.27. Size frequency distribution of left oyster valves from C2-13 from midden B-1.

Fig. 5.28. Size frequency distribution of left oyster valves from C2-14 from midden B-1.
### Table 5.7

The length of oysters (left valve) recovered from column sample No. 10 taken from the Konam-ri shell midden B-2.

<table>
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<th>MAX</th>
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<th>Q3</th>
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<td>1.38</td>
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<td>9.5</td>
<td>4.45</td>
<td>6.40</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>54</td>
<td>6.05</td>
<td>5.90</td>
<td>1.67</td>
<td>3.2</td>
<td>9.9</td>
<td>4.78</td>
</tr>
<tr>
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<td>35</td>
<td>5.89</td>
<td>5.80</td>
<td>1.53</td>
<td>3.1</td>
<td>9.0</td>
<td>4.60</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>32</td>
<td>5.66</td>
<td>5.85</td>
<td>1.17</td>
<td>3.1</td>
<td>7.9</td>
<td>4.83</td>
</tr>
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<td></td>
<td>5</td>
<td>65</td>
<td>6.74</td>
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<td>2.13</td>
<td>3.3</td>
<td>12.9</td>
<td>5.20</td>
</tr>
</tbody>
</table>

**Fig. 5.29.** Boxplot of the size frequency distribution of left oyster valves from C2 (using data from Fig. 5.15-28).

**Fig. 5.30.** Size frequency distribution of left oyster valves from C10-1 from midden B-2.

**Fig. 5.31.** Size frequency distribution of left oyster valves from C10-2 from midden B-2.
Fig. 5.32. Size frequency distribution of left oyster valves from C10-3 from midden B-2.

Fig. 5.33. Size frequency distribution of left oyster valves from C10-4 from midden B-2.

Fig. 5.34. Size frequency distribution of left oyster valves from C10-5 from midden B-2.

Fig. 5.35. Boxplot of the size frequency distribution of left oyster valves from C10 (using data from Fig. 3.30-4).
### Table 5.8
The length of oysters (left valve) recovered from column sample No. 14 taken from the Konam-ri shell midden B-2.

<table>
<thead>
<tr>
<th>SITE SAMPLE NO</th>
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<th>MEDIAN</th>
<th>STDEV</th>
<th>MIN</th>
<th>MAX</th>
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<td>9.8</td>
<td>5.73</td>
<td>7.60</td>
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<td>6.20</td>
<td>1.48</td>
<td>3.5</td>
<td>8.9</td>
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<td>6.70</td>
<td>1.54</td>
<td>3.2</td>
<td>10.1</td>
<td>5.88</td>
<td>7.85</td>
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</table>

Fig. 5.36. Size frequency distribution of left oyster valves from C14-1 from midden B-2.

Fig. 5.37. Size frequency distribution of left oyster valves from C14-2 from midden B-2.

Fig. 5.38. Size frequency distribution of left oyster valves from C14-3 from midden B-2.
Fig. 5.39. Size frequency distribution of left oyster valves from C14-4 from midden B-2.

Fig. 5.40. Size frequency distribution of left oyster valves from C14-5 from midden B-2.

Fig. 5.41. Size frequency distribution of left oyster valves from C14-6 from midden B-2.

Fig. 5.42. Boxplot of the size frequency distribution of left oyster valves from C14 from midden B-2 (using data from Fig. 3.36-41).
can also affect the size distributions of the shells, resulting in different growth rates of shells. However I believe that there was no significant environmental change throughout the formation period of midden A-2 and the other Bronze Age middens, judging from shell species assemblages from these sites. Growth-line analysis of shells, which I will undertake in the future could establish more precisely whether the marine environments during the formation period of midden A-2 were different from those of the other middens.

It can be suggested that in the Bronze Age middens A-1, B-1 and B-2, there was generally no significant change in the size of oysters recovered although a small size reduction of oysters was also observed from the later layers of middens B-1 and B-2: layer 4 of midden B-1 and layer 2 of midden B-2. This can be interpreted in the same way as for midden A-2, and may mean that the midden people were not heavily dependent on oysters for their diet. If they had intensively exploited the shells, it would have affected the oyster population, resulting in a significant reduction in the size.

At the present time it has been noted that a reduction in shell size can happen easily (see Table 5.9 and Fig.5.43-5). For example, people in Nudong-ri nearby Konam-ri, have exploited marine resources around Solsôm (Pine Island, see Fig.5.1 for location). However changes in marine salinity due to land reclamation in Asan Bay and due to chemicals used for removing salinity quickly from reclaimed land did not allow oysters, venus clams and sea
weeds to grow in the area of Ch'ŏnsu Bay near Nudong-ri during the 10 years from 1978 to 1988. After that period shells began to grow and Nudong-ri people have collected oysters and venus clams near Solsŏm since 1989. In this area oysters began to regrow naturally as conditions improved (Fig. 5.46) and venus clams were cultivated by the Nudong-ri people by scattering the juveniles. This region was protected from outside exploitation.

In winter of 1989 when they started to collect naturally grown oysters for commercial purposes, they obtained about 800 kg of wet flesh weight of oysters. Bigger oysters were collected selectively and small shells were left to grow on. The following year however, a decrease of about 10% in yield of oyster flesh and a reduction in shell size was noted.

In 1989 and 1990, oyster shells discarded by the village people were collected randomly for analysis. The result of size analysis shows size reduction of the shells (Table 5.9 and Fig. 5.43-5). Although mean values of each of samples do not differ greatly, the two samples have different size distributions. For example the sample collected in 1989 contains higher proportion of shells larger than 7.0 cm compared to the sample collected in 1990. A one-way analysis of variance gives a F value of 4.22 (with 1 and 335 degrees of freedom). This is statistically significant at the 5 % level.

It can be inferred therefore that the oyster population is quickly affected by human predation even in the selectively protected conditions shown by the example
Table 5.9. The length of modern oysters (left valve) collected at Anmyön Island in 1989 and 1990.

<table>
<thead>
<tr>
<th>SAMPLE</th>
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<th>MEAN</th>
<th>MEDIAN</th>
<th>STDEV</th>
<th>MIN</th>
<th>MAX</th>
<th>Q1</th>
<th>Q3</th>
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<tr>
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<td>6.11</td>
<td>5.95</td>
<td>1.04</td>
<td>3.5</td>
<td>9.5</td>
<td>5.50</td>
<td>6.60</td>
</tr>
</tbody>
</table>

Fig. 5.43. Size frequency distribution of left oyster valves collected from a present-day oyster processing site at Nudong-ri in 1989.

Fig. 5.44. Size frequency distribution of left oyster valves collected from a present-day oyster processing site at Nudong-ri in 1990.

Fig. 5.45. Boxplot of the size frequency distribution of left oyster valves collected from a present oyster processing site at Nudong-ri (based on data from Fig. 5.43-4).
Fig. 5.46. Natural oyster bed near Solsŏm near Nudong-ri, Anmyŏn Island.

Fig. 5.47. A modern Korean instrument ('kulddagae' in Korean) for opening oysters.
of Nudong-ri village. In the prehistoric periods, it might have been more marked than the Nudong-ri example. This is because prehistoric people might have been more dependent on shell resources than people of the present.

B. COLLECTING AND OPENING METHODS

Oysters were likely to be collected by hand while they were exposed at low tide, as happens today. Simple tools such as hammerstones might have been used to take oysters from the substrate. For this purpose today on Anmyön Island a iron tool with wooden handle (kulddagae in Korean, Fig.5.47) is used, and baskets or buckets are also used for collecting and carrying oysters.

Two methods, heating or cracking, could have been used to open oysters. The presence of burnt oysters recovered from the middens suggests roasting as one of the heating methods that might have been used. However the low frequency of burnt oysters in the middens indicates the method might not have been used very often. Other possible heating methods are boiling or smoking. However, there is no way to identify whether these methods were used because these do not leave any visible distinctive mark on shells.

Cracking normally leaves a broken mark on shells. About 20% oysters recovered from the sites had a broken edge (Fig.5.48-9). These oysters then might have been opened by the method.

Today in Korea as well as on the island, oysters are opened by a method similar to cracking without cooking. Although oysters are cooked in various dishes, they are most frequently eaten raw.
Fig. 5.48. Oysters cracked open possibly with a hammerstone.

Fig. 5.49. Inside.
In the process of opening oysters, an oyster shell is set up vertically and held by one hand on an anvil stone, keeping the right valve facing the person. The hinge ligament is broken, the right valve is separated and the flesh is taken by cutting the muscle from the left valve. During these processes the same tool used to take oysters from the substrate is employed (Fig. 5.47). This opening method leaves a distinctive notched mark on the hinge area and leaves the ventral edge slightly broken (Fig. 5.50-1). This method is very effective, taking a couple of seconds to open a shell. It is unlikely to have been used to open oysters during the Konam-ri shell midden period because no left valves showing the notched mark on the hinge area were recovered.

C. COLLECTING SEASON

Evidence for season of oyster collection can be obtained by the analysis of growth lines of the shells. Biological and ethnographic studies are also useful.

Growth-line analysis: Oysters contain growth lines at the muscle scars and the ligamental surface of the upper and lower valves (Palmer and Carriker 1979; Carriker et al. 1980; Kent 1988). However the muscle scars and the ligamental surface of the upper valve are relatively unstable due to their aragonitic structure, compared to the ligamental surface of the lower valve which has calcite structure (Kent 1988: 14). As a result, the analysis of growth lines on badly preserved valves from
Fig. 5.50. Oysters cracked open with an instrument ('kulddagae') showing damage at the hinge.

Fig. 5.51. Close-up of cracked damage at the hinge.
archaeological sites is restricted to the lower valves (ibid.).

Several papers describe the estimation of the collection season of oysters using growth line analysis (e.g., Poisson 1946; Stenzel 1971; Sambol and Finks 1977; and Waselkov 1982 quoted by Kent 1988:64 and Kent 1988). Unfortunately, I have not yet been able to analyze growth lines to interpret oyster collection season in the past although most oyster shells recovered from the sites were in good condition. Further study on growth lines is needed to examine the seasonality of oyster collecting in this region in the past.

Alternatively, a study of oyster biology, and ethnographic parallels can be used to infer the season of collection.

**Ethnographic evidence:** Today oysters are exploited between autumn and spring, especially intensively during the winter. Oysters are not collected during the summer due to their bitter taste and lower meat yields. A local resident of Anmyŏn Island told me they normally collect oysters from the end of September to the end of April because during the summer period they are very "thin" and "bitter". It is possible then to infer that oysters at the sites were also collected mainly during the winter period as is the case today.

**Biological study:** Some biological studies on oysters have been done (Ray et al. 1953; Lee and Pepper 1956). According to these studies, oysters are in poor condition
during the summer and including the spawning period. They show a reduction in weight and are easily infected by shell pests (Ray et al. 1953). The effect of the high summer temperatures result not only in an increase in disease but also in a decrease in meat weights (ibid.). In the summer, oysters show a decrease of weight, fat and carbohydrate components but possess the highest value of protein (Lee and Pepper 1956). It was suggested however that the protein component is probably least subject to change and as fat and carbohydrate contents decrease, the protein makes up a greater proportion of the remaining body tissue percentages (ibid:4).

I attempted to estimate seasonal variability in the ratio of meat weight to shell weights during the field work in Anmyön Island in 1989 and 1990. Shells were collected from the oyster bed near Solsöm at six times in different months. The sediment on the surface of shells was removed. The surface of individual shell was dried using tissue. Each shell was weighed before removing the flesh. After removing the flesh, each pair of empty shells was then re-weighed to estimate the flesh weight.

The relation of wet flesh weight to shell weight in different months of 1989 is shown in Fig.5.52-8. Correlation coefficients for meat weight to shell weight indicate positive relationship. The mean ratio of meat weight to shell weight showed the lowest value in August. The ratio became higher in later months, showing the highest value in February and April. If the possible bias from variable water content in each shell is considered,
Fig. 5.52. Scatter diagram of meat weight (MW) vs shell weight (SW) of oysters collected from Solsøm in August 1989 (N=24, Mean MW/SW=0.618, Correlation of MW and SW (Corr MW SW) =0.869).

Fig. 5.53. Scatter diagram of MW vs SW of oysters collected from Solsøm in September 1989 (N=49, Mean MW/SW=0.693, Corr MW SW=0.955).

Fig. 5.54. Scatter diagram of MW vs SW of oysters collected from Solsøm in November 1989 (N=55, Mean MW/SW=0.818, Corr MW SW=0.862).
Fig. 5.55. Scatter diagram of MW vs SW of oysters collected from Solsøm in January 1990 (N=30, Mean MW/SW=0.72, Corr MW SW=0.809).

Fig. 5.56. Scatter diagram of MW vs SW of oysters collected from Solsøm in February 1990 (N=33, Mean MW/SW=0.898, Corr MW SW=0.653).

Fig. 5.57. Scatter diagram of MW vs SW of oysters collected from Solsøm in April 1990 (N=31, Mean MW/SW=0.88, Corr MW SW=0.831).
the difference may become greater. The low meat value in August seems to be related to the loss of weight after summer spawning. It is known that in Korea oysters spawn during the summer especially between June and July (Yoo 1986:126). Therefore during this period in the past oysters might not have been exploited in this season because of the lower return.

Considering the biological study of oysters and ethnographic data, it may be possible that the main seasons for collecting oysters at the site were from the autumn to early spring, and especially in the winter. However the possibility of some oyster collection during the summer cannot be excluded, especially if other resources were lacking.

Fig. 5.58. Boxplot of the ratio of oyster MW to SW (using data from Fig. 5.52-7).
5.2. LAND SNAILS

Since Kennard's research at the end of last century and beginning of this century, land snails have been used to study local environments. Evans' work (1972) on land snail assemblages from archaeological sites provides invaluable information on the potential role of land snail study in reconstructing past environment. As pointed out by Evans (1972:5), because land snails are abundant, easy to recognize, and inhabit wide range of habitats, they can be used to reconstruct past local environments and to infer human land use at the sites. Following this, land snails have regularly been used to interpret past environment in association with palynological studies.

Land snails recovered from bulk and column samples collected from the Konam-ri shell midden sites were studied to reconstruct the environment around the sites. The habitat of the snails recovered from the sites can be divided into four main groups; woodland, catholic, open country and marsh species (based on Habe and Kosuge 1967; Hokuryukan 1973; Yoo 1986; Taiji Kurozumi, Chiba Natural History Museum in Japan, personal communication). The woodland species inhabit relatively undisturbed forests. Catholic species are common in leaf litter under trees and inhabit a broader range of conditions from forests to disturbed forest margins. Open country species occur in grasslands. Finally marsh species live in wet and high humidity environments.

The land snail species recovered from the sites and their frequencies are given in Table 5.10 and Fig.5.59.
Table 5.10. The relative proportion of land mollusc species recovered from the Konam-ri shell middens.

<table>
<thead>
<tr>
<th>GROUP SPECIES</th>
<th>SITE LAYER</th>
<th>A-1</th>
<th>A-2 LOWER</th>
<th>A-2 UPPER</th>
<th>B-1 3</th>
<th>4 5 6 8 12 12</th>
<th>B-2 3</th>
</tr>
</thead>
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<td>11.3</td>
<td>5.9</td>
<td>1.0</td>
<td>5.3 5.5 5.2 7.3 3.2 2.0</td>
<td>7.7</td>
</tr>
<tr>
<td>D. sp.</td>
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<td>0.9</td>
<td>4.0</td>
<td>8.4</td>
<td>1.3</td>
<td>1.2 1.1 2.6 1.1 15.1 10.4 17.9</td>
<td></td>
</tr>
<tr>
<td>Nipponochlamys hypostilbe</td>
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<td>0.5</td>
<td>0.8</td>
<td>2.7 1.5</td>
<td>0.2</td>
</tr>
<tr>
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<td>0.3</td>
<td>0.5</td>
<td>0.2</td>
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<td></td>
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<tr>
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<td>8.4</td>
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<td>14.1 12.1 1.3 13.4 0.5 4.3 0.3</td>
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<td>19.8</td>
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<td>1.1</td>
<td>29.2 24.7 27.1 19.5 15.7 16.4</td>
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<td>5.4</td>
<td>2.3 1.3 3.4 2.2 2.1</td>
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<td>56.5</td>
<td>42.0</td>
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<td>Vallonia costata</td>
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<td>13.7</td>
<td>1.2</td>
<td>62.1</td>
<td>15.4 4.5 1.3 16.4 5.9 15.0 3.1</td>
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<td>Assiminea japonica</td>
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<td>3.5</td>
<td>5.6</td>
<td>6.5 16.1 28.6 15.3 10.9 26.7 21.5</td>
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<td>Total (%)</td>
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<td>100</td>
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Fig. 5.59. The abundance of land snails from Konam-ri shell middens (using data from Table 5.10).
Midden A-2: The lower level of midden A-2 yielded eight species of which Allopeas pyrgula was the most abundant and accounted for 56.5%. In the upper layer of the midden there was an increase in numbers of species and shells. A. pyrgula was still predominant, constituting 41.9% of the sample. There were also woodland and catholic species recovered in relatively high frequencies in both layers. This indicates mixed conditions around the site including open grassland and disturbed open forest. The marsh species Assiminea japonica, which was recovered from both layers, seems to have been introduced to the site by humans as no other evidence of a marsh environment was recognized from the site which is located on a relatively high hill. This species is common in brackish marshes such as estuaries. When man exploited certain resources in such marshes, the shells might have been collected accidentally and brought back to the sites. This species was also recovered from all samples collected from the other midden sites and can be interpreted in the same way.

Midden A-1: Ten species were found, and among these Gastrocopta coreana was predominant, constituting 30.8%, while A. pyrgula decreased to 12.8%. Although the habitat of G. coreana is uncertain, assuming the shells inhabit an similar environment to that of G. armigerella in the same family, they are common in leaf litter or sand in coastal areas. If the habitat is correctly identified, there was generally a decrease of open country species and an increase of catholic species in the midden. This suggests
an environment of more disturbed open woodland than in earlier periods.

**Midden B-1:** In layer 12, nine species were recovered. Open country species *A. pyrgula* was abundant, accounting for 44% with 6% *Vallonia costata*. Woodland and catholic species constitute 39.4%. This reflects a mixed environment of open grassland with disturbed open woodland. In layer 8, *A. pyrgula* decreased abruptly to about 10%, although *V. costata* increased to 16.4%, and catholic and woodland species became predominant, constituting about 45% and 10%. This suggests a slightly more woody environment compared to that of layer 12. In layer 6, nine species were found. *Hawaiiia minuscula* of catholic species and *A. pyrgula* of openland species were abundant, each accounting for 24.7% and 33.8%. The shell assemblages in this layer indicate a general environment of grassland with open woodland. The higher percentage of marsh species *A. japonica* is not due to an increase in numbers of that species but to a decrease in other shell numbers recovered from the sample. In layer 5, there was an increase in catholic species which accounted for 43.2%, however open country species at about 34% are still abundant. This represents surroundings of open woodland with grassland. In layer 4, there was an increase in species and total shell numbers in the sample. However the proportion of shell assemblages of different habitat species was similar to layer 5, although a small reduction of marsh species and a slight increase of woodland species.
were recognized. This indicates a similar environment to that of layer 5. In layer 3, there was an increase of openland species to 67.9%, of which V. costata constituted 60.2%, indicating a slightly more grassland environment compared to the previous layers of midden B-1.

It is interesting to note the frequency of land snails in each layer: the dense shell layers (layer 6 and 8) produced a relatively small number of land snails compared to those shell layers with abundant soil matrix (layers 3, 4 and 5, see section 4.1 for midden component proportions). This suggests that layers with high soil matrix have been formed relatively slowly, allowing grass to grow on them with open land or catholic species inhabiting the grass, resulting in high frequencies of the species among the land snail assemblages recovered from the samples.

**Midden B-2:** Layer 3 included 25.6% of woodland, 17.9% of catholic, 34.9% of open land and 21.5% of marsh species, indicating a mixed environment of woodland and open grassland. In layer 2, the total numbers of shells and shell species increased. However, the proportion of shell assemblages was constant, although there was a small decrease of woodland species to 13.7% and a slight increase of catholic and marsh species, suggesting no distinctive environmental changes during the period of midden formation.

In addition to the bulk samples dealt above, three column samples No. 2 and 10 in midden B-1 and No. 14 in midden B-2 were analyzed for land snails.
Column No.2: Eleven species appeared (Fig.5.60). Among these species, four species occurred constantly, one species appeared from sample 6 and others occurred very rarely. *A. pyrgula* was continuously abundant with *A. japonica* and *H. minuscula*. This reflects an open grassland environment, with some open woodland, without a great change of the environment and continuous human exploitation of marsh resources throughout the period.

Column No.10: Fourteen species appeared (Fig.5.61). *H. minuscula*, *A. pyrgula*, *V. costata* and *A. japonica* were continuously abundant, however two *Discococonulus* species and *G. coreana* occurred constantly. There was no significant change in shell assemblages recognized throughout the samples, indicating a constant environment of grassland with open woodland and continuous exploitation of marsh resources.

Column No.14: Twelve species were recovered (Fig.5.62). Among these species, *H. minuscula*, *A. pyrgula* and *A. japonica* appeared continuously. *A. pyrgula* and *A. japonica* were predominant throughout the sample. The shell proportion of different habitats indicates a grassland environment with open woodland and continuous exploitation of marsh resources.

In summary, land snail assemblages included in bulk and column samples collected from the midden sites, indicate that there was a constant environment of grassland with open woodland around the sites throughout
Fig. 5.60. The abundance of land snails recorded throughout column sample No.2 at Konam-ri shell midden B-1.
Fig. 5.61. The abundance of land snails recorded throughout column sample No10 at Konam-ri shell midden B-2.
**Fig. 5.62. The abundance of land snails recorded throughout column sample No14 at Konam-ri shell midden B-2**
the midden formation period, although a little variation was recognized, and that marsh resources were continuously exploited during that period.

5.3. THE MAMMAL REMAINS FROM THE MIDDENS

Mammal remains were recovered from the Konam-ri shell middens and studied in terms of diet reconstruction and season of hunting, and to get evidence of domestication of certain kinds of animals. The remains were identified by H. Kaneko (Waseda University, Japan) and by myself by comparison with modern reference materials and are listed in Table 5.11-14. In addition to the bones identified by species levels, many more bone fragments could not be identified. Ribs are included among these. The bones and antlers recovered were all fragmented. Some of them bear cut marks and are burnt, indicating cooking by roasting. These animals would have been an important protein resource and also a valuable raw material for manufacturing various kinds of antler, bone or tusk objects (see Chapter 3). Deer and wild boar were abundant among these species, indicating that they were preferred by the midden occupants and were studied in greater detail.

5.3.1. WILD PIG REMAINS (Table 5.12)

Wild pig (Sus scrofa) remains were recovered from middens A-1, B-1 and B-2 and were the most predominant species in the mammal bone assemblage from the middens. They are assumed to be wild judging according to the skull shape
Midden A-1: Sixty seven specimens were identified. Their age has been estimated on the basis of tooth eruption and wear, and on the basis of epiphysial fusion (Hayashi et al. 1977, Bull 1982 and Nishimura 1982). Many of the pig bones derived from young animals. The presence of two right mandibles showing the pre-eruption stage of the first molar indicates a minimum of two animals younger than six months old. There are two left humeri of new-born animals indicating a minimum of two new-born animals, a right mandible showing the pre-eruption stage of the second molar suggesting an immature animal under nineteen months old and a right maxillary fragment with I1, I2 and I3 indicating the presence of a pig older than 20 months.

<table>
<thead>
<tr>
<th>SPECIES</th>
<th>SITE</th>
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<th>A-2</th>
<th>B-1</th>
<th>B-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sus scrofa</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cervus nippon</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
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</tr>
<tr>
<td>Moschus moschiferus parvipes</td>
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<td></td>
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</tr>
<tr>
<td>Vulpes vulpes peculiosa</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Felidae</td>
<td>+</td>
<td></td>
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<tr>
<td>Felis bengalensis sanchuria</td>
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<td>Meles meles</td>
<td>+</td>
<td></td>
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<tr>
<td>Rattus sp.</td>
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Table 5.11. List of identified mammal species from the Konam-ri shell midden sites.
<table>
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<tr>
<th>ELEMENT</th>
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<th>B-1</th>
<th>B-2</th>
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<td>L. R.</td>
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<td>3</td>
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<td></td>
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<td>2</td>
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<td>1(N1)</td>
</tr>
<tr>
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<td>2(N)</td>
<td>2</td>
<td>3</td>
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<td>1(U)</td>
<td>1(N)</td>
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<td>1(N)</td>
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<td>1</td>
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<td>2</td>
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<tr>
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<td>4(N1, U2)</td>
<td>1(U)</td>
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<td>1</td>
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<td>1(N)</td>
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<td>2(N1)</td>
<td>2</td>
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<tr>
<td>Proximal</td>
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<td>1</td>
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</tr>
<tr>
<td>Shaft</td>
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<td>1</td>
<td>1</td>
<td></td>
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</tr>
<tr>
<td>Distal</td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fibula</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>5</td>
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</tr>
<tr>
<td>Calcaneus</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Talus</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
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<td>Other Tarsus</td>
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<td>1</td>
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<td></td>
<td></td>
</tr>
<tr>
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<td>1 (N1)</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
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<td>2(U1)</td>
<td>1(B)</td>
<td>4</td>
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<td>II</td>
<td>1</td>
<td>1(N)</td>
<td>1(N)</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

| Total            | 67    | 54   | 15   | 136  |
|                  | 4+2(N) | 4+1(N) | 1(N) | 9+4(N) |

N1 newborn, U1 unfused, B1 burnt
( ) in #1 and #2; the remaining parts.
< > teeth not present.
.br br
Table 5.12. Identified wild pig remains recovered from the Konam-ri shell middens. #1. Maxilla are represented by a L(dm3.4(M)<11111>, a L(dm2.3) and a R(I1.2.3) in midden A-1 and a R(I1.2.3) and a R(I1.2.3,C.P1) in midden B-1. #2. Mandibles are represented by a L(c.dm2.3.4), a L(I1.2.3.c dm2.3.4), a R(dm2.3.4), a R(dm2.3.4.<M1>) a R(dm2.3.4,M1.<M2>) and other fragments in midden A-1 and a L(I1.2.3.dm2.3.4.<M1> a R(P2.3.4,M1.2), a R(M3) and other) fragments in midden B-1. #3. Loose teeth are represented by three upper teeth (L11, L13 and R13) and four lower teeth (L11, R12, R12 and <M1>) in midden A-1, four upper teeth R(I12,I1, C and P4) and five lower teeth (R12, R13, LC, RC and Rdm4) in midden B-1 and a upper L11 and two lower teeth (Ri3 and RC) in midden B-2.

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A right male canine tooth suggests a minimum of one male among the animal remains. The unfused bone remains would be related to young animals.

**Midden B-1:** Fifty four pieces were recovered. The remains derive from at least five animals including two adult males (based on two unmatched lower canine teeth) and one female (based on a right maxilla with a female canine tooth). The tooth eruption stage of the female indicates an animal older than nineteen months. Assuming that a right lower M3 and a right male mandible (the remaining part including P2.3.4.M1.2), which did not derive from one animal, may belong to the animals from which the two lower canines derive, one male would be older than thirty one months (based on M3) and the other older than nineteen months (based on the mandible remains). The wild pig remains also included an animal younger than six months (based on a left mandible of the pre-eruption stage of the first molar) and a new-born animal.

**Midden B-2:** A relatively small number of fragments (fifteen) were identified. These came from a minimum number of two animals including one new-born and one male (based on a lower male canine tooth).

**AGE:** Among the wild pigs recovered from the Konam-ri shell middens, there is a high proportion of young animals. This might reflect either a preference for young wild pigs in terms of diet or selective hunting of young animals due to
the relatively poor hunting techniques of the midden people. It is known from modern hunters that even with modern hunting equipment such as a rifle, it is very dangerous to hunt adult male wild pigs (Yi 1959). Therefore the higher rate of young animals may be related to the relative ease of their capture in comparison to adult animals.

**HUNTING SEASON:** The hunting season of pigs recovered from the middens can be inferred from the evidence of tooth development. As seen above, many of the pig remains are derived from newborn animals or animals younger than six months old. It is known that the breeding season of wild pigs is around May (Yoon 1967:34). Therefore the tooth data indicates hunting activities occurring around May or October. It can also be inferred that the animals were hunted between autumn and spring when the food supply was not sufficient. The remains of newborn animals are particularly important as an indicator of hunting activities in the spring. Taking as an modern example in Korea, today the hunting of wild animals is carried out during the winter period.

Finally, it is interesting to note that the long bones such as the humerus were broken at the distal part. This might indicate marrow extraction or tool-making. As can be seen from Chapter 3, the tusk of pigs were also used for making tools such as fish-hooks.

**5.3.2. DEER REMAINS** (Table 5.13)

Deer (*Cervus nippon*) remains were recovered from all of
the middens, although only two loose teeth (M2 and M3) of a right mandible were discovered from midden A-2. The numbers of identified bone elements represented in middens A-1, B-1 and 2 are listed in Table 5.13.

**Midden A-1:** Twenty six deer remains were identified. Most of the remains were of adult animals with fused epiphyses. The presence of two left calcanea indicates a minimum number of two animals. Unmatched right and left distal parts of humerus bones also represent a minimum number of two animals. Two remaining left and right distal humerus fragments did not allow an estimate of numbers. Two pelvic fragments were thought to derive from an adult male because of the thick pubis, especially the symphysis, through comparison with modern specimens of known sex.

The eruption and wear stage of the lower molars (M1, M2 and M3) can be used to estimate age. Using modern data, Ohtaishi (1980) studied lower molars of modern red deer (*Cervus nippon*) to infer sex, age and season of death of archaeological specimens. As a result, he provided a wear index of molars (Fig.5.63) and a correlation graph between wear index and age (Fig.5.64). Using these data, I attempted to estimate the age of one of the deer represented in midden A-1. From two lower molars (M2 and M3) derived from one animal, the second molar showed wear index number five, while the wear grade of the third molar was between six and seven, indicating approximately a three year old.

Bones such as the humerus, metacarpus, femur and
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<tr>
<th>ELEMENT</th>
<th>SITE</th>
<th>A-1</th>
<th>B-1</th>
<th>B-2</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L.</td>
<td>R.</td>
<td>L.</td>
<td>R.</td>
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<td></td>
<td>4</td>
</tr>
<tr>
<td>Cranium</td>
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<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Maxilla $#1$</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Mandible $#2$</td>
<td>1</td>
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<td>1</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Loose teeth $#3$ upper</td>
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<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Loose teeth $#3$ lower</td>
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<td></td>
<td></td>
<td></td>
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</tr>
<tr>
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<td>1</td>
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<td>4</td>
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<td>- thoracic</td>
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<td></td>
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<td></td>
<td></td>
<td>6</td>
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<td>- shaft</td>
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<td>- distal</td>
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<td>1</td>
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</tr>
<tr>
<td>- distal</td>
<td></td>
<td></td>
<td></td>
<td>(U)</td>
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</tr>
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<td></td>
<td>6</td>
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<td>Metacarpus proximal</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td></td>
<td>6</td>
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<tr>
<td>- shaft</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>- distal</td>
<td></td>
<td></td>
<td></td>
<td>2(U)</td>
<td></td>
</tr>
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<td></td>
<td>6</td>
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<td>- shaft</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>- distal</td>
<td>1(U)</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td></td>
<td></td>
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</tr>
<tr>
<td>- shaft</td>
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<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>- distal</td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Fibula</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Calcaneus</td>
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<td></td>
<td>3</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Talus</td>
<td>1(U)</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>1</td>
<td></td>
<td></td>
<td></td>
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</tr>
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<td></td>
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<td></td>
</tr>
<tr>
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<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- distal</td>
<td></td>
<td>2</td>
<td>(U)</td>
<td></td>
<td>3</td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>Phalanges II</td>
<td>2</td>
<td></td>
<td></td>
<td>3(U)</td>
<td>7</td>
</tr>
<tr>
<td>Phalanges III</td>
<td>2(U1)</td>
<td></td>
<td></td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>26</td>
<td>51</td>
<td>30</td>
<td>107</td>
<td></td>
</tr>
<tr>
<td>MNI</td>
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</table>

Table 5.13. Identified deer remains recovered from the Konam-ri shell middens. $\#1$. Maxilla are represented by two R(P2.3, 4.M1.2.3) in midden B-1. $\#2$. Mandibles are represented by a L(I1.2.3) and a R(I1.2.3,P2.3.4,M1.2.3) in midden B-1. $\#3$. Loose teeth are represented by two upper teeth (RP3.4) and two lower teeth (RM2.3) in midden A-1. $\#4$. a pair + a left fragment in midden A-1.
<table>
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<th>WEAR INDEX</th>
<th>M₁</th>
<th>M₂</th>
<th>M₃</th>
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<tr>
<td>7</td>
<td>![Diagram of M₁]</td>
<td>![Diagram of M₂]</td>
<td>![Diagram of M₃]</td>
</tr>
<tr>
<td>6</td>
<td>![Diagram of M₁]</td>
<td>![Diagram of M₂]</td>
<td>![Diagram of M₃]</td>
</tr>
<tr>
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<td>![Diagram of M₁]</td>
<td>![Diagram of M₂]</td>
<td>![Diagram of M₃]</td>
</tr>
<tr>
<td>4</td>
<td>![Diagram of M₁]</td>
<td>![Diagram of M₂]</td>
<td>![Diagram of M₃]</td>
</tr>
<tr>
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<td>![Diagram of M₁]</td>
<td>![Diagram of M₂]</td>
<td>![Diagram of M₃]</td>
</tr>
<tr>
<td>2</td>
<td>![Diagram of M₁]</td>
<td>![Diagram of M₂]</td>
<td>![Diagram of M₃]</td>
</tr>
<tr>
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<td>![Diagram of M₁]</td>
<td>![Diagram of M₂]</td>
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</tr>
<tr>
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<td>![Diagram of M₁]</td>
<td>![Diagram of M₂]</td>
<td>![Diagram of M₃]</td>
</tr>
</tbody>
</table>

Fig. 5.63. Wear index of deer molars (from Ohtaishi 1980:53).

Fig. 5.64. Changes in the average wear index represented by male Kinki deer (from Ohtaishi 1980:61).
metatarsus were broken at the proximal or distal parts, suggesting marrow extraction or tool-making.

**Midden B-1**: A relatively large number (fifty one) of remains of identified specimens were represented. Five left proximal phalanges, all fused, indicate a minimum number of five adult animals. One of these animals was possibly between 3.5 and 4.5 years old, following Ohtaishi's (1980) tooth eruption and wear stages and on the basis of a right mandible with three molars (M1-M3) used. Estimation of wear on the first molar was impossible because it was broken. However the second and third molars showed wear index numbers of 4 and 6, indicating an age between 3.5 and 4.5 years old. In addition, the presence of an ulna and a distal phalange with unfused epiphyses suggests at least a young animal.

Four humerus fragments, a metatarsus and metacarpus, broken at the distal part, suggest marrow extraction (see Binford 1981) or tool-making as these bones are rich in marrow and useful for manufacturing tools due to their length. Some of them showed several butchery cut-marks.

Five bases of shed antler were recovered. These antlers might have been collected and brought to the site as raw material for the manufacture of tools such as spearheads, arrowheads and drills (see Chapter 3). In addition to these five bases of shed antler, many fragments of antler tines and beams were recovered from the midden deposits. Some of them showed cut-marks on the surface and some of them were burnt. This would be related to tool manufacture.
Midden B-2: Twenty nine specimens were identified. Among these specimens three left middle phalanges indicate a minimum number of three animals. There were unfused bones including a distal radius, a distal metatarsus, each of the left and right proximal phalanges and a middle phalange, indicating the presence of at least one young animal.

A base of unshed antler, 5.5cm in diameter, suggests at least one of the two adult animals was male. The unshed antler base can be used to infer the season of death because red deer shed their antlers annually. The cycle of red deer antler regeneration, however, differs according to the age of the animal. For example in the case of red deer older than five or six years, antlers are shed between mid April and May, then grow until August. From September the antler consists of dead bony material (Ohtaishi 1986:125). The antler of a one year old deer is shed after June, grows from summer to autumn and becomes a dead bony structure between late autumn and early winter (ibid.). The unshed antler base recovered from the site must have derived from an adult animal, killed between September and April.

Two fragments of antler recovered separately from midden B-1 and B-2 were refitted (as had been possible with some pot sherds, see Chapter 3) suggesting that some animal remains recovered from middens B-1 and B-2 may have been derived from the same animal. This suggests that these two middens would have been formed during the same period. It may also suggest group hunting and food sharing.
activities, as commonly happens in primitive societies and modern hunter groups.

5.3.3. OTHER SPECIES, ESPECIALLY SMALL MAMMALS

Other mammal remains, mostly small animals, were relatively sparse. The mammals possibly exploited included minimum number of a musk deer (*Moschus moschiferus parvipes*), a sea lion (*Eumetopias jubata*), a dog (*Canis familiaris*), a raccoon dog (*Nyctereutes procyonoides koreensis*), a fox (*Vulpes vulpes peculiosa*), a leopard cat (*Felis bengalensis manchuria*), a badger (*Meles meles*) and two specimens of Canidae and Felidae unidentified at species level. The identified skeletal elements of these animals are listed in Table 5.14 (see also Table 5.11).

In addition, several rat (*Rattus* sp.) fragments including a number of mandibles, humeri, ulnae, pelves, femora and tibiae, were also recovered from the middens. However it is uncertain whether rats were eaten by the midden people because rats are burrowers and live around human habitations. In addition, when considering the condition of the remains which, from skulls to vertebrae, were found in a concentration, it is possible that they died naturally within the midden deposits.

GENERAL REMARKS ON MAMMAL REMAINS

Although various animals were exploited, dog is the only domesticated animal among the animals recovered from the Konam-ri shell middens. Estimation of minimum number of each animal represented by the middens (see Table 5.12-4)
suggest that they made only a small contribution to the diet of the people who formed the middens. Among these animals, only sea lion is a migratory species. It is known that they migrate from the Siberian Sea, the Bering Sea and the Sea of Okhotsk to the Sea of Japan during the winter period (Yoon 1967:97). Thus the presence of sea lion in the Konam-ri shell midden A-1 indicates the possibility of some winter hunting. Pigs also indicate hunting activities occurring around May or October.

5.4. FISH REMAINS

Fish remains recovered from archaeological sites have been studied to reconstruct past human diet, fishing activities, trade and environment (Casteel 1976; Wheeler 1978; Brinkhuizen and Clason 1986; Wheeler and Jones 1989). Identification of fish bones provides information on the species exploited while the number of individual species exploited allows us to infer preference in humanTable 5.14. Identified other mammal remains recovered from Konam-ri shell midden B-1.

<table>
<thead>
<tr>
<th>SPECIES</th>
<th>ELEMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moschus moschiferus parvipes</td>
<td>a left upper canine</td>
</tr>
<tr>
<td>Eumetopias jubata</td>
<td>a left humerus</td>
</tr>
<tr>
<td>Canidae</td>
<td>a right lower molar II</td>
</tr>
<tr>
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</tr>
<tr>
<td>Nyctereutes procyonoides koreensis</td>
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</tr>
<tr>
<td>Vulpes vulpes peculiosa</td>
<td>a left radius (shaft)</td>
</tr>
<tr>
<td>Felidae</td>
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</tr>
<tr>
<td>Felis bengalensis manchuria</td>
<td>a left femur</td>
</tr>
<tr>
<td>Meles meles</td>
<td>a right ulna</td>
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</table>

181
diet, or the relative contribution of individual species to the diet. A study of the habitats and ecology of fish provides information on the season of capture, fishing areas and fishing techniques. Fish remains are also used to estimate fish size, age and weight, season of capture and so on. A study of selected elements of individual species is used to infer fish processing techniques and trade activities.

5.4.1. FISH REMAINS FROM THE KONAM-RI SHELL MIDDENs

Fish remains from the Konam-ri shell middens were studied focusing on the aspects mentioned above. Sea bream (Chrysophrys major) is one of the species which will be discussed in detail.

In the excavations fish bones were recovered by hand, by dry-sieving of the excavated soil using a 3mm mesh, and by wet-sieving collected column and bulk samples from the midden deposits in the laboratory. At least twenty-seven different marine fish species from the fish bones recovered from the Konam-ri shell middens have been identified by H. Kaneko and by myself by comparison with modern reference materials, and are listed in Table 5.15-18.

Most of these fish species might have been exploited as food resources. It is interesting to note that Fugu sp. are included among these fish remains. Fugu sp. has a toxin (tetrotoxin) which can bring death when it is consumed. The presence of this species indicate that the people at this time already knew how to remove the toxin.
Certain fish bones would have been used as a raw material for bone instruments. Tail spines of rays have been used to make bone needles (see Chapter 3) and possibly points for fishing. They have have been used as fish-points in the Yayoi Period in Japan (Kanzawa 1988) and for weapons by many primitive societies (Wheeler and Jones 1989:85).

It is possible, however, that very small fish such as anchovy (*Engraulis japonica*), from which vertebrae were

<table>
<thead>
<tr>
<th>SPECIES</th>
<th>A-1</th>
<th>B-1</th>
<th>B-2</th>
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<tr>
<td><em>Taius tumifrons</em></td>
<td></td>
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<tr>
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+: present.

Table 5.15. List of identified fish species recovered from the Konam-ri shell middens.
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<th>Mx#3</th>
<th>Dn#4</th>
<th>Pop#5</th>
<th>Op#6</th>
<th>Sop#7</th>
<th>Hy#8</th>
<th>V#9</th>
<th>Shen#10</th>
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<table>
<thead>
<tr>
<th>L: Left, R: Right</th>
</tr>
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<tbody>
<tr>
<td>#1. Sia-kull, si-frontal, hexameandibular, plipalatine, qu-square.</td>
</tr>
<tr>
<td>#3. Mima-maxilla</td>
</tr>
<tr>
<td>#4. Dhidentary, angula-angular.</td>
</tr>
<tr>
<td>#5. Pre-preopercul.</td>
</tr>
<tr>
<td>#7. Sup-supra-opercul.</td>
</tr>
<tr>
<td>#8. Mryxoid arch, cereo-cerato-thyl, epiphasy.</td>
</tr>
<tr>
<td>#10. Shi-shoulde-ridg, clic-cleithrum.</td>
</tr>
<tr>
<td>#11. Fin, fin spine, d-dorsal fin spine, l-lateral spine, t-tail spine.</td>
</tr>
<tr>
<td>#12. Tail spine is present in the families Dasyatidae, Mobulidae and Mylioatidae.</td>
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Table 5.16. Identified fish remains recovered from midden influential shell midden A-1.
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<th>Sqp. R.</th>
<th>Hy. R.</th>
<th>V. R.</th>
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Table 5.17. Identified fish remains recovered from Konam-ri shell midden B-1.
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<td>R.</td>
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<tr>
<td>L. japonicus</td>
<td>L.</td>
<td>1</td>
<td>1</td>
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<td></td>
<td>R.</td>
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<tr>
<td>Tetraodontidae</td>
<td>hyl</td>
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<td></td>
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</tr>
<tr>
<td>P. olivaceus</td>
<td>L.</td>
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<td></td>
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<td></td>
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<tr>
<td></td>
<td>R.</td>
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<td>Rajiformes</td>
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<td>5(B1)</td>
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<tr>
<td>H. tobijei</td>
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<tr>
<td>S. melanosticta</td>
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<td>3</td>
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<tr>
<td>Squatinidae</td>
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<td>8</td>
</tr>
<tr>
<td>Triakidae</td>
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<td></td>
<td></td>
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<td></td>
<td>3</td>
</tr>
<tr>
<td>E. japonica</td>
<td>L.</td>
<td></td>
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<td>2</td>
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<tr>
<td></td>
<td>R.</td>
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<tr>
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<td>L.</td>
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<tr>
<td></td>
<td>R.</td>
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<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>4</td>
<td>14</td>
<td>1</td>
<td>58</td>
<td>.6</td>
<td>4</td>
<td></td>
<td>23</td>
<td>6</td>
<td>58</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#1. ur:urostyle.

Table 5.18. Identified fish remains recovered from the Konam-ri shell midden B-2.
recovered, might not have been brought to the sites for food. These may have been caught by chance among the larger fish and carried into the midden area, or have come from the gut contents of larger fish which had fed on them. Suzuki et al. (quoted by Suzuki 1989:102) examined the guts of modern tuna and found small fish bones, from species such as sardine, anchovy and mackerel, which had survived in them. Small fish bones, then, such as anchovy, recovered from shell deposits need not necessarily indicate consumption by humans. However it is hard to exclude the possibility that such small fish have been eaten by people in the past because today they are commonly consumed in Korea and Japan. If they were caught for food in the past, this would indicate the use of fine nets.

5.4.2. SEASON OF FISHING AND FISHING METHODS

It seems likely that the fish species studied would have been caught mainly between spring and autumn. A recent study on seasonal variation in fish assemblages in Ch'ŏnsu Bay east of Anmyŏn Island, showed distinctive seasonal fluctuations in abundance and species composition in the bay (Lee and Seok 1984; Shin 1986). This feature was interpreted as due to mainly seasonal variation in sea temperatures in the bay (ibid.). As a result a high fish population was observed in the late spring and autumn. Lee and Seok (ibid.) point out that there was a marked reduction in the number of species and abundance during the summer and suggest that the reason for this might be
due to the loss of spawners probably by mortality or wide
dispersion after spawning (ibid.). The higher number of
species and greater abundance in late spring would be
related to migrations from the sea into the bay for
spawning and feeding after wintering in the sea (Lee and
Seok ibid.). During winter very few fish were captured.
This would be due to the wintering of most fish in the sea
well off shore.

Early 20th century records also show that the fishing
season in the sea near Ch'ungnam Province is mostly
between spring and late autumn or early winter (Chosen
Sotokubu 1926). The fishing season, and fishing methods of
the species recovered from the Konam-ri shell midden based
on Chosen Sotokubu, are given in Table 5.19. Thus, if the
recent sea environment is the same as that of the
prehistoric period, fishing activities would have been
carried out between spring and autumn.

Ethnographic evidence provided by Brinkhuizen
(1983) suggests that three main fishing methods may have
been employed: (1) fishing without using tackle; (2)
fishing using actively-operated fishing tackle such as
gaffs, rods with a bob, sticks with a noose, spears and
lines with a gorge or fish-hooks; and (3) fishing using
passively-operated fishing gear such as wires, fish-
surrounds, fish-traps and fishing nets. However it is
difficult to infer the kinds of fishing methods and tackle
used in the past because such evidence is not often found.

When considering the fishery data provided by Chosen
Sotokubu and artefact data such as two fishhooks, one
<table>
<thead>
<tr>
<th>Species</th>
<th>Fishing season</th>
<th>Peaking season</th>
<th>Method ***</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bothidae*</td>
<td>May-Aug.</td>
<td>May-June</td>
<td>long lines</td>
</tr>
<tr>
<td>C. Major**</td>
<td>E.May-E.Dec.</td>
<td>E.May-L.June</td>
<td>stow nets on anchor or stake; purse seines; or hand or long lines</td>
</tr>
<tr>
<td>E. Japonica</td>
<td>L.June-L.Oct.</td>
<td>L.July-L.Aug.</td>
<td>beach seines; or dragged scoop nets with light</td>
</tr>
<tr>
<td>L. elongata</td>
<td>E.May-L.June</td>
<td>E.May-L.June</td>
<td>drift nets with pocket; or long lines</td>
</tr>
<tr>
<td>L. japonicus</td>
<td>E.July-L.Sep.</td>
<td>E.Aug.-L.Aug.</td>
<td>stow nets on stake; or long or hand lines</td>
</tr>
<tr>
<td>M. cephalus</td>
<td>year-round</td>
<td>L.Jan.-L.April</td>
<td>trawls; stone weirs; fish fences; or others</td>
</tr>
<tr>
<td>N. imbricata</td>
<td>L.May-L.Oct.</td>
<td>July</td>
<td>stow nets on anchor; or others</td>
</tr>
<tr>
<td>Photoloides</td>
<td>E.April-L.Oct.</td>
<td>E.April-L.May</td>
<td>stow nets on anchor; long lines; or weirs</td>
</tr>
<tr>
<td>Rajidae</td>
<td>M.April-M.Dec.</td>
<td>E.May-L.June</td>
<td>stow nets on anchor or stake; long lines; or others</td>
</tr>
<tr>
<td>S. quinqueradiata*</td>
<td>Aug.-Oct.</td>
<td>Sep.</td>
<td>gill nets; weirs; or hand lines</td>
</tr>
<tr>
<td>A. Schlegeli**</td>
<td>April-Nov.</td>
<td>May</td>
<td>weirs; or long lines</td>
</tr>
</tbody>
</table>

Eearly. Mmiddle. Llate.
\* Data on the fishing season of species which were not available in Ch'ungnam Province were taken from the near-by province.
\** The data given by Chosen Sotokubu for the peak fishing period of middle December appears to be a misprint. On the same page (p.10) the fishing season is given as between early May and early December. The water temperature in middle December is cold and sea bream may have already moved into the deep sea. I have therefore used early December.
\*** English terms of fishing gear are based on O et al. (1987).

Table 5.19. Fishing season and methods (based on Chosen Sotokubu 1926).
net-sinker and spearheads found from the middens (see Chapter 3), it seems likely that net fishing, line fishing and spearing were used to catch fish in the Konam-ri area in the past.

5.4.2. SEA BREAM

Sea bream, which is the most abundant among the fish species recovered from the middens, were studied in detail. Size estimation of fish from archaeological sites is useful for inferring past fishing activities, as the size of fish captured may be related to fishing methods, tackle, fishing area and season of capture (Akazawa 1969). The estimation of fish size has been attempted by means of dentaries, maxillary or premaxillary bones (Shawcross 1967; Akazawa and Watanabe 1968; Akazawa 1969), vertebrae (Casteel 1976; Enghoff 1983) and otoliths (Blacker 1974). Casteel (1975 and 1976) also discussed the possibility of estimating size using fish scales.

SIZE ESTIMATION

The estimation of sea bream size from the Konam-ri shell middens has been attempted using 32 premaxillary bones which were the most abundant and well preserved of all the sea bream bones. The length of the premaxillary bones was measured and compared with the correlation curve (Fig. 5.64) of premaxillary length and fish size, presented by Akazawa (1969) to estimate the size of sea bream from Jomon shellmounds. The measurements of premaxillary bones from the Konam-ri sites is given in Table 5.20.
Measurements of premaxillary length of sea bream from the Konam-ri shell midden sites show that their size ranges from 20mm to 45mm with a mean between 30mm and 34mm. The approximate body length of fish was deduced by using the correlation curve (Fig.5.64); calculated in this way body length ranges from about 250mm to about 550mm, with a mean at about 400mm. It is worth noting that no premaxillary bones smaller than 20mm (about 250mm body length) have been recovered. This may be related to

![Correlation curve between body length and premaxillary length of sea bream, and histogram of premaxillary length of sea bream from the Konam-ri shell midden sites (modified from Akazawa 1969:43).](image)

<table>
<thead>
<tr>
<th>Pm Length (mm)</th>
<th>A-1</th>
<th>B-1</th>
<th>B-2</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 - 24</td>
<td>3</td>
<td></td>
<td></td>
<td>3</td>
<td>9.3</td>
</tr>
<tr>
<td>25 - 29</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>6</td>
<td>18.8</td>
</tr>
<tr>
<td>30 - 34</td>
<td>2</td>
<td>10</td>
<td></td>
<td>12</td>
<td>37.5</td>
</tr>
<tr>
<td>35 - 39</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>6</td>
<td>18.8</td>
</tr>
<tr>
<td>40 - 44</td>
<td>3</td>
<td></td>
<td>3</td>
<td>9.3</td>
<td></td>
</tr>
<tr>
<td>45 - 49</td>
<td>2</td>
<td></td>
<td>2</td>
<td>6.3</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>6</td>
<td>24</td>
<td>2</td>
<td>32</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 5.20. Measurements of premaxillary length of sea bream from the Konam-ri shell middens.
different preservation rates (smaller bones may disintegrate more easily than bigger ones), sampling bias (bigger bones may be easier to find than smaller ones), fishing methods, fishing tackle, fishing area and season of capture, etc. It is unlikely, however, that all small premaxillary bones would have been destroyed, and it is thus possible that small fish were not exploited. Such selective fishing activities might be related to other factors which are discussed below.

FISHING AREA AND SEASON OF CAPTURE

The season of capture can be identified by studying growth rings on fish otoliths, scales (Casteel 1976) and vertebrae (Noe-Nygaard 1983). It is however only possible to identify season of capture when these bones are abundant, recovered in a well preserved condition and are studied in great detail with comparative data. Season of fishing can however be inferred from a study of the habitats and behaviour of present-day fish, especially migratory fish species.

Sea bream are deep sea fish, but during the spawning season they migrate close to the shore where they feed until water temperatures become colder in the late autumn or early winter. Small fish feed close inshore until they attain adult size (Akazawa 1969:46). It could therefore be inferred that large fish might be caught between the spawning season and early winter when the fish were in the coastal area and easily accessible to prehistoric fishermen, even with a relatively undeveloped fishing technology.
Today sea bream move into the coastal areas of Korea to spawn in May (Chung 1961:428) and near Anmyŏn Island are captured between early May and early December, the season peaking between early May and late June and early September and early December (Chosen Sotokubu 1926). It is during this period that the sea bream from the Konam-ri shell middens may have been captured near the island. The sea bream remains from the sites are of mature individuals and would have been readily available during their migration to the coastal area.

More precise indications of the season of capture were obtained by studying growth rings on fish scales. About 198 fish scales were recovered from bulk and column samples collected from the sites. Among these scales 51 sea bream scales were found acceptable to read growth rings. The growth ring analysis was done by myself under the supervision of Lee Tae-won, Chungnam University in Korea. Assuming the formation period of the annulus is in April (Lee Tae-won, personal communication), the estimated season of death would mostly be in early spring around in May (Table 5.21).

The estimation of age and size compositions of sea bream will be studied further, using the scales.

<table>
<thead>
<tr>
<th>Site</th>
<th>Layer</th>
<th>Season of death</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Spring</td>
<td>Autumn</td>
</tr>
<tr>
<td>A-1</td>
<td>2</td>
<td>32</td>
<td>4</td>
</tr>
<tr>
<td>B-1</td>
<td>4</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>B-1</td>
<td>6</td>
<td>11</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>46</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 5.21. Estimated seasons of death for sea bream based on growth rings on scales.
FISHING METHODS AND FISHING TACKLE

Three methods, net fishing and angling with fish-hooks and spearing might have been used in this area in the past. The evidence for net fishing is based on a shell sinker (Fig.3.7.26) discovered in midden A-1. It is made from a clam shell (Meretrix lamarcki), perforated at the umbo area, allowing it to be attached to the net. It is however difficult to prove that the net fishing method was used to catch the sea bream recovered from the sites. The size composition of fish captured by nets depends on the population structure of the target fish, and the mesh size of net used (Akazawa 1969:54). If fishing activities were carried out in the coastal area during the spawning season and after, as discussed above, it is probable that fish smaller than 250mm would have been caught along with bigger fish. However the fact that no remains of fish smaller than 250mm in body length have been recovered may indicate selective fishing using a certain size of net mesh, which did not trap small fish. However it is not possible to confirm that sea bream were caught using the net fishing method as there are no remains of nets on the sites.

Sea bream might have been caught by angling with fish-hooks according to modern analogy (Chosen Sotokubu 1926:10; Okada 1966:247). Two fish-hooks made of the canine teeth of wild pig were discovered from midden B-1 (see Chapter 3). However once again, it is difficult to confirm that this fishing tackle was used to catch sea bream.
Experimental work provides information on the relationships between the width of fish-hooks and length of fish caught by using them. It has been shown that the size of fish is selected according to the width of the fish-hook. For example, the ratio of the maximum fish mouth width of the most common sized fish captured, to the width of the fish-hook used to catch them, has been estimated at 0.4 for sea bass, 0.5 for smelt and 0.6 for mackerel (work by Koike et al., quoted by Ishikawa 1985:77-9). However fish which are smaller or larger than the size most abundantly captured can also be captured by the same fish-hook (Ishikawa 1985:78-9).

Comparison between the fish-hooks and the remains of sea bream from the Konam-ri shell middens have been made in an attempt to infer relationships between the two, based on the results of the experimental work mentioned above. The maximum mouth width of the mean size class of premaxillary (30-34mm) was deduced using the results presented by Ishikawa (1985:79-80), who calculated the maximum mouth width to be 1.25 times the premaxillary length (Fig.5.65). The deduced maximum mouth width of the premaxillary size class (30-34mm) is about 375-425cm. The ratio of the maximum mouth width of the most abundant sea bream size to the mouth of fish-hooks recovered from the Konam-ri shell middens is about 0.38-0.43. This falls into the upper range of the ratios (0.4-0.6) for the different fish species mentioned above. Although sea bream have not been studied in terms of the relationship between fish-hook width and maximum mouth width, the results from
the Konam-ri shell middens suggests that the fish-hooks from midden B-1 might have been used to catch sea bream.

It is also possible that sea bream were caught by spearing. Several bone or deer antler spears were recovered from the sites (see Chapter 3). Although no fish bones recovered show spear marks, they might have been used. An example of such a technique is found in one of the Jomon shell middens in Japan, the Shiizuka shell midden, where a frontal stabbed by a spear was recovered (Suzuki 1990:108).

Fig 5.66. Correlation curve between the premaxillary length (x) and maximum mouth width (y) of present living sea bream specimens (taken from Ishikawa 1985:80).
5.5. BIRD REMAINS

Six species of birds were recovered from the middens (Table 5.22-3). The remains of birds were few and suggest that they were unlikely to have constituted a major food resource for the midden's inhabitants. Most of the remains were recovered from midden B-1, including a minimum number of three ring-necked pheasants (*Phasianus colchicus*), a crow (*Corvidae*), a wild pigeon (*Streptopelia orientalis*), a duck (*Anatidae*), a kite (*Milvus migrans lineatus*), and a loon (*Gaviidae*). Bird remains from midden B-1 are listed in Table 5.22.

**Middens A-1:** A right carpometacarpus of duck and a left carpometacarpus and a left femur of a ring-necked pheasant were recovered.

**Midden B-2:** A right carpometacarpus of duck and a left carpometacarpus of a ring-necked pheasant were recovered.

Although they made a small contribution to the diet of the people, they can be used to infer the season of exploitation. Among these bird species ducks (*Anatidae*) and loons (*Gaviidae*) are seasonally migrating species. They move into Korea from Siberia in autumn for wintering (Kang 1962:343-86 and 401-5), when they must therefore have been exploited during this period. Bird hunting today in Korea occurs mainly during the winter season, which gives greater credence to the possibility of winter hunting of birds.
<table>
<thead>
<tr>
<th>Species</th>
<th>A-1</th>
<th>B-1</th>
<th>B-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anatidae</td>
<td></td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Corvidae</td>
<td></td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Gaviidae</td>
<td></td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Milvus migrans lineatus</td>
<td>+</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Phasianus colchicus</td>
<td></td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Streptopelia orientalis</td>
<td></td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>unidentified sp.</td>
<td></td>
<td></td>
<td>+</td>
</tr>
</tbody>
</table>

Table 5.22. List of identified bird species from the Konam-ri shell middens.

<table>
<thead>
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</tr>
</thead>
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<td>Anatidae</td>
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</tr>
<tr>
<td>Corvidae</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Gaviidae</td>
<td></td>
<td>1</td>
<td>1</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Milvus migrans lineatus</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Phasianus colchicus</td>
<td></td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td></td>
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<td></td>
<td>9</td>
</tr>
<tr>
<td>Streptopelia orientalis</td>
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<td></td>
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<td></td>
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</tr>
<tr>
<td>unidentified sp.</td>
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</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>17</td>
</tr>
</tbody>
</table>

Table 5.23. Identified bird remains from Konam-ri shell midden B-1.
5.6. OTHER ANIMAL REMAINS

In addition to animals mentioned above, remains of turtles (*Clemmys japonicus*), snakes, frogs, sea urchins and crabs were recovered from the middens. These animals would be exploited for food items although they made a very small contribution to the diet of the people.

However one example of a snake seems to indicate a natural death in the midden deposit. In midden B-1, a concentration of ribs and vertebrae of a snake were found. Other snake vertebral remains were scattered throughout the midden deposits.

Remains of a minimum number of two turtles recovered from midden B-1 included plates of the carapace and plastron, a right femur, a left pelvis and a mandible. The estimated size of one turtle is about 180mm in length.

The remains of frogs include pelves, vertebrae, humeri, femora and tibiae+fibulae. Crab remains include fragments of pincers which were mostly burnt, indicating roasting for consumption. Shell fragments and spines of sea-urchins were recovered from most column and bulk samples, suggesting regular exploitation.

5.7. HUMAN REMAINS

A left humerus of a human was recovered from midden A-1. The proximal and distal ends were broken. The reason for the presence of only this human element among all the various bones in midden deposit is not clear. It may have been buried in the midden, as in midden deposits at other sites. Neolithic middens such as Sandeung in Sangnodae-do
and Yŏnkok-ri and Yokji-do in Tôngyŏng, and Jo-do (Iron Age) yielded burials from beneath or above midden deposits. However, no evidence of regular or intact burials were found at the Konam-ri middens.

The bone is undergoing further study in an attempt to infer human diet in the past. The ratios of the stable isotopes of carbon or nitrogen in human bones, has been used to aid the reconstruction of diet and subsistence patterns of prehistoric hunter-gatherers (van der Merwe and Vogel 1978; Tauber 1981; Chisholm et al. 1982 and 1983; Schoeninger et al. 1983; Chisholm and Shutler 1984; Roksandic et al. 1988). The result of the analysis (will be provided by T. Akazawa in Japan) on the sample which is awaited from midden A-1 will provide additional information on the diet of Konam-ri people.
6. PLANT REMAINS

Very few charred plant remains were recovered: one hulled six-rowed barley grain (*Hordeum* sativum var. *hexastichum*), which was twisted, from layer 2 of midden A-1; a peach seed (*Prunus persica*) from layer 2 of midden B-2; and in dwelling 3, many millet seeds (*Panicum* sp.). It has been suggested that these millet remains may include at least three different species, among them foxtail millet (*Setaria italica*), because of the difference in size and shape (Gordon Hillman, personal communication). Infra-red spectrum analysis of each specimen is in progress by J. Evans, East London Polytechnique and this will provide some information on the specific identification of millet species. A charred and hulled japonica-type rice grain (*Oryza sativa*) was also recovered from dwelling 3. In addition a grain of wild weed (*Galium* sp.) was recovered from layer 2 of midden B-2 which seems to have been introduced to the site accidently. This wild plant is still common on the island today.

The scarcity of plant remains from midden deposits compared to animal remains may be explained in a number of ways including differential preservation and discard rates, or disposal behaviour.

In addition to these plant remains, a rice grain impression on the bottom of plain pottery was discovered in midden B-1 (see Chapter 3).

The identification of charcoal remains recovered from the midden deposits and dwellings helps in the reconstruc-
tion of the local environment and possible human behaviour involved in selecting wood resources for constructing structures and fires. Preliminary results of C. Cartwright's identification of the charcoal remains are summarized in Table 6.1. Identified species include Pinus and Quercus. Pinus sp. and Quercus sp. are commonly found today on the island, indicating generally similar environmental conditions between the midden formation period and the present.

It is known that seven Pinus species grow naturally in Korea and that P. koraiensis, P. densiflora and P. thunbergii are common (Yi et al. 1991: 151). On the basis of the present analyses samples No.2, 4 and 10 are likely to be P. koraiensis and the remaining samples No.3, 6, 7 and 11 could be either P. densiflora or P. thunbergii (based on Pak et al. 1981; Pak 1990). Although the latter two species are difficult to identify due to the similarity of their structures (Pak ibid.: 230), the samples may include both species because both are common on the island today. Further analyses of the charcoal remains of Pinus to species level will be forthcoming after comparisons with local reference material, so that the key characteristics (see the remarks shown on Table 6.1) can be identified.

The identified wood species would have been exploited for firewood or for building structures (especially samples 8 to 11 recovered from the dwellings) such as wooden posts or fences.

Although no acorn remains were recovered from the sites, the presence of Quercus sp. wood which produces
acorns, suggests their availability. The saddle querns and rubbing stones recovered from the sites (see Chapter 3) could have been used for acorn processing.

Acorns have been exploited from the Neolithic Period to the present in Korea. Seven archaeological sites have produced acorns (Watanabe 1990): Neolithic dwelling sites such as Amsa-dong, Bongge-ri, Misa-ri, Namkyŏng and Osan-ri; Simgwi-ri Bronze Age dwelling site; and the Joyang-dong grave site of the Proto-Three Kingdoms Period.

Pollen analysis of soil samples collected from the midden deposits were examined for pollen but none was found. This may reflect alkaline soil conditions from dissolved calcium carbonate from shells, the decomposition of bacteria in soils, the generally oxidised environment, and also loose soil structure which would allow pollen grains to be washed out from the sediments by rain especially the heavy rain falls during the summer. It is known that sites with strongly alkaline deposits such as shell middens and limestone caves are seldom rich in pollen.

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>SITE LAYER</th>
<th>SPECIES</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>B-1</td>
<td>6 Quercus sp.</td>
<td>no dentate ray tracheids</td>
</tr>
<tr>
<td>2</td>
<td>B-1</td>
<td>6 Pinus sp.</td>
<td>no dentate ray tracheids</td>
</tr>
<tr>
<td>3</td>
<td>B-1</td>
<td>6 Pinus sp.</td>
<td>no dentate ray tracheids</td>
</tr>
<tr>
<td>4</td>
<td>B-1</td>
<td>6 Pinus sp.</td>
<td>no dentate ray tracheids</td>
</tr>
<tr>
<td>5</td>
<td>B-1</td>
<td>9 Quercus sp.</td>
<td>no dentate ray tracheids</td>
</tr>
<tr>
<td>6</td>
<td>B-1</td>
<td>11 Pinus sp.</td>
<td>dentate ray tracheids</td>
</tr>
<tr>
<td>7</td>
<td>B-2</td>
<td>3 Pinus sp.</td>
<td>dentate tracheid walls</td>
</tr>
<tr>
<td>8</td>
<td>Dwelling 1</td>
<td>Quercus sp.</td>
<td>dentate ray tracheids</td>
</tr>
<tr>
<td>9</td>
<td>Dwelling 3</td>
<td>Quercus sp.</td>
<td>dentate tracheid walls</td>
</tr>
<tr>
<td>10</td>
<td>Dwelling 3</td>
<td>Pinus sp.</td>
<td>no dentate ray tracheids</td>
</tr>
<tr>
<td>11</td>
<td>Dwelling 3</td>
<td>Pinus sp.</td>
<td>dentate ray tracheids and spiral thickenings in the axial tracheids</td>
</tr>
</tbody>
</table>

Table 6.1. Identified wood charcoal remains recovered from the Konam-ri shell middens and dwellings.
7. DATING THE KONAM-RI SHELL MIDDENS

The artefact assemblages from the sites clearly show that midden A-2 dates from the Neolithic Period and middens A-1, B-1 and B-2 from the Bronze Age. In Chapter 3, I have shown that, on the basis of a still too limited number of radiocarbon dates and comparisons with archaeological sequences in China, the Neolithic Period in Korea can be dated between 7000 and 3000 BP, and the Bronze Age from 3000 to 2300 BP, and so we should expect that the Konam-ri sites should fall somewhere into these time ranges. Comparative analysis of pottery assemblages also helps us to place the sites more precisely in time, and elsewhere in the thesis (Chapter 3 and section 9.4). I argue that the Bronze Age middens at Konam-ri should belong to a rather brief period similar to the Songguk-ri sites dated between 2665+60 and 2500+90 bp (the 6th-4th centuries BC by researchers, NMOK 1979 and 1989).

In order to test these assumptions and to date the Konam-ri shell middens more securely on materials from the sites, charcoal and shell samples were collected from as many appropriate and secure contexts as possible, and fourteen samples were actually dated. The results are set out in Table 7.1 as uncalibrated ages based on the half-life of radiocarbon, 5568 years. Not all the samples yielded results which fitted my expectations, and the problems are discussed below. But on the whole the charcoal and shell samples dated by Beta Analytic Inc. of Miami, Florida, and the 'First-order' shell dates which I processed myself in the laboratory of Professor Claudio
Vita-Finzi in the Department of Geological Sciences, University College London, yielded dates which are believable and conformable with expectations based on comparative analyses of artefacts.

7.1 CONVENTIONAL C-14 DATES

First I will discuss the three samples (KSU-2037-9) which were submitted to the C-14 Dating Laboratory in Kyoto Sangyo University, Japan. The results, from middens B-1 and B-2, range from 1260±60 – 1590±60 bp or roughly the 4th-7th century AD. This is clearly impossible as the archaeological materials of the historic period in Korea are well known and none were found at these sites. Why these four dates from the same laboratory should all be about one thousand years younger than expected is a problem that I am now taking up with the Kyoto Sangyo University Laboratory, and until this is resolved I propose to ignore the results for the purpose of dating these sites.

<table>
<thead>
<tr>
<th>SITE LAYER</th>
<th>Material</th>
<th>Conventional Lab. C-14 dates (bp±1σ)</th>
<th>First-order C-14 dates (bp±1σ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-1</td>
<td>2 shell</td>
<td>1800±200 UCL-234</td>
<td></td>
</tr>
<tr>
<td>A-2</td>
<td>5 shell</td>
<td>3150±200 UCL-237</td>
<td></td>
</tr>
<tr>
<td>A-2</td>
<td>surface</td>
<td>3400</td>
<td></td>
</tr>
<tr>
<td>A-2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B-1</td>
<td>6 shell</td>
<td>1270±50 KSU-2036; 2420±90 Beta-44977</td>
<td></td>
</tr>
<tr>
<td>B-1</td>
<td>6 charcoal</td>
<td>1330±80 KSU-2038; 3340±80 Beta-44978</td>
<td></td>
</tr>
<tr>
<td>B-1</td>
<td>7 shell</td>
<td>1250±100 UCL-234</td>
<td></td>
</tr>
<tr>
<td>B-1</td>
<td>12 shell</td>
<td>4150±250 UCL-235</td>
<td></td>
</tr>
<tr>
<td>B-2</td>
<td>2 shell</td>
<td>2650±70 Beta-44975</td>
<td></td>
</tr>
<tr>
<td>House 2</td>
<td>3 shell</td>
<td>2620±80 Beta-44976</td>
<td></td>
</tr>
<tr>
<td>House 3</td>
<td>2 charcoal</td>
<td>1590±60 KSU-2039</td>
<td></td>
</tr>
<tr>
<td>House 3</td>
<td>3 charcoal</td>
<td>1260±60 KSU-2037; 2620±80 Beta-44976</td>
<td></td>
</tr>
</tbody>
</table>

*bp= radiocarbon years before present (1950).
**the half-life of radiocarbon= 5568 years.

Table 7.1. Conventional and First-order radiocarbon dates from the Konam-ri shell middens and houses.

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Following the receipt of these 'dates' I applied for money to the Central Research Fund of the University of London (who had already supported my visit to Japan) and thanks to their generosity, I was able to have two more charcoal and two marine shell samples dated commercially by Beta Analytic Inc. Three out of four of these gave results which are mutually consistent at the 68% confidence limits, and conform with the expected age for a Bronze Age site. One charcoal sample Beta-44978 from layer 6 in midden B-1 dated to 3340±80 bp lies outside these limits and this problem may be due to the low carbon content of the sample, which the laboratory commented on, or by the presence of some much older charcoal which, through an event impossible to identify, had become incorporated in the Bronze Age site.

7.2 FIRST-ORDER C-14 DATES

In addition to using standard laboratory dating facilities I wanted to date some of the shells myself in order to learn at first hand about dating procedures and to test in another situation the First-order dating method developed by Vita-Finzi (1983, in press) and also applied by others in recent years (Glover et al. 1990; Frankel and Story 1990). I worked under the supervision of Professor Vita-Finzi in his newly re-established laboratory in the Department of Geological Sciences, UCL, and followed the procedures described in Glover et al. (1990), although since that was published Vita-Finzi has simplified the sample preparation rig in some details from the one
described by them and illustrated here in Fig. 7.1. The advantages of this method is that it is simple, quick and cheap and can, in most cases, yield dates which are accurate if not as precise as those obtainable from conventional laboratory procedures. For example the standard error at 68% confidence limit is typically 15-300 years when working in the time range of the Neolithic and Bronze Ages, rather than the 70-90 years from conventional laboratories.

Shells with a dense cross-lamellar structure such as *Meretrix lamarcki*, *Tegillarca granosa* and *Scapharca broughtonii* were collected for dating during the excavations and from collected midden samples. Each sample for dating requires about 25g of clean shell. Their surfaces were cleaned mechanically, and chemically using 10% HCL (they lost about 2-3g in their weight during cleaning).

CO$_2$ gas for dating is trapped by following the procedures described in Vita-Finzi (1983) and Glover et al. (1990). The shell sample is located in the flask A in Fig. 7.1. 50% HCL is delivered to the shell sample. A solution of silver nitrate in trap B removes any excess HCL fumes from A, then the gas passes into a low-potassium glass vial with a stainless steel cap (C) containing a precisely weighed 1:1 mixture of Carbosorb and Permafluor from where the CO$_2$ gas is absorbed. The reaction is measured and when complete the vial will have gained about 1.26g in absorbed CO$_2$.

Seven samples from the Konam-ri shell middens were
dated in this way (Table 7.1) and a further four from shell middens at Nae-dong (Kimhae) and Kungok-ri (Haenam) on the south coast of Korea (Table 7.2). Although not in perfect agreement with the conventionally-dated charcoal and shell samples from Beta Analytical Inc., several are close enough to these, or to my expectations where there are no Beta dates for comparison, for me to regard the dating experiment as successful.

For instance two dates UCL-237 (3150±200 bp) and UCL-235 (4150±250 bp) are from the Neolithic midden A-2 and the Neolithic layer (12) at midden B-1. At the 95% limit these dates are not so far apart and are conformable with the expected age of the late Neolithic pottery found in these layers. Sample UCL-233 (3200±200 bp) is also at the 95% limit (3600-2800), not so far from the Beta-44978 (2420±90 bp) result from more shell from the same layer. And sample UCL-232 (2400±100 bp) from layer 2 of midden

Fig.7.1. Sample preparation rig (from Glover et al. 1990:563).
B-2 is entirely in agreement with Beta-44975 (2650±70 bp) from the layer below in the same midden. Only samples UCL-231 (3400±7 bp) and UCL-234 (1250±100bp) seem to be quite outside an acceptable error range for the layers and middens dated, but it should be noted that sample UCL-231 which was collected from the surface of the middens before excavation could just as easily be derived from the Neolithic midden A-2 as from the Bronze Age midden A-1. The differences between the two were not recognized at that stage.

We can describe some of the differences between shell and charcoal dates, and the variations between the former to contamination by modern carbon, as well as displaced shells (which can easily happen in midden structures). For instance it is known that marine shells are easily contaminated by modern carbon (Shackleton 1969:412; Polach 1976:278-9; Goslan and Pazdurs 1985) and by delayed circulation of C-14 in the ocean reservoir (Harkeness 1983).

In addition to dating the Konam-ri middens, samples from two other shell midden sites in Korea were dated in order to broaden the sample of dated Korean shells, and the results are given in Table 7.2 (the error ranges will be provided later).

<table>
<thead>
<tr>
<th>SITE</th>
<th>LAYER</th>
<th>FIRST-ORDER C-14 DATES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nae-dong</td>
<td>surface</td>
<td>2200 UCL-193</td>
</tr>
<tr>
<td>Kungok-ri</td>
<td>6</td>
<td>1900 UCL-196</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>2200 UCL-195</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>2100 UCL-199</td>
</tr>
</tbody>
</table>

Table 7.2. First-order dates from the Nae-dong and Kungok-ri shell middens in Korea.
Although the Nae-dong shell midden, Kimhae, has not been excavated, shell samples were collected and were given to me to date by Youn-sik Choo to get a general idea of the absolute date of the site. The result, about 2200 BP, generally fit his expectation (personal communication).

The samples from Kungok-ri shell middens, Haenam, collected by the Mokpo National University Museum during the excavation in 1986, were provided by Sung-rak Choi for dating. When considering possible error ranges (±100-200), the results generally fit with the dates provided by Choi based on archaeological evidence: layer 6 (1900±? bp, UCL-196) was dated from the mid-second to the mid-third century AD; layer 8 (2200±? bp, UCL-195) from the late first to the early second century AD; layer 11 (2100±? bp, UCL-199) from the first century BC to the first century AD (Choi 1987:77). Therefore I can say that the results from both the shell middens by the First-order method generally fit with those expected.

In summary, the First-order method was useful in allowing me to obtain reasonably accurate, quick and cheap C-14 results. Although the C-14 results by conventional and the First-order do not agree precisely with each other, they confirm that the absolute age of middens A-1, B-1 and B-2, and the houses beneath the middens is around the 8th-5th centuries BC (roughly calibrated, using Pearson and Stuiver (1986); Stuiver and Pearson (1986)), and the age is acceptable in terms of artefact assemblages.
from the sites. UCL-237 (3150±200 bp) from midden A-2 suggests that the midden might have been formed around the 15th century BC (calibrated, using Pearson and Stuiver (1986)), and this date fits well enough with the archaeological evidence from the site, especially in terms of pottery type.
8. VOLUMETRIC ANALYSIS OF THE KONAM-RI SHELL MIDDENS

The role of shellfish in prehistoric diet can never be reconstructed fully and correctly due to three main factors. Firstly, the midden may not represent the total consumption of shellfish by the people who formed the midden as I mentioned earlier. Secondly, it is hard to estimate, especially in an archaeological context, the number of people involved in the midden formation. And thirdly, there is no way to calculate precisely the length of time taken to form the midden. Despite these difficulties, it is still worth attempting to estimate the volume of a midden and to estimate the role of shellfish in the diet of people who form the midden, based on data obtained from the volumetric analysis, because they can provide a generalised answer to the question.

I attempted to estimate the volume of the Konam-ri shell middens to get some idea of the role of shellfish in the diet of the people who formed middens A-1, B-1 and B-2. Midden A-2 was excluded from the study because it was almost destroyed by farming activities before excavation.

8.1. THE VOLUME OF THE MIDDENS

The volume of the middens was calculated using Suzuki’s average thickness method (1986). Average thickness method was adopted to estimate the volume of the Konam-ri shell middens because of its relative simplicity in comparison with other methods (ibid:60). Each 1m crossing point on the excavation square was measured to estimate the average thickness of the middens. Then the total volume of the
middens was estimated by multiplying average thickness by the total area of the midden deposits.

The volume estimated in this way of the surviving part of the Konam-ri shell middens was about 33 cubic meters for midden A-1, about 25 cubic meters for midden B-1 and about 14 cubic meters for midden B-2. The proportion of shellfish within these midden volumes was calculated on the basis of the analyses that each midden approximately consisted of 80% of shells and 20% of other material in volume. Thus it can be estimated that the surviving part of midden A-1 consisted of about 26.6 cubic meters of shells, midden B-1 about 20.2 cubic meters and midden B-2 about 11.5 cubic meters.

8.2. MEAT YIELD

The volume of shells in each of the middens was then converted into possible meat weight which they might have yielded. To do this I used the data obtained from Nudong-ri in 1989. A local farmer, Pak Shi-gil, told me that in three and a half hours 134 Nudong-ri people (mainly women) gathered about 9.5 cubic meters of oysters which produced about 800kg of meat.

Although Pak Shi-gil’s information was limited only to oysters and while the ratio of meat to shell varies greatly according to species, I am not likely to make a major error with these figures for oysters as a rough guide because the Konam-ri middens are dominated by oysters (±80%). Using these data the possible meat yield from the Konam-ri shell middens was calculated as follows:
A-1: 26.6CM x (800kg/9.5CM)=2240kg
B-1: 20.2CM x (800kg/9.5CM)=1701kg
B-2: 11.5CM x (800kg/9.5CM)=968kg
*CM=cubic meter

8.3. CALORIC EVALUATION
A caloric value of meat weights was then estimated based on 61 kcal/100g of oyster meat (Yi and Sin 1977:364) (a variable in a caloric value in individual shell species was disregarded for the same reason mentioned above). The estimated caloric value of shells in middens A-1, B-1 and B-2 is as follows:

A-1: 2240kg x (610Kcal/1kg)=1,366,400kcal
B-1: 1701.1kg x (610Kcal/1kg)=1,037,671kcal
B-2: 968.4kg x (610Kcal/1kg)=590,724kcal

8.4. THE ROLE OF SHELLFISH
The role of shellfish in the past diet of the Konam-ri midden people was then estimated using the caloric data. Two unverifiable assumptions underlie the study: one is that people who formed the Konam-ri middens A-1, B-1 and B-2 did not discard shells away from these sites and that midden A-1 was formed by about ten people, midden B-1 by ten people and midden B-2 by five people.

This last assumption arose from the number of house remains discovered beneath middens B-1 and B-2 and a comparison between the size of the middens. Although the three dwellings were found beneath the middens, it can be
used as indirect evidence for inferring the number of people involved in the formation of the middens: people who had previously occupied the houses abandoned them due to fires, possibly moved slightly to the north behind the middens and then formed middens B-1 and 2 on their abandoned houses. Similar examples were noticed from shell midden sites of Jomon Period (Koike 1980), and at present the Konam-ri people discard their daily rubbish including shells beside their houses (see Chapter 9). Therefore it is possible that the two houses discovered beneath midden B-1 indicate that the midden was formed by the family members of the houses. If each house represents a family of five members, ten people would have been involved in the formation of midden B-1 and five people would have been involved in the formation of midden B-2 in accordance with the same assumption.

Assuming, on the basis of the conditions before the excavations, that a tenth of midden A-1 and a third of midden B-1 have been destroyed, the volume of both middens is roughly the same. Assuming that the same volume for the two middens indicates that they have been formed by the same number of people, it can be suggested that midden A-1 was formed by ten people. There are many unverifiable factors behind these assumptions: the main one comes from the number of people involved in the formation of these middens and the precise length of time for midden formation. There is no way to confirm the assumptions, although the similarity of artefacts assemblages between the midden layers (see Chapter 3) and several radiocarbon
dates (see Chapter 7) suggest that these sites might have been formed over a short period of time. However the role of shellfish in the diet of the Konam-ri shell midden people was estimated on the basis of these assumptions.

Assuming that midden A-1 and B-1 had been formed by ten people and midden B-2 by five with a daily caloric intake of 2000 kcal per person, the people who formed midden A-1 and B-1 would have required 7,300,000 kcal/year and those who formed midden B-2 3,650,000 kcal/year. Therefore the role of the estimated caloric value from shells in the total diet of the people could be estimated (Table 8.1). Assuming that these middens had been formed in a year, the surviving part of the middens could indicate the role of shellfish in the total diet: 18.7% in midden A-1, 14.2% in midden B-1 and 16.2% in midden B-2.

Assuming that these middens were formed in two years, the role of shellfish in the total diet is reduced by half. It seems unlikely however that the middens were formed in one or two years. The midden deposits were divided into several shell layers, especially midden B-1 where a small difference in pottery assemblages between those from earlier shell layers (layers 6 and 8) and later layers

<table>
<thead>
<tr>
<th>Midden</th>
<th>Total caloric output (kcal)</th>
<th>Population size</th>
<th>Caloric contribution of shells (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>1yr</td>
</tr>
<tr>
<td>A-1</td>
<td>1,366,400</td>
<td>10</td>
<td>18.7</td>
</tr>
<tr>
<td>B-1</td>
<td>1,037,671</td>
<td>10</td>
<td>14.2</td>
</tr>
<tr>
<td>B-2</td>
<td>590,724</td>
<td>5</td>
<td>16.2</td>
</tr>
</tbody>
</table>

Table 8.1. The caloric contribution of shells to the total diet (based on the surviving part of the middens).
(layers 3, 4 and 5) was noted. Therefore it can be concluded that the role of shellfish in the total diet of the people represented by the Konam-ri shell middens A-1, B-1 and B-2, was not so great: assuming that the middens were formed over ten years, then the contribution of shellfish would have been less than 2% (see Table 8.1). Even if we consider the area of the middens which was destroyed, the result would be similar. Although the result cannot be entirely correct due to the many variables involved in estimation procedures, it can provide an idea of the role of shellfish in the total diet of the people.

This conclusion is supported by the result of size analysis of oyster shells which is provided in section 5.1.3: no significant size reduction in oyster shells was noted throughout the main midden deposits, although the later layers in midden B-1 and B-2 showed a tendency towards small size reduction in oyster shells. This means that oysters were not exploited intensively to the extent that rapid size reduction resulted. However it is worth remembering that the role of shellfish during the winter and early spring, when food availability was low, would have been more important than at other times of the year. The growth-line analysis of shells could provide a valuable insight into this question. Further study is required in the future. I hope that the result of stable isotope analysis of the human bone recovered from midden A-1 (which is in process, see section 5.7), can also provide some information on the diet of the Konam-ri shell midden people in the future.
9. DISCUSSION

9.1. ENVIRONMENTAL RECONSTRUCTION

In the previous chapter, I have discussed the past environment at the sites. The composition of the animal and plant remains provides some information on the environment during the midden formation period: land snail assemblages indicate open grassland with woodland near the sites; the presence of deer and wild pigs which are associated with open forest suggests a well-forested environment near the sites; charcoal remains indicate a mainly pine and oak woodland which are common on the island today, indicating environmental continuity.

However the mammal species found on the sites are rare on the island today. This is partly because of the clearance of woodland for farming and building in recent years, and partly because of human over-exploitation of these animals resulting in their near extinction on the island. A local farmer informed me that roe deer were abundant on the island until very recently. Pheasant are still common and I observed them during my field work.

The marine shells represented in the sites are also similar to those present in the sea today, suggesting that no great marine environmental change has happened between the two periods. This assumption is supported by the fish assemblages recovered from the sites which are also common in the nearby sea today. From animal and plant remains then, it can be concluded that the prehistoric environment during the midden formation period was similar to that of today.
9.2. THE FUNCTION OF THE MIDDENS

Korean archaeologists have assumed that there might be a difference in the diet of prehistoric peoples from western coastal areas and those on the southern coast. This assumption arose from the difference in midden contents between the two coastal areas. The greatest difference is in the abundance of animal bones in the south coastal areas and the lack of them in the western coast.

The Konam-ri shell middens of the western coastal area produced a relatively large number and species of animal bones, suggesting that the prehistoric midden people in the western coastal areas also consumed animal flesh. Other interpretations therefore are required to solve the regional difference in midden contents.

The difference may be related to the function of middens. The function of middens which are visible archaeologically can be divided into three types:

Type A: simple shellfish processing sites.
Type B: temporary/seasonally occupied sites.
Type C: home-base sites occupied throughout the year.

Type A sites would contain only shells or sometimes instruments for shell processing. At the present-day Nudong-ri shell processing site, it was noted that there were oysters, anvils on which oysters were placed for opening, gloves used to protect hands, stone seats and charcoal (Fig.9.1-2). The charcoal came from a cooking-fire for a meal during shell processing. Type B sites
Fig. 9.1. A present-day oyster processing site at Nudong-ri near Solsŏm (top right), Anmyŏn Island.

Fig. 9.2. Close-up of the site.
would contain shells, some artefacts and possibly some food remains including animal bones, if the season of occupation was during the hunting season. Type C sites would contain shells, daily use artefacts and a large range of food debris including animal bones.

On the basis of the hypothesis that the function of middens is indicated by the midden content, I attempted to examine the function of the Konam-ri middens. As noted in the previous chapters, the Konam-ri shell middens consisted mainly of food remains such as shells, fish, mammal and bird bones, remains of crabs and sea urchins. They also yielded various types of artefacts for farming, hunting, tool-making, wood-working, food processing and ornaments. These artefact assemblages are those required not only for hunting and fishing but also for daily life. Thus the midden would be related to sites occupied for a certain length of period.

The three dwelling sites suggest that people at that time were sedentary. Those people who had lived previously at the three houses, abandoned their houses due to fires, possibly moved a bit to the north behind the middens and then formed midden B-1 and B-2 over their abandoned houses. The shell layers of midden B-1 and B-2 sloped from the north to the south (see Chapter 2). This is due partly to natural tilting of the soil layer and partly to people's behaviour involved in discarding shells, that is, people threw shells from the north behind the middens. Thus their houses would be at the north of the middens. The present day people of Konam-ri and Nudong-ri throw
shells around their houses. The selection of a rubbish dump depends on the availability of space around the outside of the house. For example if there is a depression at the front of the house, it is used for that purpose (Fig. 9.3).

Data on the season of exploitation of food resources represented by the animal and plant remains show that the Konam-ri shell midden sites were occupied year-round, so belonging to the type C midden in function. Thus the sites could contain animal remains which are normally rare in other middens located in the western coastal area. Other shell middens in this area seem to have been temporary, seasonally occupied sites. Judging from the lack of animal remains in these middens, they might not have been occupied during the winter hunting season. This hypothesis will be developed further through future analysis of shell growth-lines.

Fig. 9.3. A present-day shell midden at Nudong-ri, Anmyŏn Island.
9.3. Subsistence Patterns

The subsistence patterns represented by the Konam-ri shell midden can be reconstructed on the basis of the animal and plant remains recovered from the sites. The reconstruction of the subsistence patterns however focuses mainly on middens A-1, B-1 and B-2 due to lack of evidence recovered from midden A-2. The few plant remains recovered from the sites included cereals such as rice, barley and millet, indicating farming. The single peach seed might also suggest peach cultivation. It is known that peach (Prunus persica) has been cultivated in China for more than 3000 years (Hoshikawa 1978:210).

Evidence of the intensification of farming is difficult to obtain. However as can be seen from the analysis of the midden materials, the inhabitants of Konam-ri do not seem to have depended on shellfish and other animal resources for most of their nutrition. The subsistence economy of the Konam-ri sites then was based on farming with supplementary food from fishing, hunting and gathering shellfish and wild plants. The Songguk-ri sites of the same period support this hypothesis as they produced a lot of cultivated rice remains, indicating an economy based on farming. The role of shellfish and other animals however would have been important during the winter and early spring when people depended on stored food, and shortages probably occurred. The phenomenon of food shortage during this period has occurred until recently and today Koreans still depend on stored food for wintering.
A reconstruction of the annual cycle of subsistence patterns was attempted based on data obtained from the study of the animal and plant remains of the middens (the season of exploitation of these food resources has been dealt with in the previous chapters). The result of the reconstructed annual subsistence cycle is shown in Fig. 9.4.

To summarize: in spring, hunting, fishing and gathering of wild plants and shellfish were carried out and the cultivation of cereals such as rice and millet began. During late spring barley was harvested, providing the main food supply during the summer. In the summer, fishing and shellfish gathering continued at a reduced level. Rice and millet were harvested in the autumn to be and stored for the winter and wild plants such as acorns were collected. Oyster gathering and the hunting of wild animals also began. During the winter, stored cereal was consumed while oysters and wild animal flesh provided a supplementary food source. The analysis of shell-growth-line, tooth-growth-line of deer and wild pigs and stable isotopes of human bones is in process and will provide

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Fig. 9.4. The annual subsistence model.
information on season of exploitation of these resources and the diet of the Konam-ri midden people.

9.4. CHRONOLOGY OF THE SITES

The chronology of the Konam-ri shell middens can be calculated on the basis of their artefact assemblages and radiocarbon dates. I suggest that midden A-2 was formed during the late Neolithic period around the 15th century BC on the basis of the pottery type recovered from the site (see Chapter 3) and the result of the First-order radiocarbon date (3150± 200bp). The Neolithic shell layer of midden B-1 (layer 12) also yielded late Neolithic pottery types, and was dated to 4150±250 bp by the First-order radiocarbon dating method. Therefore it can be concluded that the shell layers from the Konam-ri sites were generally formed during the late Neolithic period.

The excavation results of the Konam-ri shell middens, especially middens A-1, B-1 and B-2 are important to understand the developmental process of the prehistoric cultures of central west Korea during the Bronze Age. Two representative sites of earlier Bronze Age have been found recently in this region: Hyuam-ri (Haemi) and Songguk-ri (Puyŏ). The former has been interpreted to be older than the latter based on artefact assemblages, especially pottery type. However no sites, showing a transitional stage between these two sites, have been found. As a result there has been a gap between the two cultures represented by these two sites. The artefact assemblages of the Konam-ri sites provide some clues to understanding
this little known period. The pottery recovered from the Konam-ri sites is particularly useful in this respect as pottery generally reflects cultural change closely as it is easily broken and so its life-time is short.

The main pottery type of the midden B-1 and B-2 was deep flower-pot shape (type I, see Chapter 3). This pottery was discovered in the Hyuam-ri dwelling sites near Anmyon Island. However it is hard to argue that the Konam-ri and Hyuam-ri sites were formed during the precisely same period because the Hyuam-ri dwelling sites produced pottery with punctuated holes below the rim where stripes were notched ('Kongryölmuntogi' in Korean, Fig. 9.5.1). This type of pottery was not discovered from the Konam-ri sites, but it is known from sites located near the Han River Basin such as Hunam-ri (Yöju) and Karak-dong and Yŏksam-dong (Seoul) which are considered as earlier than the Hyuam-ri sites. While Songguk-ri type pottery (Fig.9.5.2-3) was not discovered in the Hyuam-ri sites, it was recovered from the Konam-ri shell midden A-1 and the mainly later shell layers (layers 3, 4 and 5) of midden B-1: these pottery types, especially type IIa2, are similar to the main pottery type of the Songguk-ri sites (they are considered to be younger than those of the Hyuam-ri sites). Therefore on the basis of the plain pottery types found from the Konam-ri sites, the sites should be slightly younger than the Hyuam-ri sites.

The red-burnished pottery found at these sites also supports the argument. The Konam-ri shell midden sites yielded red-burnished pottery similar to that recovered
from the Songguk-ri sites (Fig. 9.5.4-5). This pottery type is not present in the Hyuam-ri sites.

Polished stone knives can also be used as a chronological indicator. According to Ahn (1985), spindle- and semilunar-shaped knives are earlier than triangular-shaped ones. The Hyuam-ri sites produced spindle and semilunar knives and in addition knives which were transitional in shape from semilunar to triangular, while the Konam-ri and the Songguk-ri sites yielded mainly triangular knives, suggesting that the Songguk-ri and the Konam-ri sites are later than the Hyuam-ri sites.

Therefore it can be concluded from the results of artefact assemblage analysis that the Konam-ri sites are younger than the Hyuam-ri sites. However the chronological relationship between the Songguk-ri and the Konam-ri shell midden sites is still unclear. Two possible hypotheses can be suggested: one is that the Konam-ri sites are transitional ones in the process of cultural change from the earlier culture represented by the Hyuam-ri sites to the later one represented by the Songguk-ri sites; the other is that the Konam-ri sites are not transitional ones between two sites (Hyuam-ri and Songguk-ri), but coexist with the inland Songguk-ri sites and reflect different adaptation.

Lack of archaeological evidence makes the question difficult to solve. Further archaeological work in this region is required. However the above two hypotheses can be examined using data on house types and a provisional conclusion can be made on the basis of the limited
Fig. 9.5. 1: 'Kongryŏlmun' from Hyuam-ri house A (from NMOK 1990:33); 2 and 3: Plain pottery from Songguk-ri house No.54-B (NMOK 1987:57); 4 and 5: Red-burnished pottery from Songguk-ri houses No.54-1(1) and No.55-6(2) (from NMOK 1979).

Fig. 9.6. 1: Hyuam-ri houses No.3, 4 and 5 (from NMOK 1990:23); 2: Songguk-ri house 55-4 (NMOK 1978); 3: Songguk-ri house 54-B (NMOK1987:41).
archaeological data available and the radiocarbon dates. As a result the first hypothesis was considered to be unlikely. Although the Konam-ri shell midden sites shared Hyuam-ri and Songguk-ri pottery types, the dwellings were different from those of the Hyuam-ri sites. As can be seen from the previous chapter, the Konam-ri houses were rectangular in plan with a hearth close to the centre of the floor. In addition, dwellings 1 and 2 had an L-shaped drainage structure along the north and east walls of the houses. However the Hyuam-ri dwelling sites were round, square or rectangular in plan. They had an oval-shaped pit structure with post holes at the center of the floor instead of a hearth (Fig.9.6.1). These house types were also discovered in the Songguk-ri sites (Fig.9.6.2). But the Konam-ri houses are different. It can be concluded therefore that the Konam-ri sites do not reflect a transitional process of cultural change from the Hyuam-ri sites to the Songguk-ri sites.

Thus the second hypothesis remains more likely. This can be supported by the similarity of artefact assemblages as shown above and by a similarity of house types between the Konam-ri and Songguk-ri sites. The Songguk-ri sites produced Hyuam-ri type houses, which were discovered at the 50th and 55th locations of the sites, indicating a succession of the Hyuam-ri tradition (Fig.9.6.2). In addition, the Songguk-ri sites had houses similar to Konam-ri; in particular houses found at the 54th location of the sites, which were rectangular in shape with a pit structure beside the center of the floor in each house,
are very similar to those of the Konam-ri sites (Fig. 9.6. 3). It is considered that there would be no great time gap between the two house types discovered in the Songguk-ri because they produced very similar artefact assemblages. Although the researchers questioned whether the function of the burnt pit structures beside the center of the floor in rectangular houses was as hearths, when consider the Konam-ri example, they seem to have been used as such. However no drainage structures were found in these houses, indicating a difference in detailed structure between Konam-ri and Songguk-ri houses. It can therefore be argued that if Konam-ri sites formed an intermediate stage in the process of cultural change between the Hyuam-ri and Songguk-ri sites, Hyuam-ri type houses should be present in the Konam-ri sites. But the Konam-ri houses are different from those of Hyuam-ri sites. Thus the Konam-ri sites cannot be considered as an intermediate stage between the Hyuam-ri and the Songguk-ri stages in the cultural development process.

Radiocarbon dates from the Songguk-ri and the Konam-ri sites (for the Konam-ri sites, see Chapter 7) are similar. Three radiocarbon dates are available from the Songguk-ri sites: 2665±60 bp (KAERI-186) and 2565±90 bp (KAERI-187) based on charred rice from house 54-1; and 2500±90 bp (NUTA-917) based on wood charcoal from house 54-5 (NMOK 1979:148 and 1989:133).

It can be concluded that the Konam-ri sites are located in a marginal area of the culture represented by the inland Songguk-ri sites, and they retained previous
pottery traditions represented by the Hyuam-ri sites for a relatively long period in comparison to those inland sites before adopting Songguk-ri type pottery. However Konam-ri house types are different from the Hyuam-ri type.

Radiocarbon dates from Songguk-ri and Konam-ri indicate their formation somewhere around the 8th-5th centuries BC. Researchers of the Songguk-ri sites, disregarding the result of the radiocarbon dates, dated the sites to about the 6th-4th centuries BC. However more recently it has been suggested that the Songguk-ri dates require reconsideration and may date back to the 8th-7th centuries BC (Choi 1989:11-2). I suggest that the Songguk-ri and Konam-ri sites may be dated to about the 8th-5th centuries BC on the basis of radiocarbon dates and the compatible analysis of artefact assemblages. The Songguk-ri dates remain controversial in Korean archaeology: more radiocarbon results and further archaeological work are required to solve the problem.
CONCLUSION

The Konam-ri shell middens were formed during the Neolithic (midden A-2) and Bronze Ages (middens A-1, B-1 and B-2). The subsistence economy of the Neolithic midden could not be reconstructed due to a lack of evidence, however deer teeth and shells indicate that hunting and gathering was practised. The economy of the Bronze Age middens was shown to depend on farming cereals such as rice, barley and millet, with occasional exploitation of wild resources such as mammals, fish, birds, shells and possibly wild plants. Dog is the only domesticated animal among those animals represented by the middens. The annual subsistence cycle was reconstructed to help understand the subsistence strategy of the people. It was estimated that the role of shellfish in the total diet of the people who formed middens A-1, B-1 and B-2 was not significantly important despite the quantity of shell debris. However the discovery of the Konam-ri shell middens is important as they suggest that the Bronze Age people also exploited marine resources and so raise the possibility of the discovery of more Bronze Age middens elsewhere in Korea.

Archaeological data obtained from the Konam-ri shell middens also contribute to Korean archaeology, helping in the understanding of the prehistoric culture of the western Ch‘ungnam area. The date of the Neolithic midden (A-2) was considered to be around the 15th century BC, and the Bronze Age middens and houses somewhere around the 8th-5th centuries BC similar to that of the Songguk-ri sites.
The Bronze Age middens were interpreted to be home-base sites occupied year-round on the basis of analyses of artefact assemblages, animal and plant remains recovered from the sites.

Evidence from animal and plant remains indicated that the environment of the midden formation period would have been generally similar to that of today.

Further study on artefacts, animal and plant remains will be made to get more precise information to reconstruct the cultural sequences, subsistence economy, human diet and environment of the sites.
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APPENDIX

List of animal and plant remains identified from the Konam-ri shell middens

1. ANIMAL REMAINS

PHYLUM MOLLUSCA

Class Gastropoda

Order Archaeogastropoda

Family Acmaeidae

Acmaea pallida (Gould)

Collisella heroldi (Dunker)

Family Liottiidae

Liotinaria sp.

Family Turbinidae

Lunella coronata coreensis (Recluz)

Pomaulax japonicus (Dunker)

Family Haliotidae

Nordotis discus (Reeve)

Family Trochidae

Chlorostoma argyrastoma lishkei (Tapparone-Canefri)

Umbonium costatum (Kiener)

Order Heterogastropoda

Family Epitoniidae

Gyroscla perplexa (Pease)
Order Mesogastropoda

Family Assimineidae

Assiminea estuarina (Habe)
Assiminea japonica  (Martens)

Family Bursidae

Semicassis persimilis (Kira)

Family Cerithiidae

Bittium craticulatum (Gould)

Family Diplommatinidae

Palaina pusilla (Martens)

Family Lacunidae

Stenotis carinifera (A. Adams)

Family Littorinidae

Littorina brevicula (Philippi)
L. strigata (Dunker)

Family Naticidae

Lunatia fortunei (Reeve)
Neverita didyma (Röding)

Family Rissoinidae

Alvania (Alvania) concinna (A. Adams)

Family Tornidae

Pseudoliotia pulchella (Dunker)

Family Vermetidae

Dendropoma maximum (Sowerby)

Family Potamididae

Cerithideopsilla djadjariensis (Martin)
Cerithidea rhizophorarum (Adams)
Batillaria multiformis (Lischke)
Batillaria cumingii (Crosse)
Family Litiopidae

Dialad stricta (Habe)

Diffalaba picta (A. Adams)

Order Neogastropoda

Family Buccinidae

Siphonalia cassidaeformis (Reeve)

Volutharpa ampullacea perryi (Jay)

Family Muricidae

Bedevina birileffi (Lischke)

Nucella heyseana (Dunker)

Ocenebra japonica (Dunker)

Rapana venosa (Valenciennes)

Thais clavigera (Küster)

Family Olividae

Oliva mustelina (Lamarck)

Family Pyrenidae

Mitrella burchardi (Dunker)

Zafra pumila (Dunker)

Family Terebridae

Diplomeriza evoluta (Deshayes)

Order Cephalaspidea

Family Pyramidellidae

Odostomia desimana (Dall et Bartsch)

Cingulina cingulata (Dunker)

Dunkereria shigeyasui (Yokoyama)
Order Stylommatophora

Family Bradybaenidae
Aegista sp.

Family Carychiidae
Carychiium pessimum (Pilsbry)

Family Clausiliidae
Euphaedusa sp.

Family Valloniidae
Vallonia costata (Müller)

Family Vertiginidae
Gastrocopta coreana (Pilsbry)

Family Strobilops hirasei (Pilsbry)

Family Subulinidae
Allopeas kyotoensis (Pilsbry & Hirase)
Allopeas pyrgula (Schmacker & Boettger)

Family Zonitidae
Hawaii minuscla (Binney)

Family Helicarionidae
Discoconulus sinapidium (Reinhardt)
D. sp.

Nipponochlamys hypostilbe (Pilsbry & Hirase)
Parakaliella coreana (Moellendorff)
Yamatochlamy crenulata (Gude)

Class Pelecypoda

Order Eutaxodonta

Family Arcidae
Scapharca broughtonii (Schrenck)
Tegillarca granosa (Linne)
Family Pectinidae

Chlamys farreri (Jones et Preston)

Family Pinnidae

Atrina pectinata japonica (Reeve)

Family Ostreidae

Ostrea denselamellosa (Lischke)
Crassostrea gigas (Thunberg)

Family Mytilidae

Mytilus coruscus (Gould)

Order Heterodonta

Family Myidae

Mya arenaria oonogai (Makiyama)

Family Novaculinidae

Sinnovacula constricta (Lamarck)

Family Veneridae

Cyclina sinensis (Gmelin)
Meretrix lamarcki (Deshayes)
Notochione jedoensis (Lischke)
Gomphina veneriformis (Lamarck)
Tapes philippinarum (Adams et Reeve)

Family Mactridae

Mactra veneriformis (Reeve)

PHYLUM VERTEBRATA

Class Pisces

Order Anguillida

Family Congridae

Astroconger myriaster (Brevoort)
Order Squalida
  Family Squalidae

Order Lamniformes
  Family Triakidae

Class Osteichthyes

Order Cottida
  Family Agonidae
    Chelidonichthys kumu (Lesson & Garnot)

Order Rajida

Order Mugilida
  Family Mugilidae
    Mugil cephalus (Linne)

Order Percida
  Family Branchiostegidae
    Branchiostegus japonicus (Houttuyn)
  Family Carangidae
    Seriola quinqueradiata (Temminck & Schlegel)
  Family Platycephalidae
    Platycephalus indicus (Linne)
  Family Sciaenidae
    Argyrosomus argentatus (Houttuyn)
  Family Serranidae
    Lateolabrax japonicus (Cuvier & Valenciennes)
  Family Sciaenidae
    Nibea imbricata (Matsubara)
Family Sparidae
  Acanthopagrus schlegeli (Bleeker)
  Chrysophrys major (Temminck & Schlegel)

Order Pleuronectida
Family Bothidae
  Paralichthys olivaceus (Temminck & Schlegel)
Family Myliobatidae
  Holorhinus tobiiei (Bleeker)

Order Clupeida
Family Engraulidae
  Engraulis japonica (Temminck & Schlegel)
  Ilisha elongata (Bennett)
  Sardinia melanosticta (Temminck & Schlegel)
Family Salmonidae

Order Tetrodontida
Family Tetraodontidae
  Fugu pardalis (Temminck & Schlegel)
  Sphoeroides rubripes (Temminck & Schlegel)

Class Reptilia
Order Chelonia
  Clemmys japonica (Temminck et Schlegel)

Order Squamata
  Suborder Serpentes

Class Aves
Order Anseriformes
Family Anatidae

Order Columbiformes
Family Columbidae
  *Streptopelia orientalis* (Latham)

Order Falconiformes
Family Accipitridae
  *Milvus migrans lineatus* (J.E. Gray)

Order Galliformes
Family Tetraonidae
  *Phasianus colchicus* (Butulin)

Order Gaviiformes
Family Gaviidae

Order Passeriformes
Family Corvidae

Class Mammalia
Order Carnivora
Family Canidae
  *Canis familiaris* (Linnaeus)
  *Nyctereutes procyonoides koreensis* (Neukoori)
  *Vulpes vulpes peculiosa* (Kishida)
Family Felidae
  *Felis bengalensis manchuria* (Mori)
Family Melinae
  *Meles meles* (Linnaeus)

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Family Oatriidae

_Eumetopias jubata_ (Schreber)

Order Artiodactyla

Family Cervidae

_Cervus nippon_ (Temminck)

_Moschus moschiferus parvipes_ (Hoppister)

Family Suidae

_Sus scrofa_ (Linnaeus)

Order Rodentia

Family Muridae

Genus Rattus

2. PLANT REMAINS

DIVISION PINOPHYTA

Order Coniferales

Family Pinaceae

_Pinus sp._

DIVISION MAGNOLIOPHYTA

Order Fagales

Family Fagaceae

_Quercus sp._

Order Graminales

Family Gramineae

_Hordeum sativum_ (L.)

_Oryza sativa_ (L.)

_Setaria italica_ (Beauv.)
Order Rosales

Family Rosaceae

Prunus persica (Sieb. & Zucc.)

Order Rubiales

Family Rubiaceae

Galium sp.