ZOOARCHAEOLOGY OF THE EARLIEST FARMING PERIOD

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SUMMARY

Part I of this book discusses the use of animal resources in the earliest known farming period in the Tokai area, central Japan. Chapter 1 summarizes the findings from and questions raised by preceding studies and introduces the aims of the present research. Subsequent chapters analyze animal remains from the Yayoi period and investigate shellfish gathering (chapter 2), fishing (chapter 3), and hunting (chapter 4) activities. Chapter 5 investigates the circumstance in

the final Jōmon period just prior to the beginning of farming. Finally, chapter 6 examines the usage of animal resources in the earliest farming period.

Part II of this book discusses future prospects, given the remaining tasks and questions outlined in part I of the case study. Chapter 7 investigates the research method of animal remains, chapter 8 presents the methodology of zooarchaeology, and chapter 9 states the social contribution of the research results. This book gives the results of real observation of approximately 53,000 animal remains and approximately 25,000 contemporary vertebrate specimens.

Part I. Case Study of the Tokai Area (Ise Bay Coast and Mikawa Bay Coast)

Chapter 1. Study Aims

The aim of the present study is to examine people's usage of animal resources in the earliest farming period based on research on animal remains from the final Jōmon period to the Yayoi period.

The Jōmon period began approximately 16,000 years ago and is defined by the hunter-gatherer society that lived in Japan at that time. This period is divided into seven stages: the incipient stage, earliest stage, early stage, middle stage, late stage, and final stage. The Yayoi period (1,300 BC–300 AD), which followed the Jōmon period, was a time when Japan was inhabited by an agrarian society and when rice paddy cultivation began.

Usage of plants greatly changed in the Yayoi period relative to the Jōmon period and earlier. Therefore, research on subsistence in the Yayoi period has so far primarily been based on evidence of plant usage, such as rice cultivation and dry-field farming. In the Yayoi period, research on animal remains did not advance in comparison to the research on the remains in the Jōmon period. However, if the transition from the Jōmon period to the Yayoi period involved a change in society from hunter-gatherer to agrarian, animal usage could be expected to change in addition to plant usage. Specifically, if animal usage

changed with the beginning of farming, people living in the Yayoi period were likely to have specialized in agriculture; we could then conclude that subsistence activities markedly changed in the Yayoi period. However, if animal usage did not change with the beginning of farming, people living in the Yayoi period were unlikely to have specialized in agriculture, even if they cultivated plants. We could then conclude that subsistence activities did not greatly change in the Yayoi period.

Research on fishing and hunting in the Yayoi period has mainly centered on the analysis of fishing and hunting tools and not on the analysis of animal remains. Researchers investigating the Yayoi period have given different interpretations of typological changes in fishing and hunting tools and have stated that "fishing activities developed greatly and hunting activities did not develop in the Yayoi period." They have determined that the effects of typological changes in fishing tools would have been an "increase in volume of catch" and interpreted this as a "development in fishing activities." They also thought that "fishing villages appeared" at a significant point in the evolution of fishing tools and have stated that "food-collecting activities became focused on fishing." On the other hand, the typological changes in hunting tools during the Yayoi period have also been interpreted as an "increase in power" and "differentiation between hunting tools and weapons" rather than as a "development in hunting activities." Researchers have also suggested that "war was initiated" at a significant point during the development of hunting tools and have described how "hunting tools changed to weapons."

In addition, research on animal remains from the Yayoi period has focused on domestication. Zooarchaeologists have not directly discussed hunting activities but have stated that "hunting activities became minimized."

Taking into account the influence of concepts that represent the Yayoi period, such as "agriculture," "division of labor," "war," and "domesticated animals," researchers investigating the Yayoi period have stated that "fishing activities

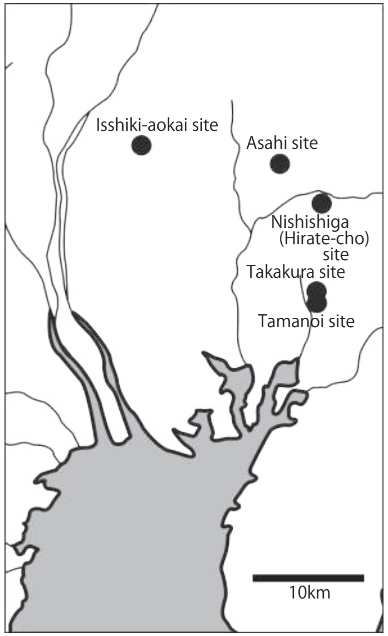


Figure 1 Location of the archaeological sites (inner part of Ise Bay)

Figure 2 Studied areas

The Tokai area faces the Pacific Ocean. The Ise Bay is on the west side, and the Mikawa Bay on the left.

developed but hunting activities did not develop in the Yayoi period." However, my theory is that research on fishing in the Yayoi period had developed; however, research on hunting in the Yayoi period had not developed. Researchers investigating the Yayoi period are likely to have considered more aspects that fit the existing research framework than those that do not.

Japanese archaeologists have carefully excavated shell mounds from the hunter-gatherer society of the Jōmon period and have also collected micro remains. However, they often do not appropriately investigate shell mounds from the agrarian societies after the Yayoi period. Research conducted in this way is more of a "disrespect of materials due to emphasis on theory" rather

than a "divergence between materials and theory." This has contributed to the lack of development in research on animal remains from the Yayoi period in contrast to research on the Jōmon period.

Research area. In the present study, Tokai, a region that has a large distribution of shell mounds from the final Jōmon period to the Yayoi period, was selected as the research area. The Tokai region is located in the center of Honshu Island, Japan, and borders the Pacific Ocean. In this area, there are two inner bays: Ise Bay and Mikawa Bay (Fig.2). Chapters 2 to 4 focus on studies on the inner part of Ise Bay, where animal remains from the Yayoi period are deposited. Chapter 5 focuses on studies on the Mikawa Bay coast, where remains from the final Jōmon period are deposited.

In chapters 2 to 4, five sites on the inner part of Ise Bay are discussed (Fig.1). Micro remains have been collected by sieving sediments from these sites. Of these five, the Tamanoi site is from the final Jōmon period and all other sites are from the Yayoi period.

Chapter 2. Shellfish Gathering

Shell mounds decreased in number and size during the Yayoi period. Clams (*Meretrix lusoria*) excavated from the sites became significantly larger after the latter half of the early Yayoi period.

Estimated length and height of shells. For clams, a major type of shellfish that was excavated from the sites, shell size (length and height) was investigated. However, most clams found were damaged, for example, there were very few shells for which length and height were measurable. For example, of the clams that were excavated from the Asahi site, the length of shells was measurable in 16.7% and the height of shells was measurable in 14.4%. To increase the number of analytical samples, I, therefore, estimated the length of shells and height of shells from the excavated shell fragments. First, I measured the length of shells, height of shells, and length of external ligaments of the intact

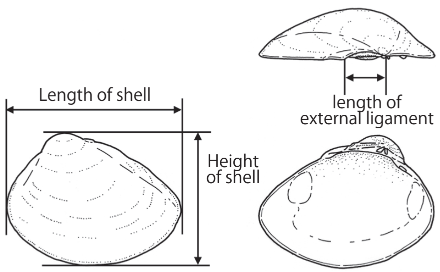


Figure 3 Measured areas

excavated clams using digital calipers (Fig.3). Next, I calculated the correlation between length of external ligaments, length of shells, and height of shells of excavated clams. An equation for estimating the length and height of shells from the length of external ligaments was derived.

I performed regression analysis on 431 samples for which measurement was possible for the length of external ligaments and length of shells (length of shell: 26.69–114.50 mm). A strong correlation was observed between the length of external ligaments and length of shells (R^2=0.958, $p<0.01$). The equation for estimating the length of shells (Y: mm) from the length of external ligaments (X: mm) of excavated clams was $Y = 0.01335X^2+2.68574X+9.42915$.

Similarly, regression analysis was performed on 605 samples for which measurement was possible for the length of external ligaments and height of shells (height of shell: 22.78–89.36 mm). A strong correlation was found between the length of external ligaments and the height of shells (R^2=0.966, $p<0.01$). The equation for estimating the height of shells (Y: mm) from the length of external ligaments (X: mm) of excavated clams was $Y = 0.00277X^2+2.27748X+8.3817$.

Changes in the size of clams. I estimated the length of shells of 2,354 excavated clams (Fig.4). The length of shells of clams became significantly greater after the first half of the early stage Yayoi period ($p<0.01$). Similarly, the height of shells of 2,369 excavated clams was estimated, which also became significantly greater after the first half of the early stage Yayoi period ($p<0.01$).

After the first half of the early stage Yayoi period, people stopped collecting shellfish and the capture pressure on clams decreased. Therefore, it is likely that people of the Yayoi period preferred to collect large clams. I postulate

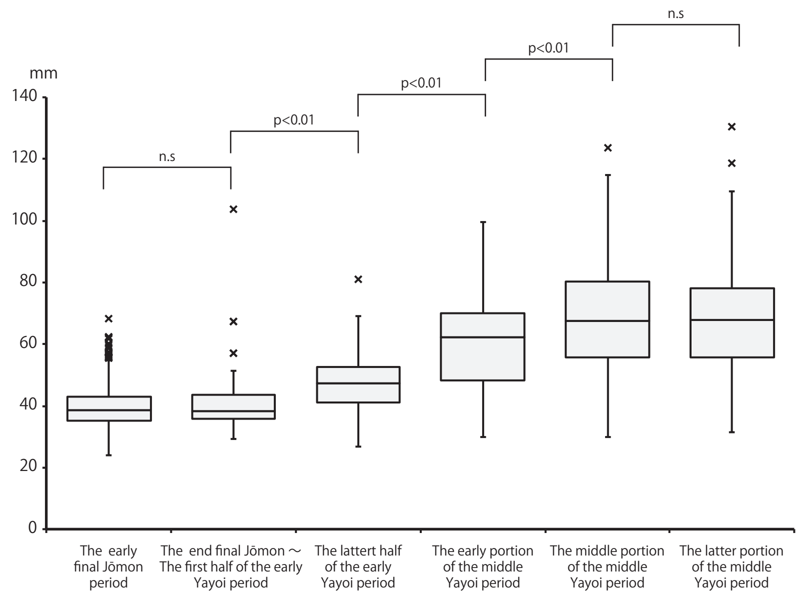


Figure 4 Periodical changes in the length of shell of clams

Significant differences in the length of shell of clams was observed between those from the end final Jōmon period and those from the latter half of the early stage, between those from the latter half of the early Yayoi period and those from the early middle stage, and between those from those from midterm of the middle stage.

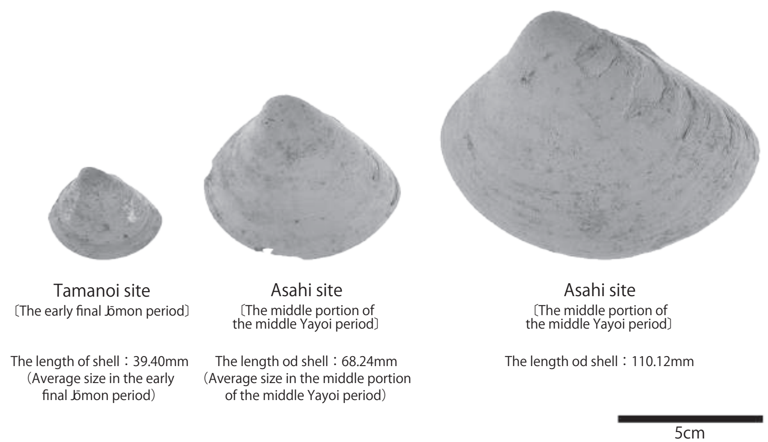


Figure 5 Excavated clams (Completed material)

that the reason for decreased shell collecting in the Yayoi period was that the shellfish gathering season overlapped with the farming season. Based on shell growth-line analysis, it is believed that shellfish was collected between spring and early summer during the Jōmon period. The spring tide season is best suited for shellfish gathering because the water moves a great distance from the shore at low tide; however, this coincides with peak farming season. I suggest that because farming began at a large scale during the Yayoi period, shellfish gathering occurring at the same time decreased.

Chapter 3. Fishing

In chapter 3, fish remains excavated from five sites along the inner part of Ise Bay are discussed and changes in fishing activities are investigated (Fig.6). Sediments from the study sites were filtered and fine fishbones were collected.

Fishing grounds. Fishing grounds at each site were investigated with regard to the environment inhabited by fish remains that were excavated from these sites. First, I categorized the fish remains excavated from Ise Bay based on the environments they inhabited and ecology of fishes (Tab.1). Excavated fishes were categorized into three large groups (classes I, II, and III) based on horizontal distribution; subsequently, these groups were further subdivided based on ecology (classes a, b, and c).

Fishing activities at each site reflected geographical conditions (Fig. 7). From the Asahi site, Isshiki-aokai site, and Nishishiga (Hirate-cho) site, located in the alluvial lowlands, freshwater fish (group I) and migratory fish distributed in the coastal mid-to-lower layers (group IIb) were excavated in great numbers. Among these sites, those in freshwater as well as coastal areas were utilized as fishing grounds. In particular, small carp (*Cyprinus carpio*) were excavated in abundance. For this reason, I suggest that people of the Yayoi period living in lowlands actively used fishes that were cultivated in localized shallow freshwater areas such as paddy fields.

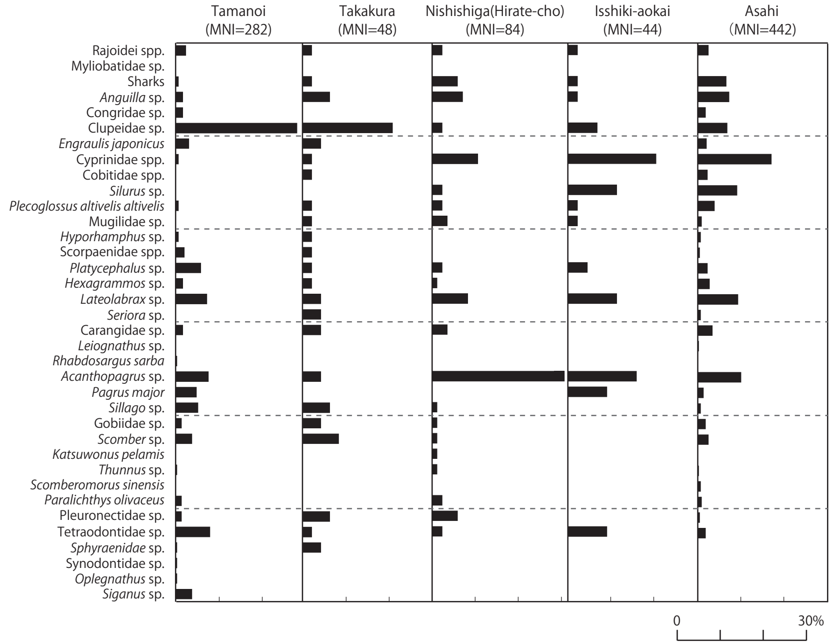


Figure 6 Composition of fish remains

In contrast, fishes that migrate within the coastal surface layers (group IIa) were excavated in abundance from the Tamanoi site and Takakura site located in the highlands. Among these sites, coastal regions were mainly used as fishing grounds, whereas freshwater areas were relatively unused.

Fishing seasons. Fishing seasons were determined by analyzing Japanese pilchards (*Sardinops melanostictus*), a major species found in coastal fisheries. Groups of fishes that seasonally migrate along the inner part of Ise Bay are groups IIa and IIb. In particular, fishes of group IIa migrate in groups within the coastal surface layer; therefore, they were likely to have been caught together by net fishing. At each site, the group IIa family that was most abundantly excavated was Clupeidae spp. Japanese pilchard and dotted gizzard shad were identified based on bones of the head, first vertebrae, and second vertebrae.

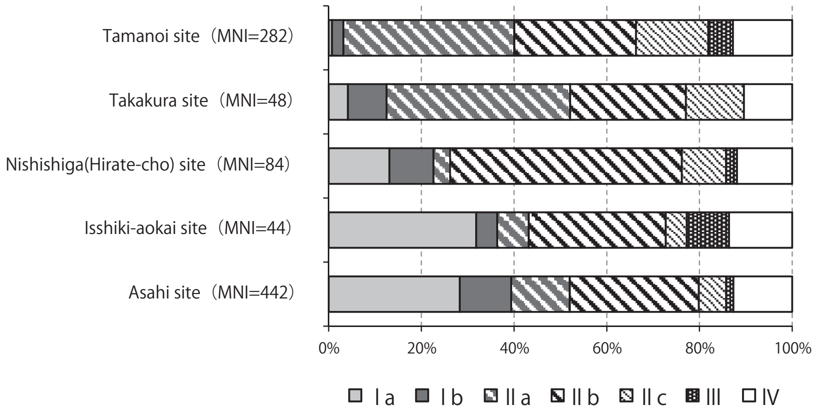


Figure 7 Comparison between fish types

Table 1 Fish types

Fish groups	Living Environment and Ecology
Ⅰ a	Genuine freshwater fish
Ⅰ b	Diadromous fish
Ⅱ a	Migratory fish that swims in the coastal surface layers
Ⅱ b	Migratory fish that lives in the intermediate to basal layers of the coast
Ⅱ c	Fish that lives permanently within the bay
Ⅲ	Fish that lives in the bay entrance to outer sea
Ⅳ	Fish that cannot be categorized as above

Fish remains were categorized into groups depending on the living environment and ecology in the Ise Bay.

Clupeidae spp. was abundantly found during excavation in comparison to other seawater fishes; therefore, I considered that abundantly present Japanese pilchards were the majority of the fish belonging to the Clupeidae spp. excavated from the sites. Hence, I investigated the fishing season of the Japanese pilchard.

First, using contemporary Japanese pilchard specimens, I created an equation for estimating body length from measurements of the abdominal vertebrae. Next, the abdominal vertebrae of Japanese pilchards excavated from the sites were measured and body lengths were estimated using the equation. Finally,

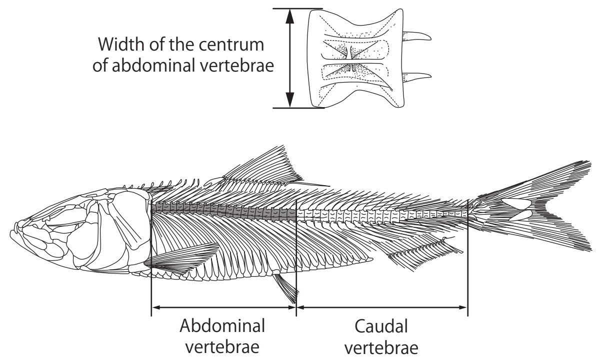


Figure 8 Measured parts of the abdominal vertebrae

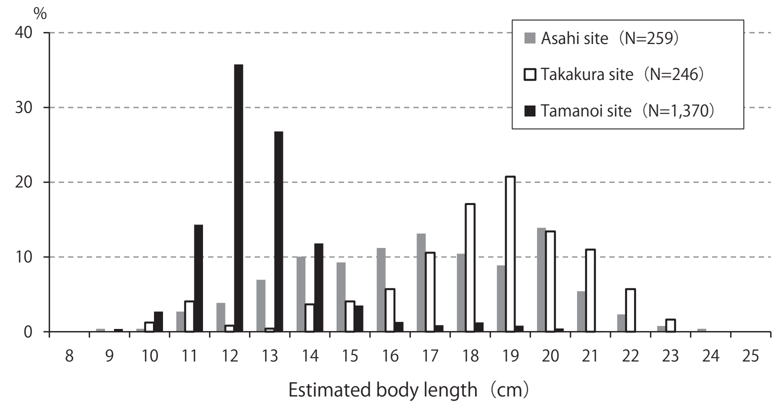


Figure 9 Estimated body length of the excavated Japanese pilchard

the pilchard fishing season at each site was estimated based on the timing of the Japanese pilchard migration within Ise Bay.

I performed regression analysis by measuring the body length and abdominal vertebrae of contemporary Japanese pilchard specimens (Fig.8). A strong correlation was observed between body length and the transverse diameter of the centrum (R^2=0.947, p<0.01). The equation for estimating body length (Y: mm) from the transverse diameter of the abdominal vertebrae centrum

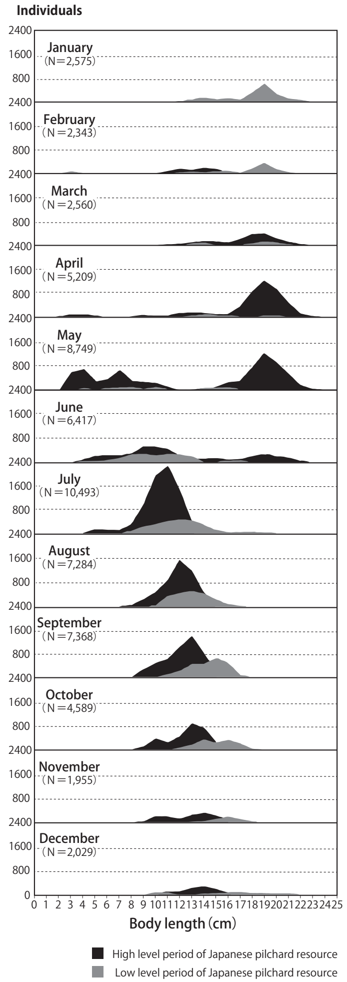


Figure 10 Body length composition by month (1952–2011) for the Japanese pilchard in Ise Bay

This graph shows the body length composition by month for the Japanese pilchard (approx. 60,000 individuals) that migrated to the Ise Bay. This information was created from 60 years of data presented within the business report of the Aichi Fisheries Research Institute.

of Japanese pilchards was derived as $Y = 0.453X^2 + 3.59X + 4.541$. I estimated the body length of Japanese pilchards excavated from the study sites using this equation. The estimated body lengths of Japanese pilchards excavated from the Tamanoi site was were between 11 and 13 cm, and the estimated body lengths of Japanese pilchards excavated from the Takakura site were between 18 and 19 cm (Fig.9). The body lengths of Japanese pilchards excavated from the Asahi site were widely distributed between 14 and 20 cm.

The Japanese pilchard spawns outside Ise Bay between January and May and subsequently migrates to Ise Bay to feed. Japanese pilchards are born in the winter-spring season and migrate during July-October. Large Japanese pilchards (body length, approximately 18–20 cm) migrate during the winter-spring season, whereas small Japanese pilchards (body length, approximately 10–15 cm) migrate during the summer or fall (Fig.10). Therefore, the pilchard fishing season at the Tamanoi site in the final Jōmon period is thought to have been summer or fall. Similarly, the pilchard fishing season at the Takakura site in the early stage Yayoi period is thought to have been winter or spring. Species of the Clupeidae spp. family, primarily Japanese pilchard, were excavated in high abundance from the Tamanoi site and Takakura site. For this reason, the estimated pilchard fishing season represents the overall fishing season at these sites. By comparing the Tamanoi site (final Jōmon period) and the Takakura site (early stage Yayoi period), located in the Atsuta Plateau, the fishing season was found to have been switched from summer-fall to winter-spring.

Changes in fishing activities. In sites in the alluvial lowlands, both coastal and freshwater areas were used for fishing. On the other hand, at highland sites, the coast was a major fishing area and freshwater areas were rarely used. Based on comparison between the final Jōmon period and the Yayoi period, the fishing season at the highland sites changed from summer-fall to winter-spring. I suggest that the people of the Yayoi period spent time previously devoted to fishing on other subsistence activities, resulting in this change in fishing season (Tab.2).

Chapter 4. Hunting

In chapter 4, the season of death of sika deer (*Cervus nippon*) is estimated on the basis of observed tooth development. It was discovered that the main sika deer hunting season was during the winter at the Asahi site in the Yayoi period. In

Table 2 Fishery activities in each site

Site		Date of Fish remains	Mainly fish remains	Fishing Area (Major Fishing Method)	Fishing Season (The pilchard fishing)
Alluvial lowland	Asahi	The latter half of the early Yayoi period ～ The latter portion of the middle Yayoi period	Cyprinidae spp. and *Acanthopagrus* sp.	Coastal and freshwater area (Pierced and Pole fishing)	Year-round
	Nishishiga (Hirate-cho)	The latter half of the early Yayoi period / The middle portion of the middle Yayoi period	Cyprinidae spp. and *Acanthopagrus* sp.	Coastal and freshwater area (Pierced and Pole fishing)	Unknown (lack of samples)
	Isshiki-aokai	The latter portion of the middle Yayoi period	Cyprinidae spp. and *Acanthopagrus* sp.	Coastal and freshwater area (Pierced and Pole fishing)	Unknown (lack of samples)
Highland	Tamanoi	The early final Jōmon period	Clupeidae spp. (Mainly Japanese pilchard)	Coastal area (Net fishing)	Summer and Fall
	Takakura	The latter half of the early Yayoi period	Clupeidae spp. (Mainly Japanese pilchard)	Coastal area (Net fishing)	Winter and Spring

this chapter, I also show that people at the Asahi site acquired deer antlers by methods other than hunting.

Animal resource use at the Asahi site. The Asahi site is a valuable site from which a large volume of vertebrate remains were excavated; these can be used to comprehensively investigate animal resource use in the Yayoi period. Approximately 94% of the mammalian remains excavated from the Asahi site were of boar (*Sus scrofa*), sika deer (*C. nippon*), and dogs (*Canis lupus familiaris*) (Fig.11). Very few other mammals were discovered. In particular, boar was the most abundant mammalian remain found, and most of them were cubs or young boars (Fig.12). Therefore, I conclude that boar domestication was at an early stage at the Asahi site.

People living at the Asahi site, which is located in the alluvial lowlands, actively hunted fishes such as carp (*C. carpio*) or catfish (*Silurus* sp.) that live in lowland swamps around the site as well as birds such as wild duck (Anatinae spp.) or wild goose (Anserinae spp.). Boar, the most abundant mammal present, also prefers lowland swamps as their wallow. In addition, people living at this

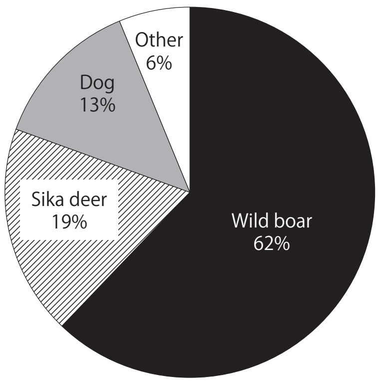


Figure 11 Composition of the mammalian remains excavated from the Asahi site

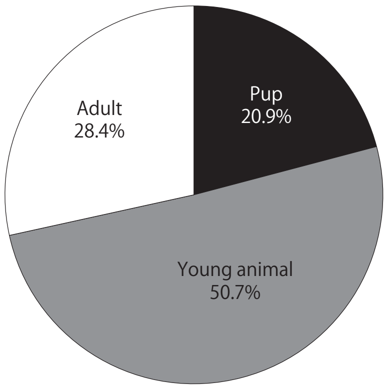


Figure 12 Age of boar excavated from the Asahi site

site selectively hunted sika deer within forests at some distance from the site. Hardly any other forest mammals, such as racoon dog, fox, and weasel, were excavated. Therefore, I discuss hunting activities on the basis of sika deer excavated from the Asahi site.

Sika deer hunting season. I conducted X-ray imaging on the mandibles of 144 contemporary sika deer individuals (74 male, 66 female, 4 unknown) whose ages in months were apparent in order to observe tooth development stages. By referring to the text by Brown & Chapman (1991ab), tooth development was classified into ten stages. The correlation between tooth development stage and age in months was determined by regression analysis. In all 42 cases in which more than three lower teeth remained, a strong correlation was observed between tooth development stage and age in months (Tab.3). Therefore, I was able to estimate the season of death of sika deer excavated from the study sites, even from damaged samples.

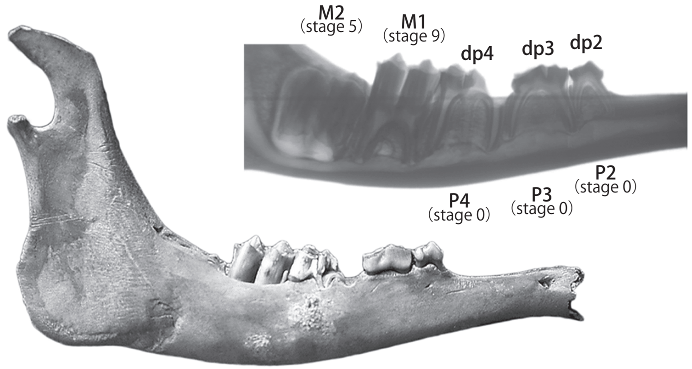
Using the derived equation, I estimated the season of death of sika deer excavated from the Asahi site (Fig.13). I found that the deaths of sika deer excavated from the Asahi site were concentrated in winter (Fig.14).

Reconstruction of sika deer hunting. The sixth lumbar vertebrae of a sika deer with a stone arrowhead stuck inside was excavated from the Asahi site (Fig.15,16). I performed an X-ray computed scan image to accurately determine the angle of incidence of the stone arrowhead and determined that the people of the Yayoi period shot their arrows almost horizontally towards the lower abdomen of the deer diagonally from their right side. The stone arrowhead had not reached the spinal cord of this deer. Proliferation of bone was observed surrounding the stuck stone arrowhead, thereby leading to the conclusion that it did not inflict a fatal wound and that the deer escaped with the arrowhead stuck in its body. However, this deer was excavated from the Asahi site, so it is understood that it was later captured by the people living at this site.

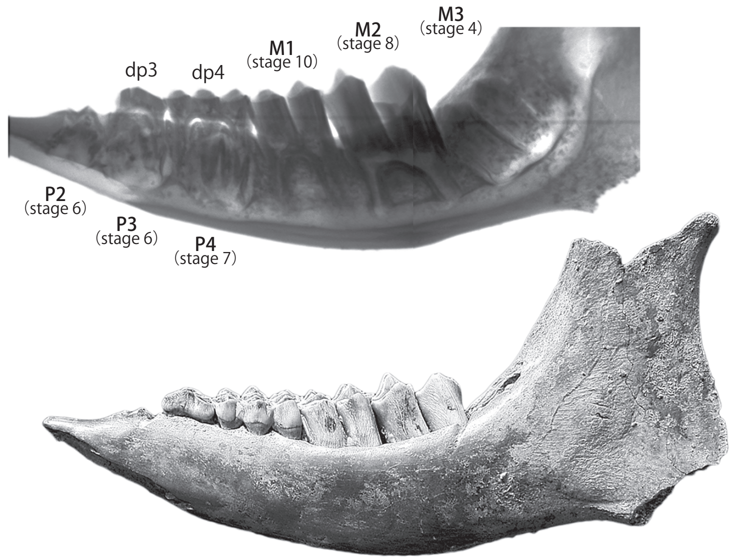
Next, I created a replica of this specimen for exhibitions using a 3D printer on

Table 3 Equation used for age estimation
(X: total score, Y: estimated age in months)

Remained teeth in mandible	Range of total score	Cubic regression equation	R^2	*P*
P2+P3+P4	$1 < x < 25$	$y = 0.002x^3 - 0.078x^2 + 1.423x + 7.953$	0.893	< 0.01
P2+P3+M1	$3 < x < 27$	$y = 0.003x^3 - 0.194x^2 + 4.399x - 17.435$	0.943	< 0.01
P2+P3+M2	$0 < x < 26$	$y = 0.002x^3 - 0.081x^2 + 1.838x + 1.007$	0.968	< 0.01
P2+P3+M3	$0 < x < 25$	$y = 0.002x^3 - 0.071x^2 + 1.398x + 7.932$	0.937	< 0.01
P2+P4+M1	$3 < x < 27$	$y = 0.003x^3 - 0.188x^2 + 4.248x - 16.641$	0.944	< 0.01
P2+P4+M2	$0 < x < 26$	$y = 0.002x^3 - 0.084x^2 + 1.836x + 1.049$	0.968	< 0.01
P2+P4+M3	$0 < x < 25$	$y = 0.001x^3 - 0.061x^2 + 1.277x + 8.015$	0.940	< 0.01
P2+M1+M2	$4 < x < 28$	$y = -0.001x^3 + 0.027x^2 + 0.581x - 3.003$	0.969	< 0.01
P2+M1+M3	$3 < x < 27$	$y = 0.002x^3 - 0.132x^2 + 3.504x - 14.041$	0.945	< 0.01
P2+M2+M3	$0 < x < 26$	$y = 0.001x^3 - 0.053x^2 + 1.542x + 1.459$	0.964	< 0.01
P3+P4+M1	$3 < x < 27$	$y = 0.003x^3 - 0.188x^2 + 4.196x - 16.262$	0.946	< 0.01
P3+P4+M2	$0 < x < 26$	$y = 0.002x^3 - 0.088x^2 + 1.851x + 1.052$	0.969	< 0.01
P3+P4+M3	$0 < x < 25$	$y = 0.001x^3 - 0.053x^2 + 1.189x + 8.075$	0.946	< 0.01
P3+M1+M2	$4 < x < 27$	$y = 0.002x^3 - 0.071x^2 + 1.906x - 8.378$	0.940	< 0.01
P3+M1+M3	$3 < x < 27$	$y = 0.002x^3 - 0.129x^2 + 3.417x - 13.562$	0.950	< 0.01
P3+M2+M3	$0 < x < 26$	$y = 0.001x^3 - 0.055x^2 + 1.540x + 1.494$	0.967	< 0.01
P4+M1+M2	$4 < x < 28$	$y = 0.001x^3 - 0.036x^2 + 1.435x - 6.427$	0.973	< 0.01
P4+M1+M3	$3 < x < 27$	$y = 0.002x^3 - 0.132x^2 + 3.391x - 13.249$	0.952	< 0.01
P4+M2+M3	$0 < x < 26$	$y = 0.001x^3 - 0.063x^2 + 1.575x + 1.471$	0.968	< 0.01
M1+M2+M3	$4 < x < 28$	$y = -0.0002x^3 + 0.019x^2 + 0.564x - 2.461$	0.962	< 0.01
P2+P3+P4+M1	$4 < x < 35$	$y = 0.002x^3 - 0.134x^2 + 3.403x - 12.827$	0.945	< 0.01
P2+P3+P4+M2	$0 < x < 34$	$y = 0.001x^3 - 0.064x^2 + 1.616x + 1.552$	0.966	< 0.01
P2+P3+P4+M3	$0 < x < 33$	$y = 0.001x^3 - 0.033x^2 + 0.914x + 8.334$	0.943	< 0.01
P2+P3+M1+M2	$4 < x < 36$	$y = 0.0004x^3 - 0.033x^2 + 1.530x - 7.224$	0.972	< 0.01
P2+P3+M1+M3	$3 < x < 35$	$y = 0.002x^3 - 0.118x^2 + 3.175x - 12.205$	0.951	< 0.01
P2+P3+M2+M3	$0 < x < 34$	$y = 0.001x^3 - 0.051x^2 + 1.462x + 1.719$	0.966	< 0.01
P2+P4+M1+M2	$4 < x < 36$	$y = 0.0005x^3 - 0.038x^2 + 1.603x - 7.477$	0.972	< 0.01
P2+P4+M1+M3	$3 < x < 35$	$y = 0.002x^3 - 0.115x^2 + 3.080x - 11.675$	0.952	< 0.01
P2+P4+M2+M3	$0 < x < 34$	$y = 0.001x^3 - 0.052x^2 + 1.450x + 1.770$	0.966	< 0.01
P2+M1+M2+M3	$4 < x < 36$	$y = 0.0001x^3 - 0.015x^2 + 1.173x - 5.321$	0.969	< 0.01
P3+P4+M1+M2	$4 < x < 36$	$y = 0.001x^3 - 0.044x^2 + 1.692x - 7.831$	0.974	< 0.01
P3+P4+M1+M3	$3 < x < 35$	$y = 0.002x^3 - 0.112x^2 + 3.010x - 11.285$	0.953	< 0.01
P3+P4+M2+M3	$0 < x < 34$	$y = 0.001x^3 - 0.052x^2 + 1.438x + 1.814$	0.967	< 0.01
P3+M1+M2+M3	$4 < x < 36$	$y = 0.0002x^3 - 0.020x^2 + 1.240x - 5.560$	0.972	< 0.01
P4+M1+M2+M3	$4 < x < 36$	$y = 0.0004x^3 - 0.029x^2 + 1.370x - 6.097$	0.973	< 0.01
P2+P3+P4+M1+M2	$4 < x < 44$	$y = 0.0005x^3 - 0.044x^2 + 1.700x - 7.866$	0.973	< 0.01
P2+P3+P4+M1+M3	$3 < x < 43$	$y = 0.001x^3 - 0.080x^2 + 2.451x - 8.572$	0.950	< 0.01
P2+P3+P4+M2+M3	$3 < x < 43$	$y = 0.001x^3 - 0.041x^2 + 1.289x + 2.192$	0.964	< 0.01
P2+P3+M1+M2+M3	$4 < x < 44$	$y = 0.0003x^3 - 0.032x^2 + 1.462x - 6.595$	0.972	< 0.01
P2+P4+M1+M2+M3	$4 < x < 44$	$y = 0.0004x^3 - 0.034x^2 + 1.484x - 6.639$	0.973	< 0.01
P3+P4+M1+M2+M3	$4 < x < 44$	$y = 0.0004x^3 - 0.036x^2 + 1.497x - 6.655$	0.974	< 0.01
P2+P3+P4+M1+M2+M3	$4 < x < 52$	$y = 0.0003x^3 - 0.033x^2 + 1.443x - 6.284$	0.973	< 0.01



No.1 60A-shell layer



No.2 61A-SD III (layer 1)

Figure 13 X-ray image of the mandible of the sika deer excavated from the Asahi site

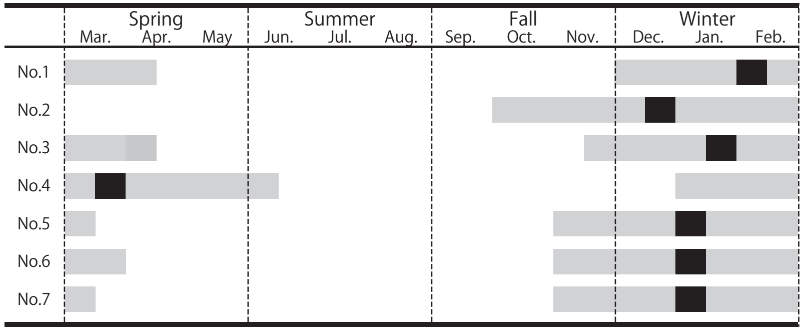


Figure 14 Period of the death of sika deer excavated from the Asahi site

the basis of the X-ray computed scan data obtained from the analysis (Fig.17). Bones in this replica were made from transparent materials and the stone arrowhead was made from colored materials. It was possible to clearly see and touch the replica to understand that the stone arrowhead did not reach the spinal cord.

Distribution of antlers. Sika deer antlers and bones were the main materials used for making bone and antler implements. Therefore, I investigated the acquisition of materials for implements.

Parts of the sika deer used as materials for implements in the Asahi site were the antlers, mandible, scapula, ulna, metacarpals, and metatarsals. By examining the usage rate of materials used for bone and antler implements, part (approximately 10%–20%) of the sika deer mandible, scapula, and ulna were utilized. In contrast, antlers were completely utilized (100%) and most (more than 94%) of the metacarpals and metatarsals were

Figure 15 The 6th lumbar vertebrae of the sika deer with a stuck stone arrowhead

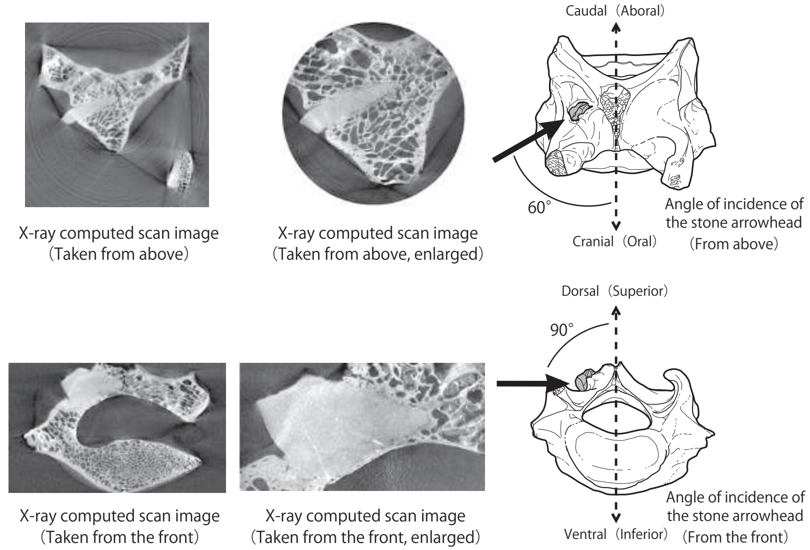


Figure 16 Angle of incidence of the stone arrowhead

Figure 17 Replica created with a 3D printer

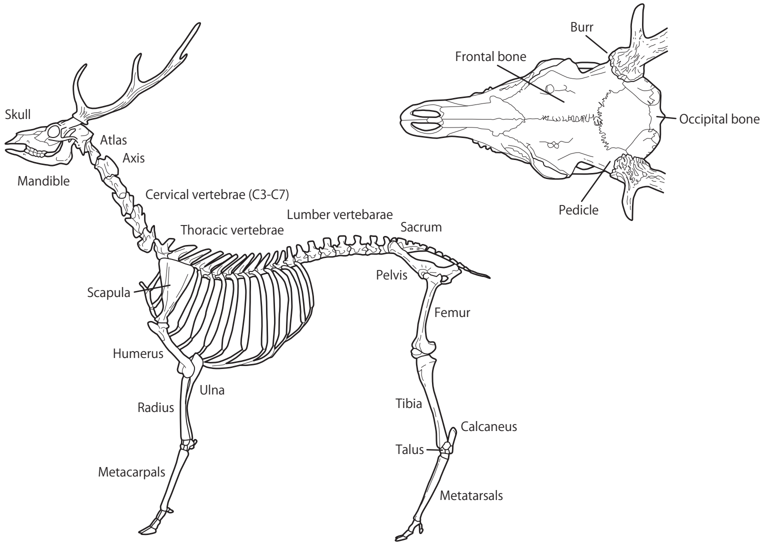


Figure 18　The skeleton of the deer

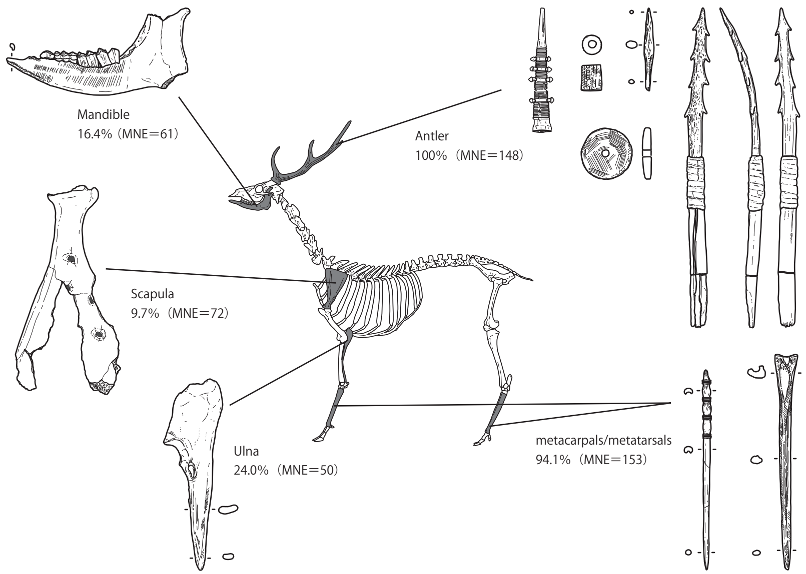


Figure 19　Parts used as materials for instruments, and their usage rate

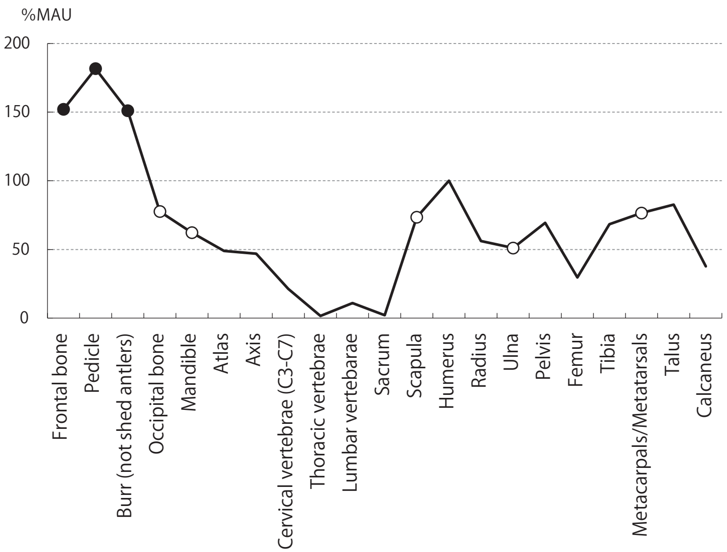


Figure 20　Excavated volume of parts used as materials for instruments (Asahi site)

Out of the parts that became instruments, ● indicates parts that are greater in number than the number of remains of the hunted individual, and ○ indicates the parts that are equal in number to the number of remains of the hunted individual.

utilized (Fig.19).

I investigated the volume of excavated parts that were used for bone and antler implements and discovered that the method of acquisition was different for antlers and parts other than antlers. Parts other than antlers were obtained from the carcasses of hunted sika deer at the Asahi site. However, this was not the only source of antlers (Fig.20). The people living at this site also used antlers attached to bone, obtained by cracking the cranium (Fig.21, 22). We were unable to determine whether they collected shed antlers themselves or whether they acquired them through distribution. Therefore, I investigated antlers attached to bone and not shed antlers to reveal the distribution of antlers.

Sika deer shed their antlers in spring, which regrow every year. The velvet antler grows rapidly in the summer and becomes stiff in fall. I have already revealed that sika deer were hunted primarily in winter. I hypothesize that sika deer were hunted in winter for two reasons: subsistence during the farming off-season and acquisition of antlers.

Chapter 5. The circumstance prior to the beginning of farming

The circumstance in the final Jōmon period just prior to the beginning of farming is discussed in chapter 5. Just before farming began, the people of the Jōmon period lived dispersed among small sites. They migrated between multiple sites in a short period of time. Specific resources were excavated in large quantities from sites of the latter half of the final Jōmon period. I investigated the large-scale production of shell bracelets in the Atsumi Peninsula and determined

Figure 21 Bone-attached antlers (restoration from contemporary specimens of the sika deer)

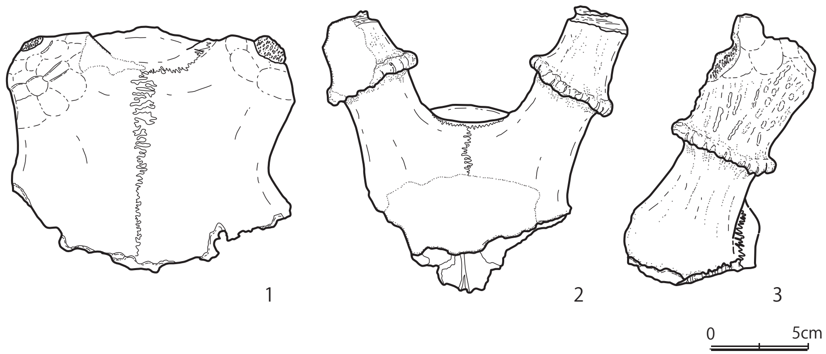


Figure 22 Example of usage of "bone-attached antlers" (Asahi site)

This figure shows the remains of cut-off antlers excavated from the Asahi site.
1: the frontal bone and pedicle of the sika deer. The trace in the pedicle suggests that is was cracked by an impact.
2: the frontal bone, pedicle, and burr of the sika deer. There are traces of diving by grooving in antlers.
3: the left frontal bone, pedicle, and burr. The trace in the antler stem and tine suggests that is was cracked by an impact.

that a widely distributed network was formed.

Changes in the latter half of the final Jōmon period. In chapters 2, 3, and 4, I discussed the usage of animal resources In the earliest farming period in the inner part of Ise Bay. However, samples from the final Jōmon period are scarce at this site. Therefore, I could not discuss in detail the circumstance in the earliest farming period.

In chapter 5, the Mikawa Bay coast, where a large number of vertebrate remains from the final Jōmon period have been reported, is investigated. I discovered that a large change occurred in the latter half of the final Jōmon period. A large site was created in the first half of the final Jōmon period, but in the latter half of the final stage, the people of the Jōmon period dispersed to smaller scale sites. Shell midden layers also decreased in number and size.

Furthermore, shell midden layers no longer contained vertebrate bones. A multilateral study on animal remains found the Ikawazu shell mound to be a settlement where people permanently stayed throughout the year in the first half of the final stage. However, in the latter half of the final stage, vertebrate bones were no longer deposited in the shell midden layers at this site. People living at the Ikawazu shell mound still deposited shells there but began to deposit fish and mammalian bones in different locations. I suggest that there was a change from a settlement morphology in which people resided year-round and deposited shells, fishes, and mammals together to a settlement morphology in which people migrated between multiple sites, one for depositing shells and another for depositing fishes and mammals.

Concentration of specific remains/artifacts. In the latter half of the final Jōmon period, sites emerged from which over 5,000 items such as stone arrowheads and polished stone axes have been excavated. Within the inner part of Mikawa Bay, a shell midden layer with a maximum height of 2.5 m was formed within the area of 185 × 40 m in the Onishi shell mound. The volume of this shell midden is 5877 m^3, mainly comprising clams and hardly any soil. The

Onishi shell mound is described as a workspace for opening and processing clam shells in the coastal area.

I hypothesize that a widely distributed network was formed. Many of the sites along the Mikawa Bay coast reduced in scale in the latter half of the final stage; only sites at the mouth of Mikawa Bay reached their developmental peaks in the latter half of the final stage. The humeri of people from the Hobi shell mound, located at the tip of the Atsumi Peninsula, were among the strongest of those of the Japanese islands, so these people are thought to have actively worked on material transportation by sea.

Large-scale production of shell bracelets. Shell bracelets made from bittersweet clams (*Glycymeris albolineata*) are widely distributed in the Tokai area.

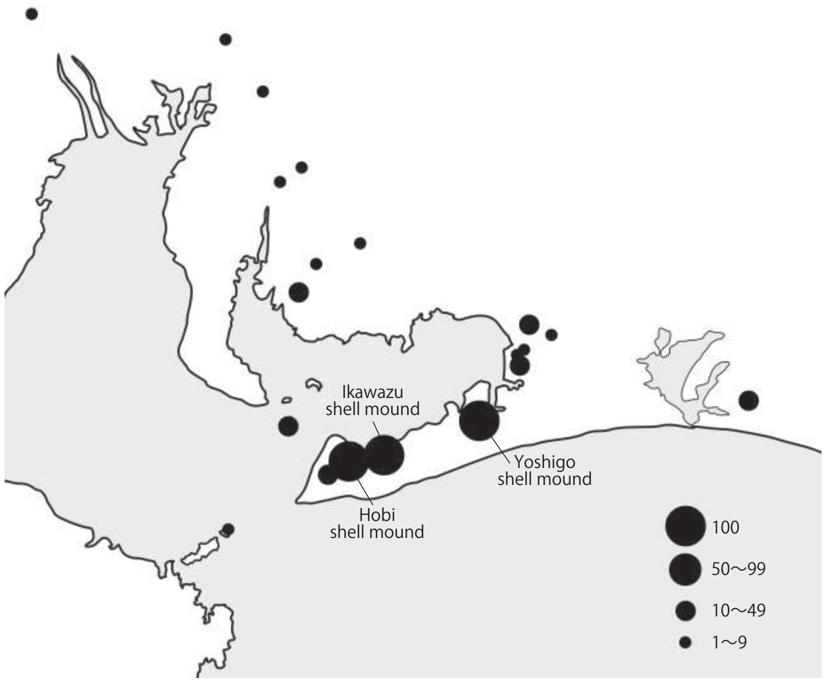


Figure 23 Distribution of shell bracelet made from bittersweet clams in the Tokai region

However, the Atsumi Peninsula is the only site from which these shell bracelets have been excavated in large quantities (Fig.23).

Shellfish were collected for food from different areas than those collected for shell bracelet materials. The people of the Jōmon period of the Atsumi Peninsula collected shellfish for food in the inner bay, near the study sites. In addition, they collected shellfish to use as materials for shell bracelets in the outer sea side of the Atsumi Peninsula. Collection of shell bracelet materials was an independent activity and was not carried out alongside food collection.

Excavated shell bracelets have “marks of abrasion by water currents” and “marks inside the shell showing predation by other species.” Because of these predation marks, I suggest that the materials used for shell bracelets were from dead, not living, shellfish (Fig.24). Therefore, I conclude that shellfish used for shell bracelets were dead shellfish that washed up on the beach. Bittersweet clams that were used as materials for shell bracelets live at depths of 5–10 m in the outer sea. There is a big difference between the collection of live and dead shellfish: If the people of the Jōmon period collected bittersweet clams by diving under the sea, they would have needed to acquire specialized skills. However, collecting dead shellfish at the shore requires no special equipment or skills.

I studied beached shells at 22 locations along the coast of the Atsumi Peninsula. Of the 3,672 beached shells, the most abundant shellfish found was bittersweet clams, which were used to make shell bracelets. At one location on the outer sea side of the Atsumi Peninsula, bittersweet clams were washed up in large quantities (Fig.25, 26). Based on the study as well as the additional previous 10 years of investigation, I confirmed that bittersweet clams were washed up on the outer sea side of the Atsumi Peninsula. Similarly, bittersweet clams are known to have been washed up in various locations in Japan near sites from which a large volume of shell bracelets made of bittersweet clams have been excavated. During the Jōmon period, there were several locations

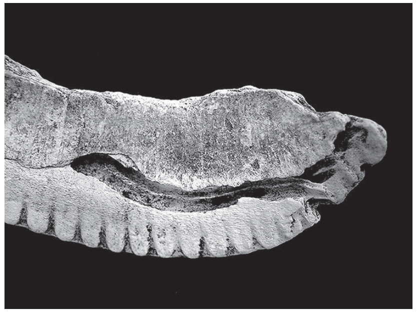


Figure 24 Traces of predation observed in the inner side of the shell

Figure 25 Status of shell fish washed-up on the shore of the Atsumi Peninsula

Figure 26 Status of bittersweet clams washed-up on the shore

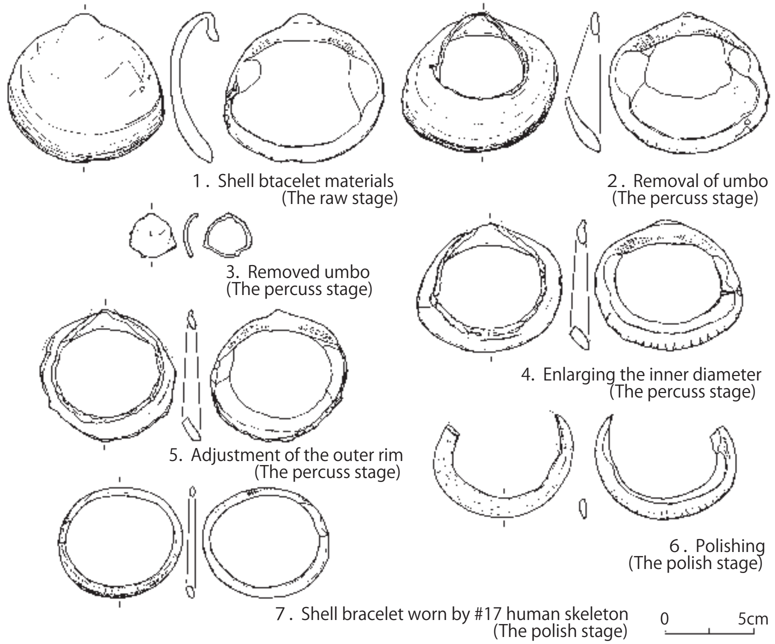


Figure 27 Process of making shell bracelet from bittersweet clams

scattered around the outer sea side of the Atsumi Peninsula where bittersweet clams were collectively washed up.

Furthermore, a greater volume of shell bracelets from the latter half of the final Jōmon period have been excavated. The ratio of incomplete to complete shell bracelets also increased. Therefore, I conclude that export of shell bracelets increased during the latter half of the final stage.

Chapter 6. Conclusion

During the earliest farming period (from the final Jōmon period to the Yayoi period) along the Ise Bay and Mikawa Bay coasts, animal resource usage changed in the following manner.

Communities prior to farming initialization. During the latter half of the final Jōmon period, prior to the beginning of farming, communities at large sites dispersed to relatively smaller sites. Such communities migrated between multiple locations over a short period of time.

I have presented a discussion of the Mikawa Bay coast in chapter 5. It is highly likely that a similar change occurred during the latter half of the final stage on the inner part of Ise Bay. Shell middens decreased in number and in size within this area and vertebrate bones were no longer deposited in shell middens.

Shellfish gathering. The number of shell mounds as well as the size of shell middens decreased in the Yayoi period. After the latter half of the early Yayoi period, the size of excavated clams significantly increased. I suggest that shellfish gathering, which occurred during the farming season, decreased.

Fishing. At sites located in alluvial lowlands, coastal as well as freshwater areas were major fishing areas. People of the Yayoi period living in lowlands proactively used fishes that reproduced in localized shallow freshwater areas such as paddy fields.

In contrast, coastal areas were used as the main fishing grounds at sites located in highlands. In the Yayoi period, people living in highlands used the time and energy previously spent on fishing for other subsistence activities. The fishing season changed from summer-fall to winter-spring in the early stage of Yayoi period.

Hunting. At the Asahi site, where the use of vertebrate resource can be comprehensively studied, vertebrates that came close to the lowlands near the site were used proactively. Boar domestication was at an early stage.

The people living at the Asahi site hunted sika deer in forests at some distance from the site. The main sika deer hunting season was winter. Antlers were acquired by hunting and through distribution. Sika deer were hunted in winter for two reasons: subsistence during the farming off-season and acquisition of antlers.

Timing of changes in subsistence. Along the inner part of Ise Bay, such

changes in vertebrate resource usage occurred in the latter half of the early Yayoi period. In contrast, this change was likely to have occurred after the middle portion of the middle Yayoi period along the Mikawa Bay coast, where sizes of clams did not change between the final Jōmon period and the early stage Yayoi period. Large clams from after the middle portion of the middle Yayoi period have been excavated.

Cultivated plants emerged at the same time in the Ise Bay and Mikawa Bay coastal areas. Millet emerged in the late final Jōmon period, and rice emerged in the first half of the early stage Yayoi period. Both were brought from the Eurasian Continent via the Korean Peninsula to Japan together with farming technology. However, there was a difference in the timing of vertebrate resource usage change between the Ise Bay coast and the Mikawa Bay coast. The change occurred early on the east side of the inner part of Ise Bay and later on the west side of the Mikawa Bay coast. Even if rice was used on the Mikawa Bay coast, there was a period lasting for several hundred years in which the overall subsistence activity did not change.

Part 2. Future Prospects

Chapter 7. Research Method of Animal Remains

Burnt vertebrate bones. Animal remains are greatly affected by the sites' deposition environment. In Japan, animal remains are difficult to preserve because of the high temperatures, pluvial climate, and soil acidity caused by volcanic ash, which cause them to decompose and eventually disappear from normal sites. For this reason, zooarchaeology research into the Jōmon period is concentrated in the Pacific Ocean coast, across which shell mounds are distributed. Shell gathering decreased with the start of farming during the Yayoi period. Shell mounds formation was decreased and animal remains became even harder to preserve.

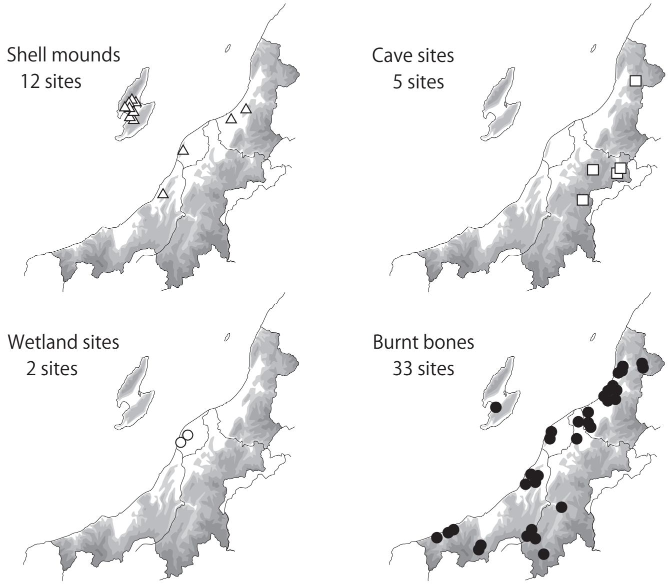


Figure 28 Site from the Jōmon period from which animal remains were excavated (Niigata Prefecture)

When burnt, vertebrate bones become less affected by the deposition environment; therefore, they are excavated from sites other than shell mounds. Burnt vertebrate bones were investigated in chapter 7 and the subject of analysis was from Niigata Prefecture, which is located in the Japan sea coast where shell mounds are hardly distributed.

I collectively studied sites from the Jōmon period in Niigata Prefecture, where animal remains were excavated. As a result, burnt bones were discovered most frequently. Shell mounds were located in the coastal area, whereas cave sites were located in the mountainous areas and wetland sites were located in lowland areas. In contrast, sites from which burnt bones were excavated were widely distributed throughout Niigata Prefecture (Fig.28). Burnt bones are not affected by locational environments, which constitute a significant advantage for research on animal remains that are otherwise easily affected by deposition

environments.

I analyzed 8,826 (66.93 g) items of burnt bones from the Rokutanda-minami site and identified 34 taxonomical groups of fishes (Fig.29). Salmon (Salmonidae sp.), carp (Cyprinidae sp.), and sweet fish (*Plecoglossus altivelis altivelis*) that live in freshwater areas were excavated from this site. In particular, salmon was found in abundance, indicating that people from this region fished salmons intensively. Saltwater fishes excavated from this site included the Japanese pilchard (*Sardinops melanostictus*) and mackerel (*Scomber* sp.), which swim in the surface layers; the bastard halibut (Paralichthyidae sp.) and righteye flounder (Pleuronectidae sp.), which reside in the lower layers; and the black seabream (*Acanthopagrus* sp.) and Japanese seabass (*Lateolabrax* sp.), which prefer brackish waters. Inhabitants of this site not only fished salmon but also undertook multiple fishery activities in the sea. Therefore, burnt bone analysis enabled us to investigate the usage of animal resources.

What archaeologists should do at the excavation site. There are very few zooarchaeologists in Japan. Therefore archaeologists who perform excavations frequently request zooarchaeologists to analyze samples for them. Although many high-quality books have been published on zooarchaeology, such literature is often written for zooarchaeologists, with few books presenting the archaeologists' point of view. The books, therefore, provide information on "what archaeologists should do at the excavation site," based on the assumption that they will request analysis to zooarchaeologists. This chapter summarizes the aspects that archaeologists should consider when requesting analysis of excavated animal remains to zooarchaeologists.

When zooarchaeologists are not permanently present at the excavation site; therefore, archaeologists should accurately record the information that is lost at the excavation site and be responsible for informing the zooarchaeologist. Information that is lost at the excavation site includes sediments of the excavated layer of animal remains and the excavated state of animal remains. Insufficient

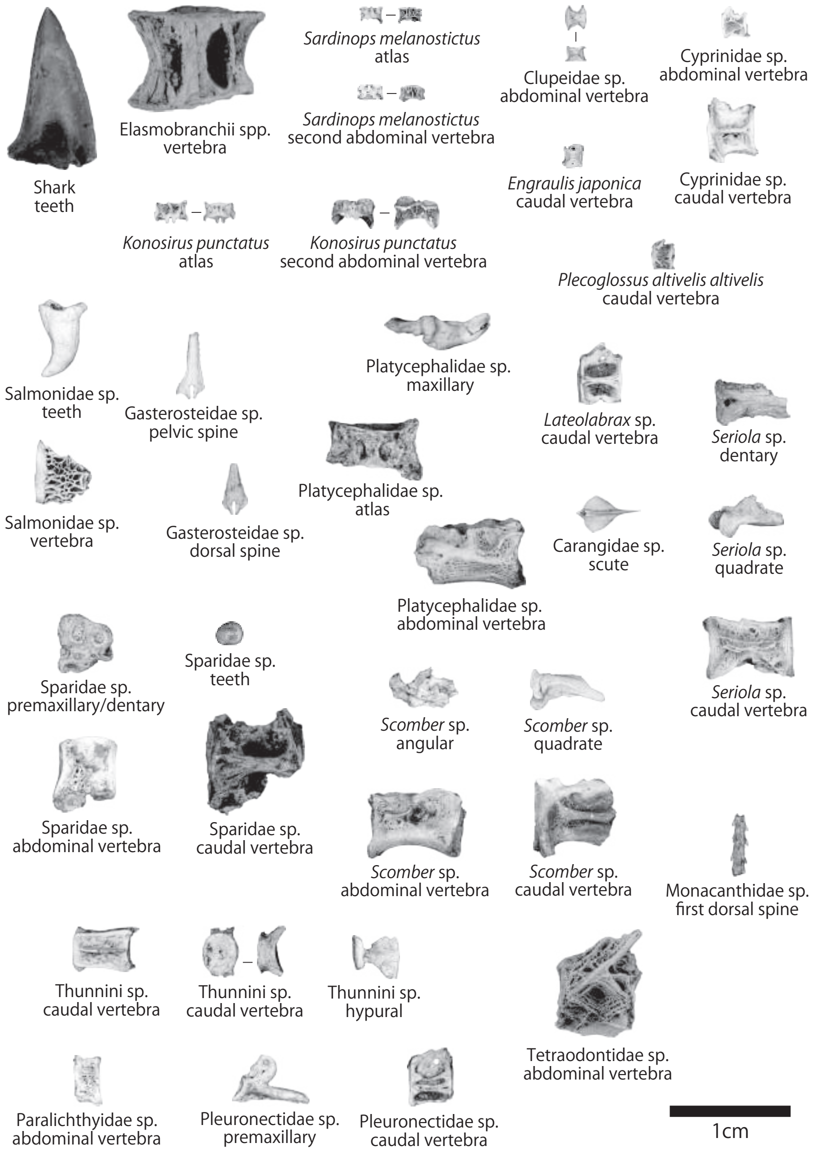


Figure 29 Burnt fish remains excavated from the Rokutanda-minami site (Jōmon period)

excavation site records will limit productive research of animal remains.

Archaeologists should draw a figure showing the excavated state of animal remains when they are excavated in a collective amount. It is recommended to take a digital photo and print it prior to picking up the bones (Fig.30). Archaeologists should write a number on the printed photo and identify the bones according to this number so that zooarchaeologists can match the photos with the bones later. Archaeologists should not wash the bones excessively as it may affect DNA analysis. Species identification and age estimation are based on the cranium and limb diaphysis. Therefore, archaeologists should pick up these parts carefully so as to avoid damage.

Wet sieving is required for detailed studies on zooarchaeology. The samples are collected from certain shell middens during large-scale excavations on shell mounds. Poorly planned shell midden sample collections represent a huge burden for the subsequent steps. Wet sieving should be performed on limited shell midden soil, and the workload that fits within the budget and time period should be realistically estimated. Burnt bones are sometimes found in kilns/furnaces, waste disposal holes, and burnt homes. Although the cost-efficiency of unplanned wet sieving sediments is low, to record the feature cross-section, only half of the sediments in the feature should be dug, and sieving should be performed in the part of the soil that was dug (Fig.31). The remaining half of

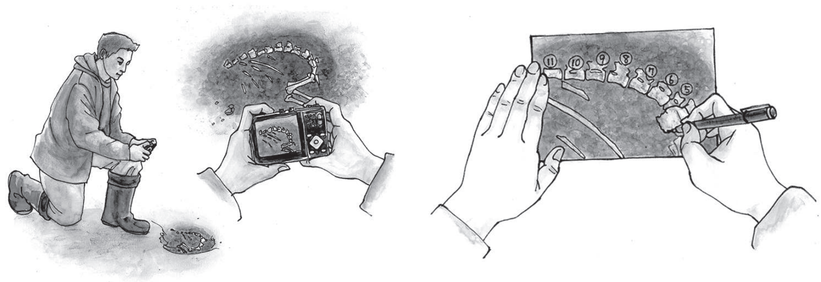


Figure 30 Writing a number on the printed photo, then picking-up the bones

the sediments in each strata from which burnt bones were excavated should be removed from the features. The use of flotation along with wet sieving is recommended. In addition to burnt bones, this method allows the collection of carbonized nuts and seeds from the soil of the same feature.

When non-specialists of zooarchaeology extract very small finds from the sieve's remaining materials, only the materials judged as bone are delivered to zooarchaeologists. In other words, materials that they were unable to recognize as bone do not reach zooarchaeologists for analysis. Zooarchaeologists should extract very small finds preliminarily to prevent this limitation.

Chapter 8. Methodology of zooarchaeology

Age evaluation. Among the most excavated mammals in Japan (boar, sika deer, cow, horse, and dog), the sika deer is the only species whose bone age have not been studied in the past. Therefore, we conducted a basic study on the age of contemporary sika deer's bones, which is presented in chapter 8.

The whole body anatomy of the sika deer was studied using contemporary skeletal specimens of 219 individuals (68 males, 108 females, and 43 unknown) held by the Tochigi Prefectural Museum. The state of the epiphysiodesis was observed in 92 parts, which comprised 10 front limbs, 8 hind limbs, 20 phalanges, and 54 vertebrae (Fig.32). Aging-associated changes in epiphysiodesis were then divided in the following three steps: epiphysis and diaphysis are unfused and dissociated (score 0), epiphysis and diaphysis are fused but an epiphyseal line is present (score 1), and epiphysis and diaphysis are fused and an epiphyseal line is absent (score 2). The status of the diaphysis fusion was evaluated via the quantification of each of the three steps (Tab.4).

Figure 31 Test by sieving archaeological soils

To date, age estimation of sika deer was only possible using a teeth-based procedure, thereby requiring jaw bones excavated in good conditions from specific sites. The results of the present study allow age estimation of sika deer excavated from a wide range of sites.

Ethnoarchaeology and Experimental archaeology. As part of a study on the middle range theory, which allows studying the relationship between human activities related to usage of vertebrate resources and its evidence, I conducted a study on experimental archaeology and ethnoarchaeology.

Currently in Japan, only food resources (meat) are obtained from hunted boar and sika deer. Therefore, it is hard to obtain a model of vertebrate resource usage that does not involve feeding. Furthermore, in contemporary Japan, it is hard to study ethnoarchaeology similarly to Binford and Brain's work because the Japanese law prohibits abandoning hunted or dissected vertebrate residuals.

Therefore, the study of vertebrate resource usage was performed by accompanying the nomadic lifestyle in the Zavkhan Plovince in Mongol. Mongol is an area where several vertebrate resources are used and the vertebrate remains can be used after disposal. The process of formation of animal remains can be divided into the following stages: hunting, dissection, usage, disposal, and post-disposal. For each stage, the relationship between human activities related to vertebrate resource usage and traces left on bones as a result was observed and the artefactual and non-artefactual factors related to the formation of animal remains was recorded (Fig.33). In addition, the adequacy of Brain's model,

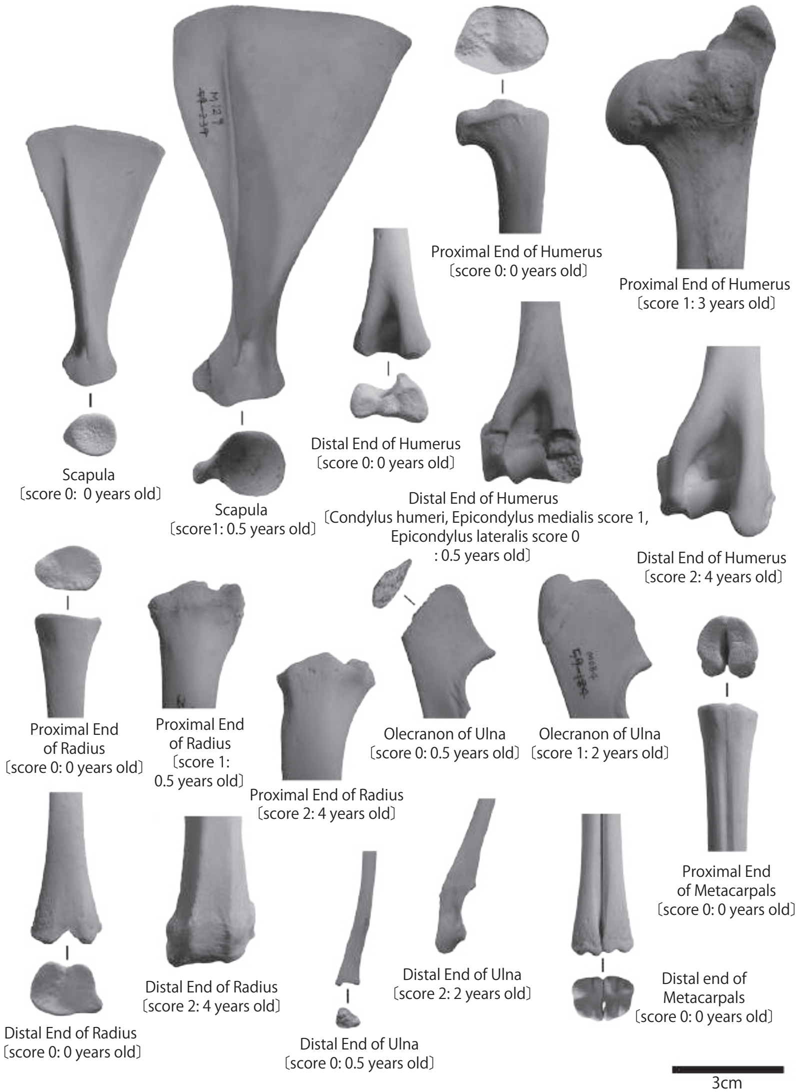


Figure 32 State of epiphysiodesis of the contemporary sika deer (front leg)

Table 4 Period of epiphysiodesis of the sika deer

Element			N	Age（95% prediction intervals）					
				Score 0	N	Score 1	N	Score 2	N
Forelimbs	Scapula	Tuberculum infraglenoidale	212	0–0.5	129	0.5–1.5	7	1–2	76
	Humerus	Proximal end	212	0–2	163	1.5–4	6	3–5	43
		Distal end (Condylus humeri, Epicondylus medialis)	183	0–0.5	14	0.5–1.5	113	1–2	56
		Distal end (Epicondylus lateralis)	183	0–0.5	86	0.5–1.5	42	1.5–2	55
	Radius	Proximal end	213	0–0.5	12	0–0.5	44	0.5–1	157
		Distal end	213	0–2	162	2–3	5	2–4	46
	Ulna	Proximal end (Olecranon)	210	0–2	161	2–4	5	3–5	44
		Distal end	210	0–2	163	2	1	2–5	46
	Metacarpals	Proximal end	200	0–0.5	7	–	0	0–1	193
		Distal end	199	0–1.5	156	2	1	2–3	42
Hindlimbs	Pelvis	Acetabulum	212	0–0.5	107	0.5–1.5	30	1–2	75
	Femur	Proximal end	210	0–1.5	156	2–4	9	3–5	45
		Distal end	211	0–1.5	158	2–3	9	3–4	44
	Tibia	Proximal end	212	0–1.5	160	2–4	8	3–5	44
		Distal end	212	0–1.5	146	1–2	9	1.5–3	57
	Calcaneus	Tuber calcanei	197	0–1.5	154	2–4	6	3–5	37
	Metatarsals	Proximal end	201	0	5	–	0	0–0.5	196
		Distal end	201	0–1.5	156	2–3	4	2–4	41
Phalanges	Proximal phalanx	Proximal end	195	0–0.5	128	0.5–1.5	15	1–2	52
		Distal end	195	–	0	–	0	0	195
	Middle phalanx	Proximal end	195	0–0.5	128	0.5–1.5	7	1–2	56
		Distal end	195	–	0	–	0	0	195
	Distal phalanx	Proximal end	195	0	5	0.5	4	0–1	186
Vertebral column	Atlas	Dorsal tubercle	189	0	8	0.5–1.5	147	2–4	34
		Ventral tubercle	189	0	8	0.5–1	126	0.5–2	55
	Axis	Head of vertebra (dens, cranial articular process)	185	0	9	0–1	51	0.5–1.5	124
		Foosa of vertebra	187	0–2	76	0.5–4	90	5–6	21
	Cervical vertebrae (C3–C7)	Head of vertebra	943	0–2	276	0.5–4	493	4–6	174
		Foosa of vertebra	932	0–2	505	0.5–5	337	5–10	90
	Thoracic vertebrae	Head of vertebra	2423	0–3	994	0.5–5	1161	4–13	268
		Foosa of vertebra	2424	0–3	1220	0.5–6	974	5–13	230
	Lumber vertebrae	Head of vertebra	1142	0–2	361	0.5–2	638	3–6	143
		Foosa of vertebra	1143	0–3	430	0.5–4	582	3–6	131
	Sacral vertebra (S1)	Head of vertebra	189	0–2	86	0.5–2	78	3–4	25
		Foosa of vertebra	187	0–2	53	0.5–3	113	4–6	21

Score 0 : Epiphysis and diaphysis are unfused and dissociated.
Score 1: Epiphysis and diaphysis are fused but an epiphyseal line is present.
Score 2: Epiphysis and diaphysis are fused and an epiphyseal line is absent.

which represents the effect of dogs on animal remains and has been frequently used in Japan, was verified (Fig.34, 35).

Next, animals were dissected according to traditional Mongolian procedures. Skeletal specimens of dissected goats were prepared, and the relationship between human activities related to vertebrate resource usage and traces left on bones as a result was recorded (Fig.36). Studies in the fields of ethnoarchaeology and experimental archaeology complement each other. Ethnoarchaeological studies aim to record the overall formation process. Overlapping traces from multiple activities were observed on vertebrate bones, thereby preventing the understanding of traces left from vertebrate dissection alone. To tackle this limitation, I conducted a study in the field of experimental archaeology and revealed the relationship between vertebrate dissection and traces left on bones.

Chapter 9. Contribution for Society

Most excavations conducted in Japan are urgent pre-excavation investigations associated with civil engineering work. Whenever archaeological sites have to be destroyed because of development work, Japanese archaeologists conduct excavation investigations prior to construction to record the information of the archaeological site that will disappear. Approximately 8,000 excavation investigations per year are performed in Japan. We are expected to contribute for society by providing the results obtained from excavation investigations.

Chapter 9 presents information pertaining to the use of those results. Results of studies on animal remains and plant remains excavated from archaeological sites were used for nature restoration projects, aiming to restore the natural environments that disappeared in the past.

The literature on nature restoration projects stated that the projects should aim to restore the natural environments of the Jōmon or Yayoi periods. However, actual nature restoration projects have not regenerated nature in

Slaughter using traditional procedures

Blood is collected from the thoracic cavity

The prayer wheel is turned close to the head

Cut off hands and feet

He strips off the skin with his fist

They take out the intestine

He scoops out the blood collected in the thoracic cavity with a cup

They separate the upper and lower bodies

He sprinkles salt on the stripped off fur skin

Figure 33 Slaughter and dissection of sheep using traditional procedures

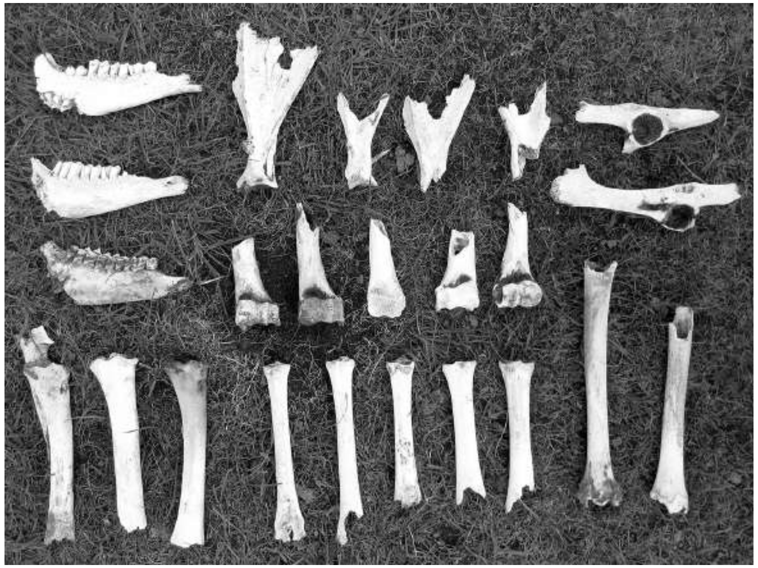


Figure 34 Sheep and goat bones disposed around the yurt

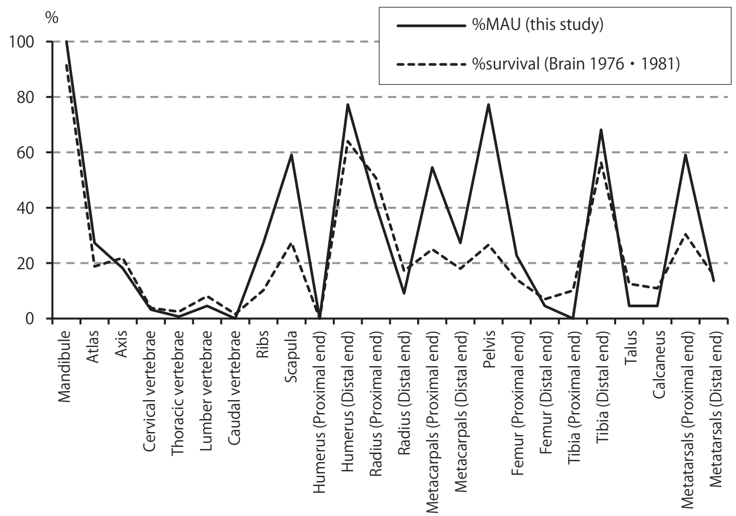


Figure 35 Comparison between "sheep and goat gathered in Mongol" and "goat gathered in Southern areas of Africa"

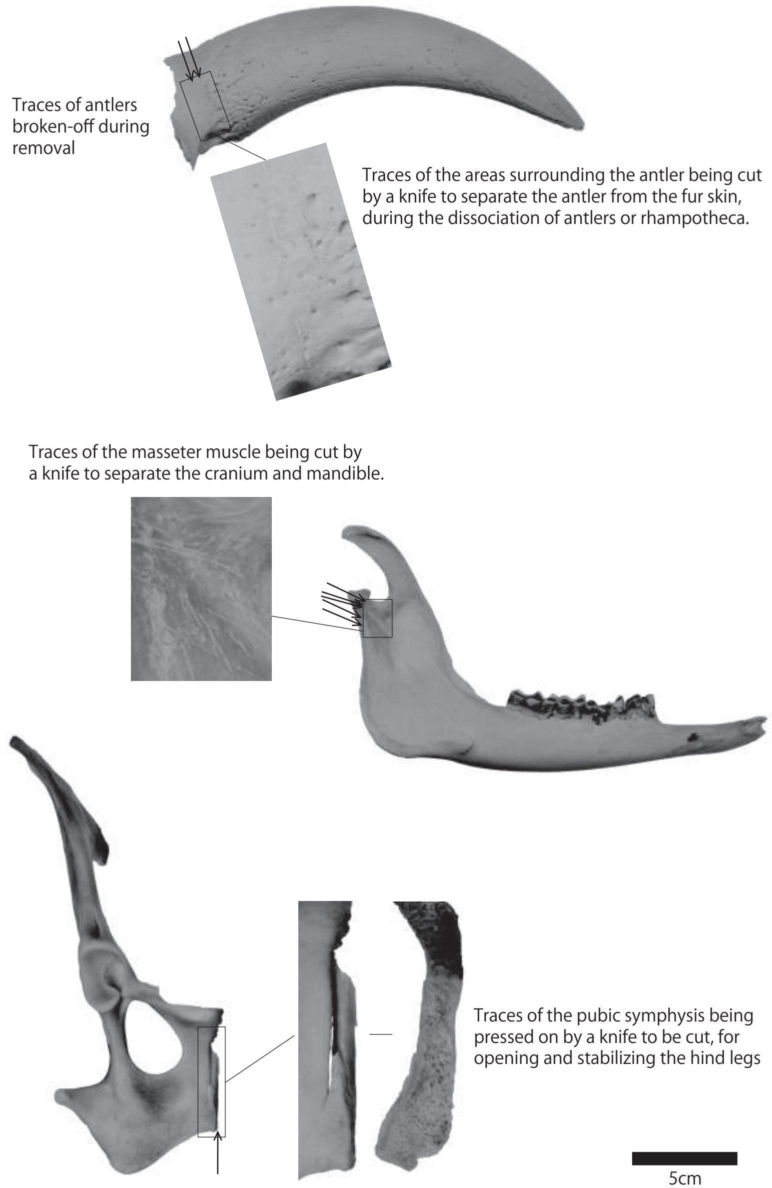


Figure 36 Traces left on bone from dissection experiments

the Jōmon or Yayoi periods but regenerated the state of nature around the time period from approximately 50–60 years ago. The reason why the nature from 50–60 years ago has been regenerated is that this period corresponds to the childhood of the people who take part in the nature restoration project. Childhood memories of the authors are described in the literature related to nature restoration projects, which shares the following common logic: there was plenty of beautiful nature in my childhood, and this nature has continued without changing from the past (the Jōmon or Yayoi period). However, this nature has been destroyed in association with economic growth, so we must take action to regenerate this nature.

These authors have assumed that the nature from their childhood had not changed since the Jōmon or Yayoi periods. However, they have not presented academic arguments to support that the natural environments from 50–60 years ago correspond to those of the Jōmon or Yayoi periods. Diverse nature existed in Japan, and different types of relationships were formed between nature and the people living in the Japanese islands. Authors of the literature on nature restoration projects have over-simplified the history of such human-nature relationships. Although they use the past as evidence, they actually disregard history.

Our investigations on how our study results can be used answers our own questions on how we should present our study results. Some environmental archaeologists have made statements similar to those made by the authors of the nature restoration project. Today, we are strongly expected to contribute back to society through our archaeological study results. People are interested in study results that are easily empathized by modern society.

Have we not changed the past so that it fits the ideal state of the present? Have we not neglected that past that is not ideal from the present's point of view? We need to further discuss the ways in which archaeology can contribute for the society.