Social complexity in the Late Jomon period: the constitution of the Shimo'ota shell mound cemetery of the Boso Peninsula, eastern Kanto, Japan

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ABSTRACT

This paper aims to examine social complexity during the Late Jomon period (2500–1200 cal BC) in eastern Japan. Previous reconstructions of Jomon society have analysed settlement and cemetery organization and differences in house size and grave goods found within various sites, and suggest segmentary social units and social stratification. However, recent studies have revealed two distinct types of cemetery in western Japan based on different organizational principles of residential membership and other pan-tribal sodalities such as clanship after the Late Jomon period. This approach is useful to estimate social complexity, including social stratification, in terms of inter- and intra-clan differentiation. I have therefore adopted this approach in conducting an osteo-archaeological analysis of skeletal remains found in the Shimo'ota shell mound in the Kanto region of eastern Japan. My analysis of the cemetery's spatial organization and tooth crown measurements of the remains reveal that the Shimo'ota cemetery site was atypical in that its occupants were selected from surrounding settlements based on the principle of clan sodality. Taking into considering a number of other sites viewed as representative of typical cemeteries of this region, I conclude that these sites were organized according to different social principles of kinship and clanship corresponding to the social formation of egalitarian tribes.

KEYWORDS: Late Jomon period, eastern Japan, social complexity, cemetery type, skeletal remains, tooth crown measurements

Introduction

The social composition and complexity of the Jomon Period in the Japanese archipelago have been investigated mainly through analyses of cemetery and settlement sites. Outcomes of the analyses of cemeteries and other mortuary practices have been used to reconstruct specific social entities, such as lineages and other kin groups (e.g. Harunari 1973; Hayashi 1977, 1979, 1998; Takahashi 1991; Yamada 1995, 2008; Taniguchi 2002).

Mizuno Masayoshi modelled fundamental social units from the analyses of settlements

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comprising circular configurations of pit dwellings. He found that a settlement and cemetery were divided into basically three segmental units, each of which contained a pair of componential features such as pit dwellings and graves, for example, as seen in the spatial organisation of the Oyu stone circle (Mizuno 1968, 1969). He argued that considering the nature of the social group represented by the pair of pit dwellings, it reflected a family based on the correspondence of segmental units seen in both settlements and cemeteries (Mizuno 1969).

Hayashi Kensaku also focused on the spatial organisation of a cemetery to reveal the nature of the social group reflected there (Hayashi 1977, 1979). The analyses of burial distribution, grave goods and sex of buried individuals revealed the spatial segments within a cemetery. These spatial segments were interpreted as representing households (Hayashi 1979). In addition to the cemetery comprising several segmental social units, he also found the dualistic dividing principle mainly seen in the varied orientations of the burials. This dualistic division seen in mortuary treatment of the body was interpreted as indicating the difference in membership originating from each specific settlement (Hayashi 1998, pp. 92–6). Harunari Hideji found two groups (2C type and 4I type) of ritual tooth extraction patterns, with the two types related to distributional segments of burials within a cemetery (Harunari 1973). Harunari believed that the ritual tooth ablation was conducted in two different rites of passage. Two maxillary canines were apparently removed in an initiation ritual, whereas two mandibular canines and/or four incisors were removed in a marriage rite. Harunari interpreted the 2C type individuals as people marrying into a settlement from outside and the 4I type as those originating from the settlement (Harunari 1973, 2002). These interpretations were based on the settlement which was formed by a clan member including people marrying from outside (Harunari 1973). Moreover, the settlement organisation was assumed to be reflected in a cemetery.

Takahashi Ruzaburo analysed the Kusakari shell mound in Chiba Prefecture which was formed in a concentric circular configuration of pits and pit dwellings. The eastern half of this settlement was divided into eight segments of pit dwellings, part of which was reused as burials after their decay. Takahashi interpreted these segments as representing the kin groups (Takahashi 1991). Yamada Yasuhiro also focused on two segments seen in both burials and pit dwellings at Gonbenbara shell mound in Chiba Prefecture. He interpreted the segments of burials and pit dwellings as belonging to a household or small scale family (Yamada 1995, 2008).

These studies attempt to reconstruct the social constitution of the settlement based on several assumptions. One of them was that a settlement was an exogamous unit. The interpretations of dichotomous types of ritual tooth extraction (e.g. Harunari 1973) and body orientation in burials (Hayashi 1998) were based on this assumption. However, this assumption was criticised because the social image of the modern era was used to reconstruct prehistoric society (Tanaka 1998). Tanaka Yoshiyuki alternatively introduced the tribal social organisation and descent principle as a more appropriate model for reconstructing Jomon society (Tanaka 1998). After this critical argument on this assumption in previous studies, the segmental units of pit dwellings and graves in settlements and cemeteries were then interpreted as representing lineages or clan segments based on the ethnographic outcomes (e.g. Tanaka 1998, 1999; Mizoguchi 2002; Taniguchi 2002). In other words, a settlement was recognised as organised by several different exogamous social groups of lineages or clan segments (Tanaka 1998).

Besides these arguments on the segmental constitution of settlements, dualistic division has been of interest to many scholars (e.g. Mizuno 1969; Harunari 1973; Hayashi 1977, 1998). Kobayashi Tatsuo believed this dualistic pattern was more broadly found in the distribution of pit dwellings and shell mounds in a settlement based on the correlates of dualistic spatial division and two forms of hearths in a large public house, as well as the construction of two pairs of stone circles (Kobayashi 1996, 2004). This duality seen in various material patterns was interpreted as representing dualistic principles similar to the phratry seen among the Tlingit (Kobayashi 1996, 2004, pp.116–33).

Secondly, the studies mentioned above were based on the assumption that a settlement, cemetery and the segmental units between them corresponded to each other. Sasaki Koumei criticised this assumption and argued the possibility that certain cemeteries were constructed by several settlements. His argument was based on one example of spatial organisation at the Nishida site, Iwate Prefecture because the amount of burials in the central circular area exceeded the number of residential features surrounding the outermost circular area of the site (Sasaki 1991, p.185). This possibility was also based on two rows of graves at the centre of the cemetery area in the Nishida site. The two rows are estimated to signify dual organisation of the community (Tanaka 1998, 1999), and the individuals who settled in both the Nishida site and the other settlements were selected to be buried according to that dual organisation (Mizoguchi 2002, p.105). In addition to this argument, internally segmented stone circles and circular-banked cemeteries are thought to be regional core cemeteries and ceremonial places (Kobayashi 1986; Tanaka 2008a) which are mortuary places for individuals selected from different settlements (Tanaka 2008a).

As seen above, the multiple clan or clan segment constitution of a settlement and cemetery are argued mainly based on the spatial organisation of large-scale and regional core settlements and cemeteries. The argument is strengthened by the examination of broader social networks based on the distributions of various material cultures (Mizoguchi 2002). Osteoarchaeological studies verified the archaeological estimation of the cemetery in which individuals were selectively buried from different settlements (Tanaka 2008a, 2008b). However, because these studies examined a cemetery located in western Japan, this kind of osteoarchaeological examination remains to be verified with the Jomon society in eastern Japan.

Besides investigations on their primary social units, Jomon societies have been studied from the perspective of social stratification (e.g. Watanabe 1990; Kobayashi 1996; Nakamura 1999). The stratification of Jomon society was argued by Watanabe Hitoshi who systematically used ethnographic analogy referring to socially stratified hunter-gatherers from areas surrounding the North Pacific Rim (Watanabe 1990). The problem of social stratification was approached in terms of increasing grave goods, specifically those given for child graves in the Tohoku region from the Late to Final Jomon periods (Nakamura 1999), and the existence of specific ornaments placed on limited numbers of individuals (Kobayashi 1996).

However, although these arguments focused on the vertical differentiation of the society, another viewpoint exists on the stratification of society regarding its complexity of vertical and horizontal differentiations, in particular the inter- and intra-clan differentiation. For example, as a society becomes more vertically differentiated, individuals interred in specifically high-ranking cemeteries are expected to be more strictly limited to members of a specific clan and lineages within a community according to inter- and intra-clan differentiation (cf. Tanaka 2000). Although principles for selecting individuals to be buried in atypical cemeteries will be an important clue towards understanding societies in terms of their vertical and horizontal complexities, the constitutional differences among cemeteries of the Jomon Period have only been examined in western Japan (Tanaka 2000, 2001, 2008a, 2008b). Because of the abundance of skeletal remains, focusing on the differences in cemetery compositions will also contribute to evaluating social complexities of human groups living in the eastern part of the archipelago.

This paper analyses one prominent cemetery site of the early half of the Late Jomon Period (Late Jomon Period: 2500–1200 cal BC), the Shimo'ota shell mound, located in the Kanto Area. It examines the composition of the cemetery, either based on a specific or non-specific settlement by analysing burial distribution and tooth crown measurements by which biological affinity of buried individuals can be estimated.

Model, material and methods

Model: Types of cemetery

This investigation incorporates the two cemetery types proposed by Tanaka which are described below (cf. Tanaka 2008a, p. 55).

Type 1 is a typical cemetery, wherein social groups constituting a settlement were buried. Type 2 is an atypical cemetery, wherein individuals selected from different

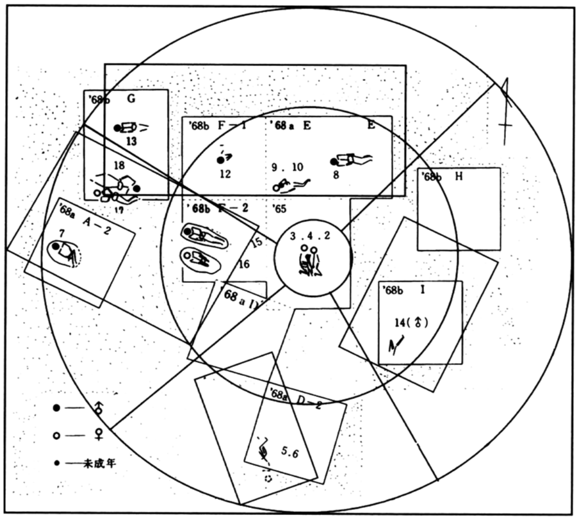

Figure 1. Example of the atypical type of cemetery: the circular cemetery of the Yamaga shell mound (Tanaka 2008a, p. 54)

settlements were buried (Figure 1). The latter type of cemetery can be evaluated as one for specific individuals selected by specific principles, such as social rank, social status, kinship and gender.

These two cemetery types are hypothesised based on previous findings of different kinds of settlements and cemeteries (Kobayashi 1986). The typical cemetery type is expected to correspond to the ordinary settlement. On the other hand, there are atypical cemeteries, such as stone circles and circular-banked cemeteries. They are thought to be regional core cemeteries (Kobayashi 1986; Tanaka 2008a), because parts of them were used as ceremonial places and located at regular intervals (Matsunaga 1998). These cemeteries are thought to correspond to the atypical cemetery type in the hypothetical model discussed above. This kind of cemetery is hypothesised as one for selected individuals from the regional society because of its characteristics as the core cemetery and ceremonial place.

We hypothesise that test results will reflect the constitutional differences between the two cemetery types. The first type is expected to include individuals with a high degree of biological affinity. The atypical/specific type of cemetery is thought to include individuals who have more distant biological affinity than expected in the typical cemetery type. This hypothesis can be tested by use of tooth crown measurements. Details of the methodology are presented in the following section.

Material

The cemetery examined is the Shimo'ota shell mound located in the central part of the Boso Peninsula in the Kanto Area (Figure 2). Three research areas were excavated from 1997 to 1999 (Figure 3, 茂原市教育委員会Mobara City Board of Education 2003). More than 100 skeletal remains from the early half of the Late Jomon Period were excavated in research area No. 1. Most individuals were interred in single primary burials. In

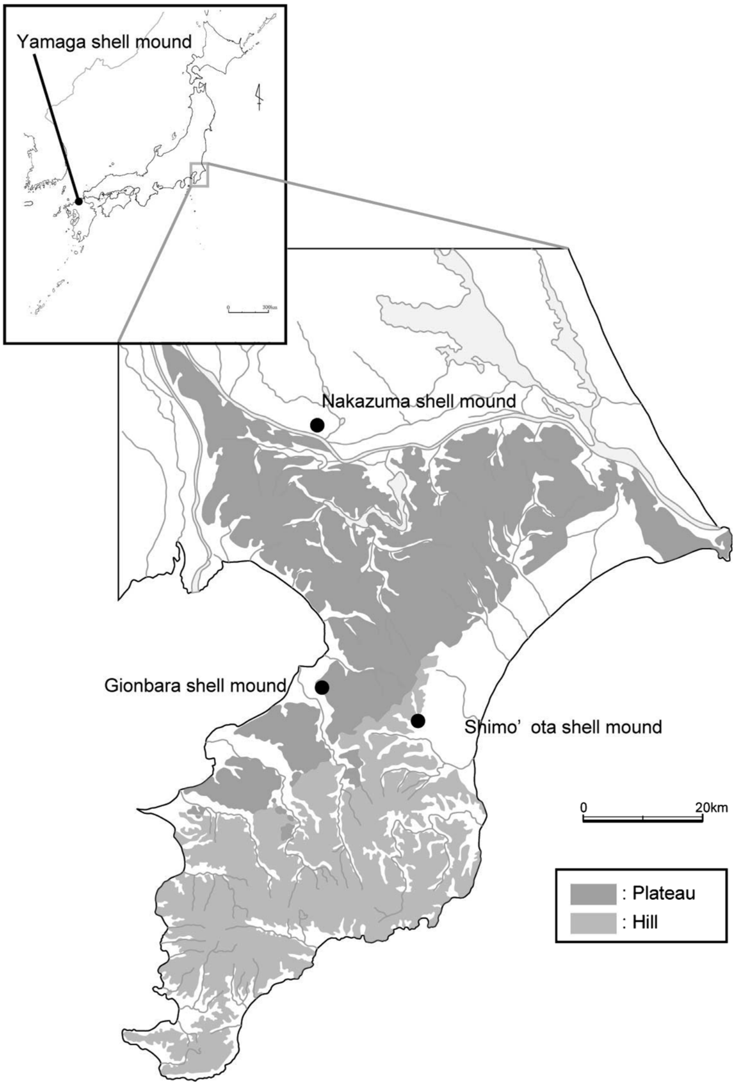

Figure 2. Locations of sites

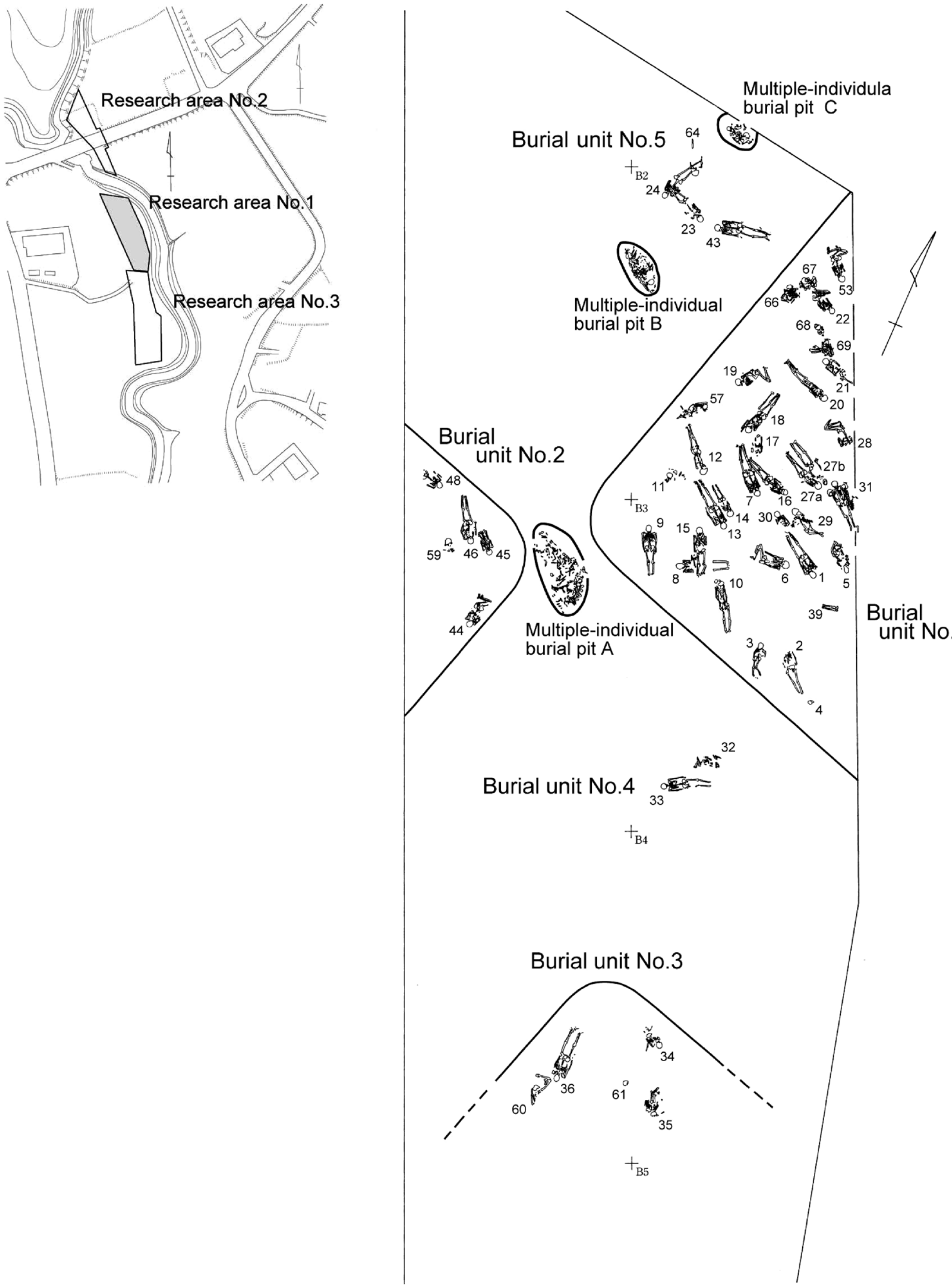

Figure 3. Burial distribution and reported burial units in research area No. 1 (S=1/200, modified from Sugaya 2000, p. 815) With kind permission from Mobara City Board of Education.

Table 1: Burial type and number of skeletal remains in the Shimo'ota shell mound

Burial type	Adult			Nonadult			Total
	Male	Female	Sex unknown	Adolescence	Child	Fetus	
Individual primary burials	12	12	5	0	4	0	33
Reburials	4	1	0	0	1	0	6
Multiple-individual reburial pits	12	8	13	4	14	0	51
	28	21	18	4	19	0	90

addition to these individual primary burials, several secondary burials (No. 66 to No. 69) contained disarticulated individuals, of which five adults and one child were found. In addition to these, three multiple-individual burial pits contained 9–32 individuals who had been reinterred. These two kinds of reburials are distinguished by the number of individuals included and their locations in the cemetery area. The number of individuals interred in each burial type is shown in Table 1. Reported Q-mode correlation coefficient scores (Combination of teeth: Upper P^1, P^2, M^1. Kato & Matsumura 2003, p. 199) are used for the statistical analyses of tooth crown measurements.

Method 1: Analysing the spatial organisation of the Shimo'ota cemetery

Three different analyses were conducted from an osteoarchaeological perspective. The spatial distribution of burials within the research area was examined based on analysis of body orientations, and their relationships to sex differences and locations of the multiple-individual secondary burial pits. Analyses of the spatial organisation will contribute to the eventual discovery of meaningful spatial units in the cemetery.

Method 2: Analysing tooth crown measurements

Analyses of tooth crown measurements were used to estimate biological affinity among the skeletal remains. The pioneering work of Hanihara *et al.* (1983) showed that mesiodistal diameter measurements of the tooth crown are a reliable indicator of biological kin relationships between individuals. Doi *et al.* (1986) refined this method by adding measurements of buccolingual diameter and identifying useful combinations of teeth by analysing modern samples for which they could control biological affinity. They then applied this method to reconstructing kinship among individuals buried in tunnel tombs from the late Kofun Period (*ca.* 6^{th} to 7^{th} centuries AD). A tunnel tomb is a type of mounded tomb constructed by digging a chamber tunnel in the hill slope and mountainous area that dates from the middle of the 5th to 7th centuries AD. The tunnel tombs were constructed with entrance features and passages for reuse. Thus, as a general mortuary process, several individuals were sequentially buried in the same chamber over several generations.

Sequential interments in the same chamber left several archaeological signatures, such as depositional sequences of the passage, skeletal arrangements, and assemblages of sue wares. This archaeological evidence enables us to reconstruct the intervals between each interment in cases when the tombs were well-preserved. Based on the reconstruction of sequences and interment intervals within a chamber, generational relations between individuals were hypothesised to correspond with the results of tooth crown measurements.

The osteoarchaeological use of this method is based on contemporary clinical studies of the relationship between tooth crown measurements and kin relation. Collecting modern control samples of both kin-related and unrelated individuals with various combinations of teeth, studies compared Q-mode correlation coefficients scores of each pair of individuals and concluded that a value of more than 0.5 can be used as a criterion for estimating kin relations to within the third degree of consanguinity (Doi *et al.* 1986). In addition to information on age and sex, studies examined archaeological information as mentioned above to construct hypothetical models of the composition of burial generations. By testing the hypothetical models using tooth crown measurements, kinship was reconstructed between individuals buried in a tunnel tomb (e.g. Tanaka 1995).

In contrast to the circumstances of tunnel tombs of the Kofun Period, it is difficult or impossible to infer certain sequences and time intervals among primary grave pits or interments in the communal cemeteries of the Jomon Period. Moreover, the duration of use in most cemeteries of the Jomon Period is difficult to estimate because not all graves contain burial goods.

These conditions make it difficult to apply the method for estimating kinship using tooth crown measurements similar to the studies from the Kofun Period. As long as it is difficult to estimate the duration of cemetery use, we must consider the possibility of morphological resemblances seen in tooth crown measurements attributable to accidental resemblance. An effective technique for addressing this problem is to compare statistical differences between average scores of the Q-mode correlation coefficient of an archaeological sample and a biologically unrelated modern control sample by using the t-test (Tanaka & Doi 1987; Tanaka 2008a). A significant difference between the two average scores of the Q-mode correlation coefficient indicates that an archaeological population contained a certain number of individuals with close biological affinity, although any concrete kin relation between each pair of individuals is unknown. In contrast, an insignificant difference between the two average scores signifies the

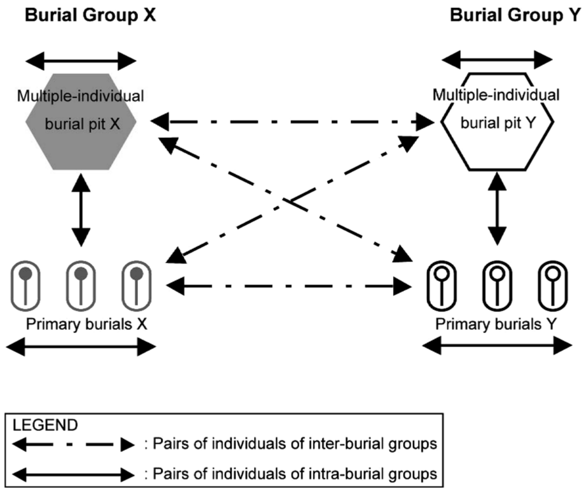

Figure 4. Categories of pairs of individuals by archaeological entity

possibility that an archaeological sample contains fewer individuals with close biological affinity.

Before statistically comparing average scores of the Q-mode correlation coefficient, it is necessary to examine the adequacy of the spatial groups, including individual primary burials and multiple-individual burials. In accordance with the complex of primary individual burials and multiple-individual burial pits, pairs of individuals in the analysis of tooth crown measurements varied. Those pairs can be categorised by inter- and intra-burial groups, inter- and intra- burial types of individual primary burial and multiple-individual reburials (Figure 4). These various categories of pairs are expected to include both useful and less useful pairs for estimating biological affinity among a sample population.

Based on analysis of the spatial distribution of burials, primary individual burials are grouped with other primary burials and multiple-individual burial pits. Comparisons of averages of Q-mode scores of pairs of individuals in primary burials with those in multiple-individual burials are used to evaluate the adequacy of the archaeological grouping. Whole pairs in each category (Figure 4) are then compared by frequencies of Q-mode scores for the same purpose.

Method 3: Examining arrangements of skeletal remains in multiple-individual reburial pits

Although the above analysis is useful for estimating the structure and contents of a cemetery used over a long period of time, two possibilities can potentially account for an insignificant result between the average scores of the Q-mode correlation coefficient of an archaeological sample and those of a non-kin modern control sample. One possibility is that the archaeological sample includes a smaller number of individuals with positive biological affinity. The second prospect is that even though a certain number of individuals with close biological affinity are included in the archaeological sample, a decrease in the Q-mode average scores can result from a long span of successive generations. This would make it difficult to find any significant differences in the modern control sample.

Fortunately, articulation of the skeletal remains in multiple-individual secondary burial pits can help us choose between these two possibilities because the degree of preservation of articulated body parts enables us to estimate the relative length of generation depth among them.

The articulation of body parts represented by skeletal remains was previously mentioned as a trait seen in some multiple-individual reburial pits in this region (Sugaya 2007, p. 114). Differing rates of soft tissue decomposition from different body parts can play a role in estimating the relative generation depth of individuals reburied in multiple-individual pits. Because more persistent body parts are expected to be preserved more frequently in secondary burials than other parts that decay earlier, they will contribute to the relative estimate of generation depth. In contrast, we can use the disarticulation-prone body parts for identifying individuals reburied after a short-term interval after primary interment (cf. Duday 2009, p. 26).

Differences in the persistence of body parts was seen in research of ossuaries in the north-eastern region of North America, wherein the frequencies of articulated bones differed by body part (Ubelaker 1974; Williamson *et al.* 2003). Bones of the foot, leg (tibia and fibula) and thoracic vertebrae were reported as most frequently articulated in Ossuary II of the Nanjemoy Creek Juhle site (Ubelaker 1974, pp. 28–31). The lumbosacral joint, pelvis and ankle were also frequently articulated in the Ossuary (Ubelaker 1974, pp. 28–31). In contrast, bones of the hip joint, shoulder, elbow and knee were articulated less frequently (Ubelaker 1974, pp. 28–31). Similar patterns were reported in the Moatfield Ossuary in Toronto, Ontario (Williamson *et al.* 2003). In general, parts supporting the body weight are persistent (lumbar vertebrae, lumbar-sacrum, pelvis (sacro-iliac vertebrae), knee, ankle and tarsal-metatarsal (Lisfranc joint) (Duday 2009, p. 27). These observations are mutually consistent and also partially correspond to forensic cases, wherein the vertebral column was reported as the part preserved most frequently in the primary location of the corpse (Haglund 1997, p. 391).

Aside from these differences between the relative persistence of articulations, the decomposition rate is another critical problem for estimating the longevity of generations included in a multiple-individual reburial pit. This is because various factors originating from natural and artificial agents and their interrelation contribute to decomposition rates (Mann *et al.* 1990; Rodriguez 1997; Roksandic 2002; Duday 2009).

Several estimates have been made for the decomposition rates of certain body parts, such as eleven months for knee joints (Duday 2009, p. 26), and eight months for lower legs and foot bones (Ubelaker 1974, p. 67). Several ethnological examples can also be useful for the estimating decomposition rates in archaeological cases. Based on ethnological reports of exhumations of primary burials in preparation for secondary burials in several areas of the Japanese archipelago (Ito 1979; Nagata 1979), Tanaka estimated that remains take approximately ten years to be completely skeletonised (Tanaka 1995, pp. 69–70). Although estimates of decomposition rates in forensic studies vary (e.g. Furuhata 1964; Ikeda 2006), useful estimates state that decomposition of ligaments and cartilage takes approximately three to four years, and a body buried underground becomes completely skeletonised after seven to ten years (Hojyo *et al.* 1958, p. 48).

Because Ubelaker's (1974, p. 67) estimation was based on the assumption that a body was buried in the death house or scaffold until reburial or the 'feast of the dead' (Twaites 1896–1901, JR 10: 278–303), the decomposition rate was estimated to be very short.

Although accurate estimates of decomposition rates remain to be determined, it is plausible to estimate that the decomposition of remains takes well under ten years. In other words, an individual dead for over ten years is expected to be skeletonised. This means that it is difficult to use states of body part articulation to discern the length of intervals among individuals buried for more than ten years before secondary inhumation. For example, we cannot distinguish between individuals buried for 20 years from those buried for 30 years just by the arrangement of their skeletal remains. In spite of these problems and limitations in estimating the post-mortem interval, the occurrence of articulated body parts and their frequency are expected to provide partially useful information for estimating the relative depths of generations, if the death rate is assumed to be constant over the generations. The longer the depth of generations contained in a secondary burial, the lower the percentage of articulated individuals is expected to be and vice versa (Figure 5).

For a comparative estimate of the depth of generations in secondary burials of the Shimo'ota shell mound, the same kind of secondary burial excavated from the Nakazuma shell mound is used. Individuals in this burial pit were estimated by the analyses of tooth crown measurements to include several biologically related groups (Matsumura *et al.* 1996; Funahashi 2009). Comparing the state of articulation of remains in the secondary burial pits at both sites allows us to determine differences in the relative generation depth of each reburial pit.

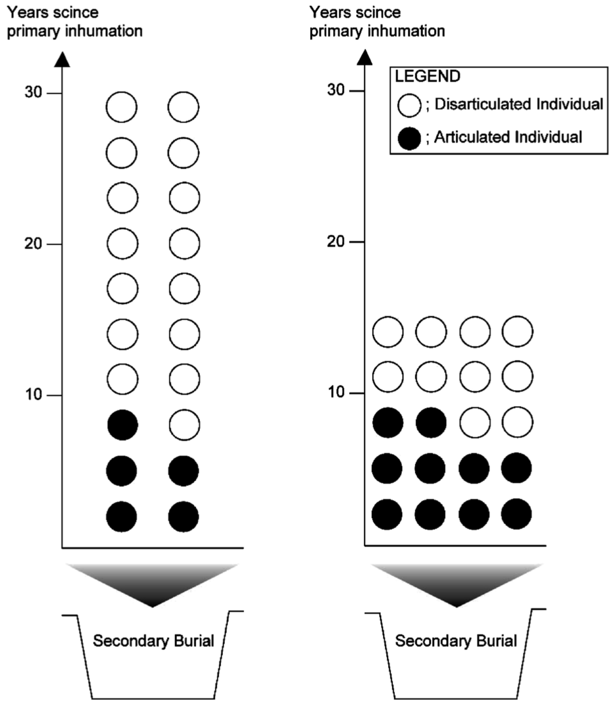

Figure 5. Post-mortem decomposition and depth of successive generations in multiple-individual burials

Analyses and results

Site formation processes

The Late Jomon Period cemetery was initially thought to be divided into five units of graves based on the spatial distribution of burial pits (Figure 3). Despite this classification of burial units, water flow was found to have disturbed a substantial part of the research area except for the central part (Figure 6, Mobara City Board of Education 2003). Because of the disturbance of the later site formation, the distributional pattern uncovered by the excavation should not be considered a direct reflection of the original spatial organisation of the cemetery area. Although it is difficult to reconstruct the original spatial organisation from the disturbed and fragmentary distribution of graves, several other cemetery sites in the Kanto area also comprise a complex of primary burials and multiple-individual secondary burials similar to the Shimo'ota shell mound. The Gionbara shell mound (Figure 2) is one such site. Individual primary burials are distributed to form circular cemetery areas, each centred around a multiple-individual secondary burial (cf. Yamada 1995, p. 58; Ishikawa 2011). In light of this spatial pattern,

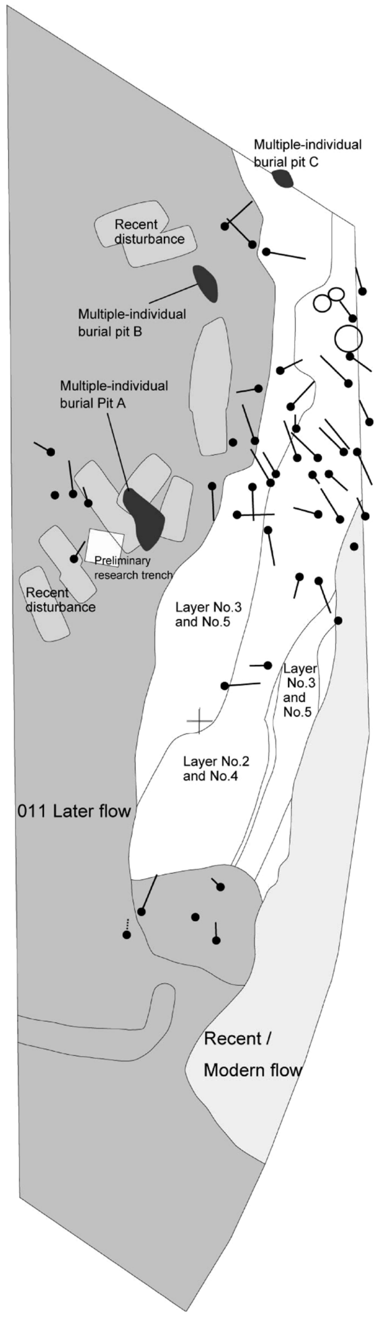

Figure 6. Burial distribution and site formation of research area No. 1 (S=1/250, modified from Mobara City Board of Education 2003, pp. 28, 29, 39) With kind permission from Mobara City Board of Education.

burial distributions of the Shimo'ota shell mound can be evaluated differently.

Re-examination of the cemetery spatial structure

Distribution of burials and body orientations

Body orientation in burials is thought to be among the possible clues for reconstructing the spatial pattern of cemeteries. Several variations in body orientation were found among individuals in the research area. Observing the variations of body orientation in accordance with the burial units established in the research report, I found that burial unit No. 1 included two main orientations, type 1 (north-west) and type 3 (east-south); and two minor methods, type 2 (west-south) and 4 (north-east, Figure 7). Most interments among the burial units other than No. 1 are oriented to the south (Figure 7).

Assuming that the spatial pattern of the cemetery is circular with a multiple-individual secondary burial area at its centre, variations in body orientation can be evaluated in another way: Types 1 and 3 in burial unit No. 1 can be considered to follow concentric circles surrounding the multiple-individual secondary burial pit A (Figure 8). The same pattern can be observed in burial unit No. 2. Although some variations do not follow these circular lines, such as individuals in Nos. 6, 8, 18 and 57 in burial unit No. 1, and individual No. 48 in burial unit No. 2, these minor variations can be argued to follow the concentric circles formed around multiple-individual burial pit B (Figure 8).

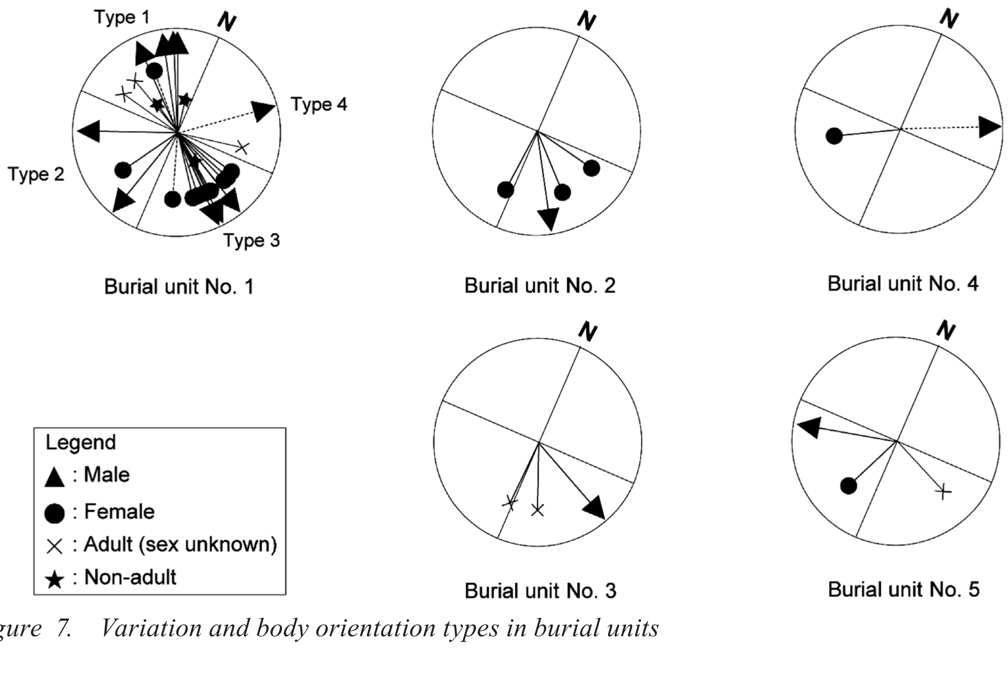

Figure 7. Variation and body orientation types in burial units

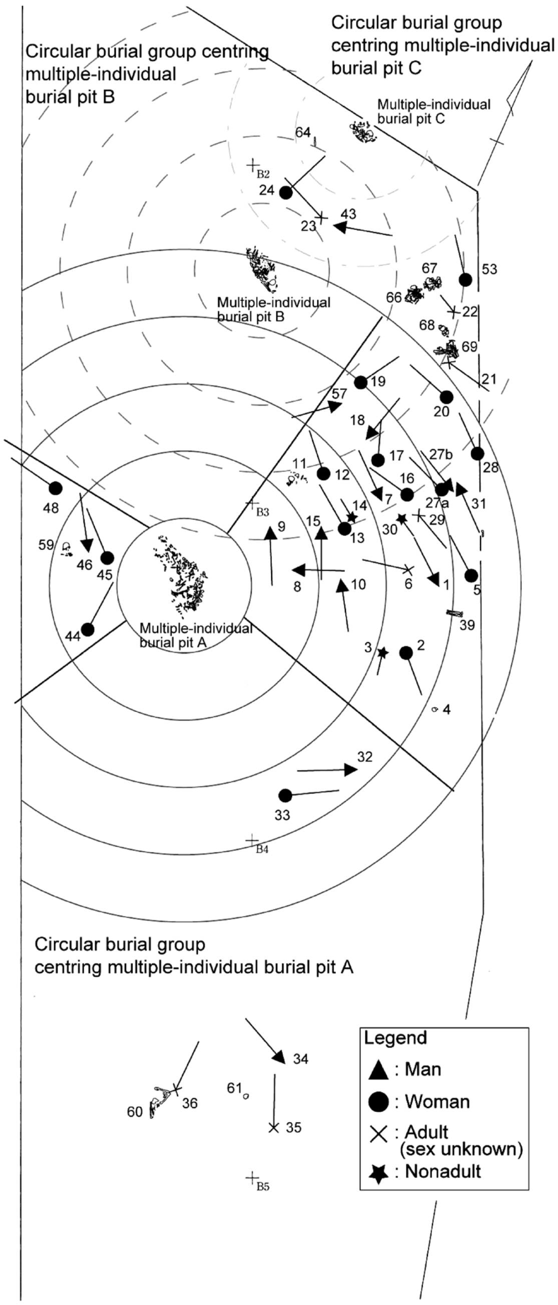

Figure 8. The circular spatial organisation of the Shimo'ota shell mound (S=1/200, modified from Mobara City Board of Education 2003, p. 39) With kind permission from Mobara City Board of Education.

Despite the disturbance of the later water flow, I can discern from these observations that the cemetery was organised in a circular arrangement. Based on the assumption of a circular cemetery organisation centred around multiple-individual reburial pits A to C, the burials can be re-classified into three groups, burial groups A through C. However, those in burial group C are unclear because of the marginal location of multiple-individual reburial pit C.

Body orientations and sex differences

We had a sufficient number of samples to evaluate the relationship between body orientations and sex differences only in the north-western part of burial group A. Body orientation type 1 is seen mainly in the southern half of the area, in contrast to body orientation type 3 which mostly appears in the northern half with several deviant individuals. Adult males dominate type 1 (male: 4, female: 1, adult sex unknown: 2, child: 2) in contrast with type 3 (male: 3, female: 9, adult sex unknown: 1, child: 1), wherein females are predominant. Nevertheless, no statistical difference is evident between body orientation types 1 and 3, and sex difference (p=0.10068). Based on this spatial distribution of the body orientation types within part of the circular cemetery area, the cemetery area of burial group A could possibly be composed of several segmental units divided by different body orientations but not significantly related to the sex difference.

Re-examination of tooth crown measurements

In the research report for this site, Kato and Matsumura estimated that the individuals in multi-individual secondary burials were related by kin, because a sufficient number of pairs had Q-mode scores over 0.5 (Kato & Matsumura 2003, p. 185). However, as previously mentioned, we should examine the Q-mode score averages by comparing them with a non-kin control sample to eliminate accidental similarities expected in cemeteries used over long periods of time.

A preliminary test of archaeological groupings of burials

I first conducted a preliminary examination of the adequacy of burial groups reconstructed by spatial analysis. Among the four primary individual burials undergoing tooth crown measurement, three individuals (S20, S48 and S53) can be classified by their body orientations as coming from either burial group A or B. According to the circular cemetery plans, S20 can be classified as part of burial group A and S48 and S53 as part of burial group B. Average scores of the Q-mode correlation coefficient of these individuals paired with those reburied in the multiple-individuals reburial pits A and B can be used to verify the archaeological groupings. As shown in Table 2, the averages of pairs containing individuals in the same burial group tend to be higher than those of the pairs from different burial groups. This includes pairs from S20 of burial group A and

Table 2: Mean values of the Q-mode coefficient correlation in pairs between individuals from primary individual burials and multiple-individual burial pits A and B

Pairs	Number of pairs	Mean	Std
Burial group A: S20*Multiple-individual A	7	0.239	0.333
S20*Multiple-individual B	3	−0.289	0.291
Burial gorup B: S48*Multiple-individual B	3	0.005	0.463
S48*Multiple-individual A	7	−0.106	0.689
Burial group B: S53*Multiple-individual B	3	0.295	0.628
S53*Multiple-individual A	7	−0.312	0.500
Burial group B(1): S66*Multiple-individual B	3	0.119	0.145
S66*Multiple-individual A	7	−0.284	0.511

(1) Reburied individual of S66 is classified in burial group B by high mean value seen in the pairs with individuals of mutiple-individual burial B, as the body direction of this individual is unknown.

those buried in multiple-individual burial pit B, although the pairs of samples are limited in number. This tendency signifies in part the adequacy of burial groups estimated by the distribution of graves and body orientations. Based on this pattern, reburied individual S66 can be classified as part of burial group B because of its higher average when paired with individuals of multiple-individual burial pit B rather than those of pit A (Table 2).

A similar pattern is seen in the frequencies of the Q-mode correlation coefficient of pairs between the inter-burial groups (Figure 9, category 2-1) and intra-burial groups (Figure 9, category 2-2) of A and B which were calculated from a total of 91 pairs of individuals (Figure 10-1). Pairs containing individuals from different burial groups showed a higher frequency of lower Q-mode scores than pairs of individuals from the same burial groups (Figure 10-2). This means that the pairs between the intra-burial groups are expected to be meaningful for analysing biological affinity of the sample population.

These pairs (category 2-2) can be divided into two categories of paired individuals from burial groups A and B. The numbers of pairs of individuals in each burial group was further divided according to the categories indicated in Figure 9 (burial group A: categories 4-1, 2, 3; burial group B: categories 4-4, 5, 6). Among these categories of paired individuals, the Q-mode scores of pairs of individuals from primary burials (S48, S53 and S66) of burial group B (Figure 10-4, pair 4-6) had a relatively limited distribution in a higher range; however, the number of pairs is limited. Apart from this category of pairs in burial group B, most categories of pairs from both burial groups A

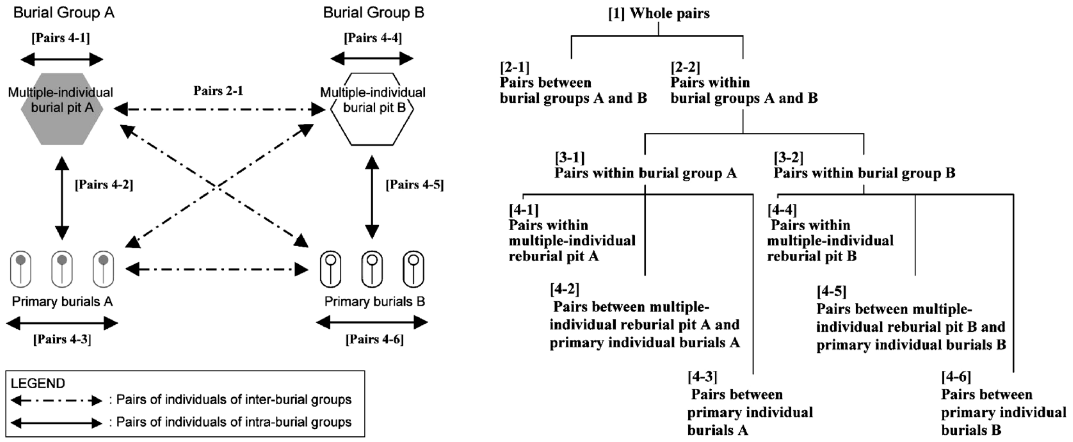

Figure 9. Categories of pairs of burial groups and the hierarchical relationship among categories

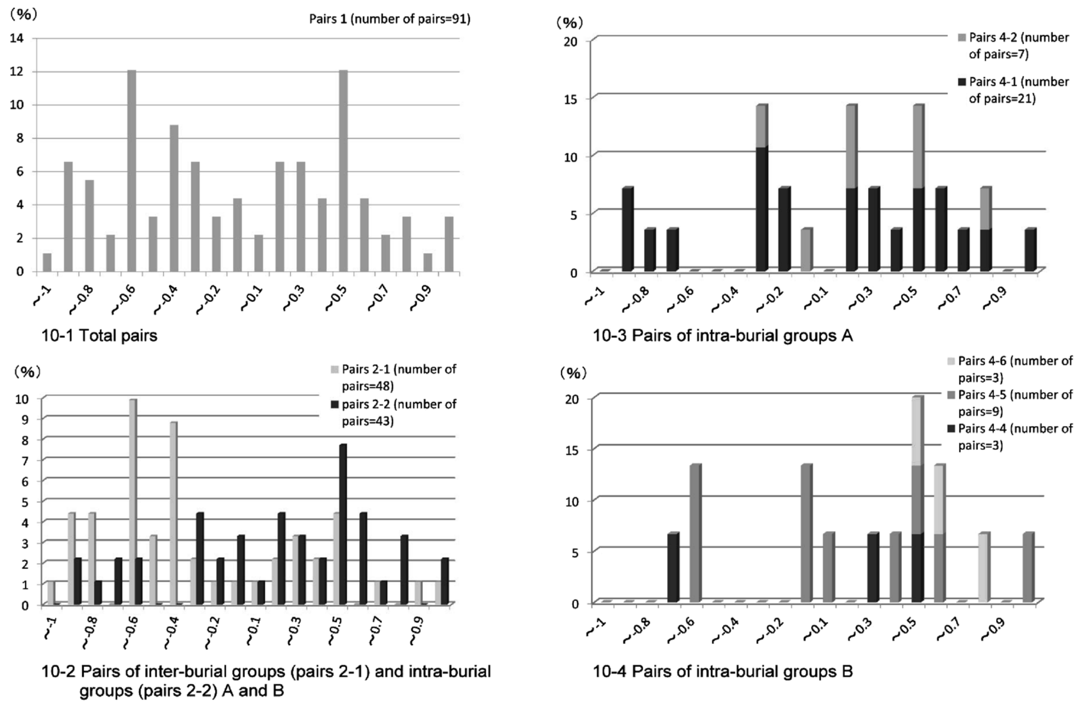

Figure 10. Frequencies of the Q-mode correlation coefficient

Table 3: Statistical test of the mean values of the Q-mode coefficient correlation

Category of pair	Number of pairs	Mean	Significance
Category 1 : Total pairs	91	−0.0564	
Category 2-1 : Between burial groups	48	−0.2322	
Category 2-2 : Within burial groups	43	0.1399	
Category 3-1 : Burial group A	28	0.1089	
Category 3-2 : Burial group B	15	0.1978	
Category 4-1 : M-I burial pit A	21	0.0656	
Category 4-2 : M-I burial pit A*Primary burial in group A	7	0.2390	
Category 4-4 : M-I burial pit B	3	0.0007	
Category 4-5 : M-I burial pit B*Primary burial in group B	9	0.1398	
Category 4-6 : Primary burial in group B	3	0.5689*	
Non-related modern control sample	200	0.019	

Sources of the non-related modern control sample is from Tanaka *et al.* 1987.
Mean values were calculated from the Q-mode correlation coefficient scores reported by Kato and Matsumura 2001 (Combination of teeth: Upper $P^1P^2M^1$).
Significance level $\alpha<0.05$; *, $\alpha<0.01$; **

(Figure 10-3, Category of pair 4-1 and 4-2) and B (Figure 10-4, Category 4-4 and 4-5) included a similarly wide range of Q-mode scores rather than obviously different ranges.

Comparing the averages of Q-mode correlation coefficient scores

Most results of the statistical significance test using the reported Q-mode scores (Kato & Matsumura 2003, p. 199) were negative (Table 3). Calculations were conducted in various categories, such as the entire sample and various pairs categorised by burial groups A and B. Although only pairs between those in primary individual burials in burial group B (category 4-6) differed significantly from the non-kin control group, the number of pairs was limited. No other categories of pairs differed significantly with the control non-kin sample.

Articulation of skeletal remains and the relative depth of generations

Articulated body parts in pit B of the Shimo'ota shell mound

As mentioned in the methodological discussion, if averages of Q-mode scores among an archaeological sample do not differ significantly from the non-kin control sample, two possibilities arise. The result could indicate that an archaeological sample includes fewer individuals with close biological affinity. Similarly, the result could reflect actual biological affinity among reburied individuals obscured by the repeated, long-term interment of successive generations. Skeletal arrangements in multiple-individual

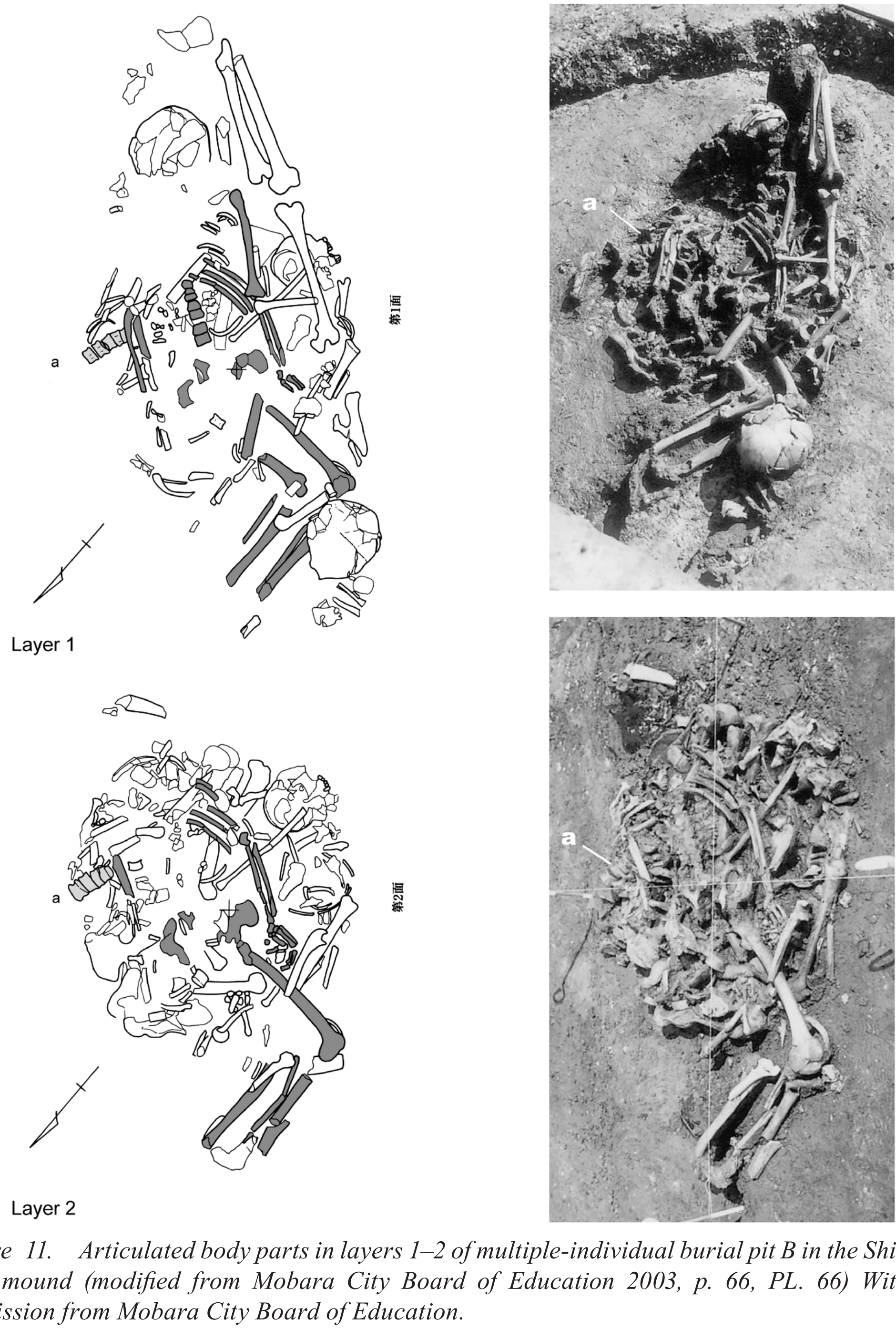

Figure 11. Articulated body parts in layers 1–2 of multiple-individual burial pit B in the Shimo'ota shell mound (modified from Mobara City Board of Education 2003, p. 66, PL. 66) With kind permission from Mobara City Board of Education.

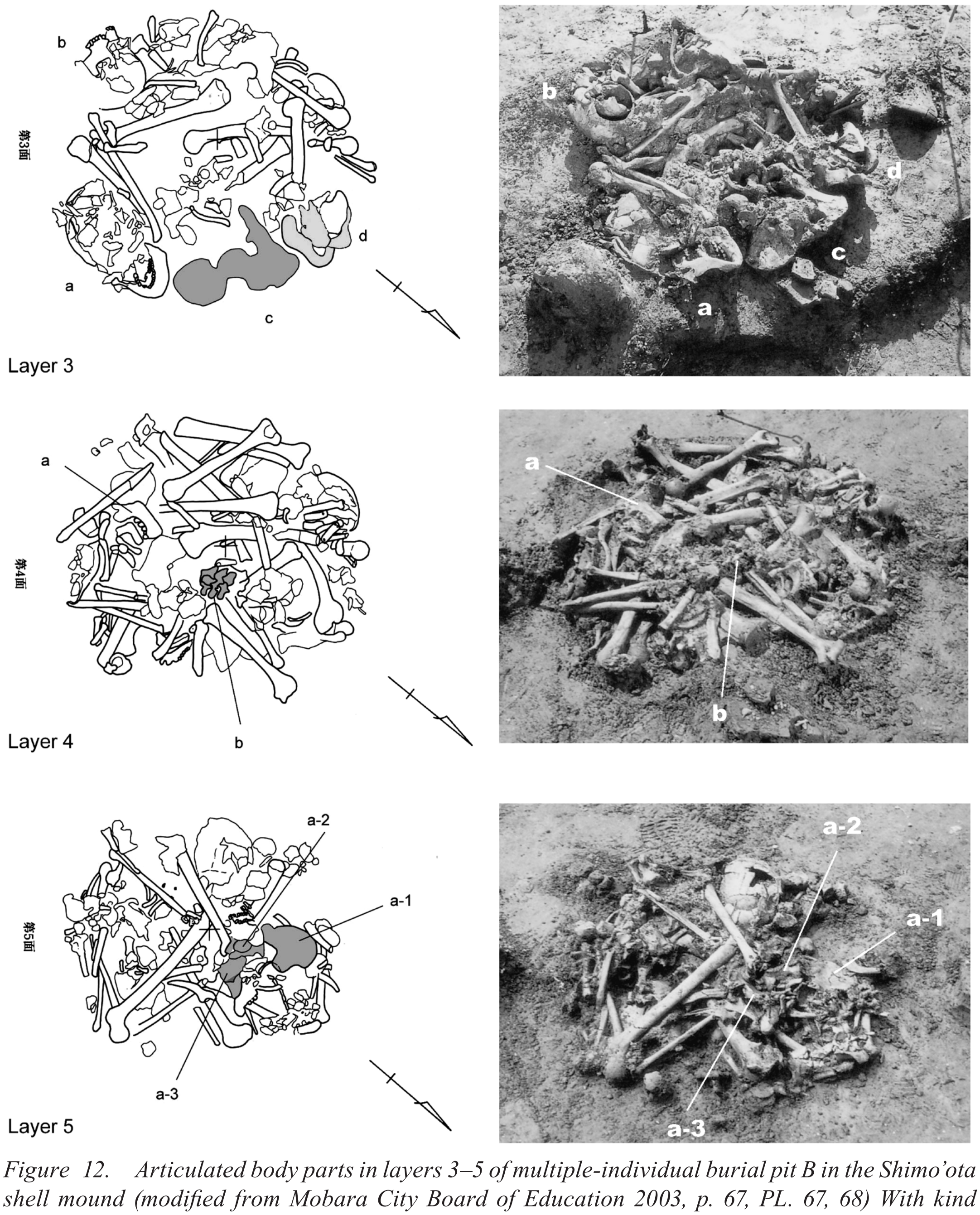

Figure 12. Articulated body parts in layers 3–5 of multiple-individual burial pit B in the Shimo'ota shell mound (modified from Mobara City Board of Education 2003, p. 67, PL. 67, 68) With kind permission from Mobara City Board of Education.

secondary burial pits are expected to play a role in identifying the correct possibility.

First, I will summarise earlier field observations related to this point to complement the following examination with second-hand information of reported figures and photographs. In general, arrangements of skeletal remains involved a large number of partly articulated bones, although a few were anatomically dissociated in their location (Mobara City Board of Education 2003, p. 63). The articulated parts were reported to be sections of vertebral columns as well as several ribs which were preserved in anatomical order in pit B. In pit A, several humerus-radius-ulna and femur-fibula-tibia sets were preserved intact. Field observations indicated that many individuals were reburied before complete decomposition of soft tissue (Mobara City Board of Education 2003, p. 63).

Among the three multiple-individual reburial pits (A, B and C) pit B was sufficiently documented to allow further examination of the arrangement of remains.

Pit B was reported in six layers (Figures 11–12). This pit included nine individuals among which were five adults (male: 3, female: 2) and four adolescents. In the first and second layers, several sets of bones were preserved in anatomical order. One prominent trait in these upper layers was an identifiable individual with most of its post-cranial parts articulated and preserved in anatomical order (Figure 11: dark grey). Beside this individual, there was also part of an articulated vertebral column (Figure 11: a).

In the south-eastern part of the third layer was a cranium with articulated temporomandibular joint excavated and removed (Figure 12: Layer 3, a). There were also two sets of pelves located from the north to north-eastern part of the pit. In the eastern part, a sacrum and ilia were articulated (Figure 12: Layer 3, c), and the other coxal bones were not severely dissociated (Figure 12: Layer 3, d). In addition to these articulated body parts, the other cranium merits attention: it was disarticulated from its mandible, but most of its maxillary dentition was preserved (Figure 12: Layer 3, b). From the fourth to fifth layers, a partially articulated vertebral column (Figure 12: Layer 4, b) and pelvis bones were found, of which the sacrum and ilia were in nearly anatomical connection (Figure 12: Layer 5, a-1, 2 and 3).

Examination of the documented materials of multiple-individual burial pit B indicates that the articulated body parts consist of both of those prone to relatively early decay such as the temporomandibular joint, and those persisting longer such as the sacroiliac articulation and vertebral column (cf. Duday 2009). The pit also included an individual buried after a short post-mortem interval. It is also worth noting that dentition from the maxilla and mandible was preserved in numerous cases, since teeth tend to become dissociated from their alveoli early in the natural disarticulation sequence (cf. Haglund 1997, p. 383).

Comparison with the Nakazuma site

Evaluating the arrangement of skeletal remains from the Nakazuma site is useful for

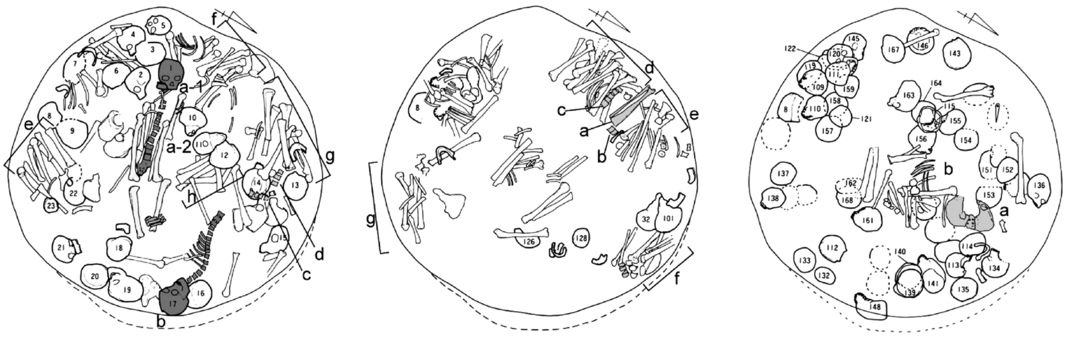

Figure 13. Articulated body parts in multiple-individual burial pit A in the Nakazuma shell mound (modified from Toride City Board of Education 1995, pp. 125, 126) With kind permission from Toride City Board of Education.

comparison between the relative number of generations interred in the multiple-individual burial of the Shimo'ota shell mound. From secondary burial Pit A, 96 individuals were excavated. Among these, 60 adults were identified (male: 41 and female: 19) (取手市教育委員会Toride City Board of Education 1995).

In the uppermost layer, the cranium and vertebral column were articulated in two individuals (Figure 13). According to the research report, most bones were disarticulated, although a few partially articulated bones and sets of metacarpals and metatarsals were found. A number of bundles of limb bones were also found in the pit (Toride City Board of Education 1995, p. 123). From these observations it can be inferred that the 96 individuals were reburied in the pit after most of their body parts had decomposed and skeletonised (Toride City Board of Education 1995, p. 127). In addition, a small number of partly articulated vertebral columns and pelves were seen in the middle and lower levels of the pit (Figure 13). However, the frequency of articulated body parts is low relative to the extremely large number of individuals buried there.

As previously mentioned, pit B of the Shimo'ota site contained a number of individuals whose relatively persistent body parts were articulated as well as several body parts that tend to disarticulate sooner. Comparing the degree of preservation of articulated body parts in the multiple-individual burial pits from both sites, at least the individuals reburied in pit B at the Shimo'ota site are estimated to cover the same or shorter span of generations as those in pit A at the Nakazuma site.

Discussion and conclusion

The cemetery type at the Shimo'ota shell mound

Two types of cemetery, typical and atypical, were described at the beginning of this paper. If the site were a typical cemetery, buried individuals would be expected to have a high degree of biological affinity. In contrast, an atypical cemetery would be expected to include individuals with more distant biological affinity (cf. Tanaka 2008a).

The re-examination of tooth crown measurements from the Shimo'ota population tested these implications by using the average scores of the Q-mode correlation coefficient. Results indicated that the individuals buried in this cemetery do not differ significantly from those in the modern non-kin control sample.

Negative statistical test results raised two possibilities according to the relative degree of decomposition of those who were exhumed and reburied in the multiple-individual burials. Comparing the decomposition rates in the multiple-individual burial pit of the Nakazuma shell mound, in which individuals differed significantly from the modern control non-kin sample, the Simo'ota population was estimated to include successive generations of the same or lesser length of time than the Nakazuma population.

These two data sets, combined with the relatively short period covering the interred generations and the negative results seen most statistical tests using averages of the Q-mode scores with the modern control sample, allow me to consider the possibility that the Simo'ota population included both a large number of individuals with relatively distant biological affinity and a certain number of closely related individuals. Based on this estimate, the cemetery areas of the Shimo'ota shell mound can be classified as the atypical rather than the typical type.

Implications for social complexity during the Late Jomon period

What social structures underlie an atypical cemetery and how does this cemetery type reflect social memberships or principles? The Shimo'ota cemetery area can be reconstructed as comprising several burial groups, each of which has a circular spatial organisation centred around a multiple-individual burial pit. The segmental units divided by body orientation were found within a circular burial group centred around multiple-individual burial pit A, although the spatial segmentations could be examined only in a severely limited area due to disturbance by later water flow disturbance. This inner-segmental spatial organisation signifies that the cemetery was not a simple accumulation of random interment. One of the most plausible social motivations for the formation of the atypical cemetery type might be that its burial groups encompass a larger social group than a settlement which is thought to be the organisational basis of the atypical cemetery type (cf. Tanaka 2008a). The deceased in atypical cemeteries are thought to belong to several different clans, whose segmental units such as lineages dispersed among different settlements and were co-resident with other lineages, originating from different clans (Figure 4).

In the pioneering settlement analyses of the 1960s, segmental units in a settlement and cemetery were of interest and were interpreted relying on various concepts such as family (Mizuno 1969), household (Hayashi 1979) and kin group (Takahashi 1991). After the critical introduction of social anthropology studies after the 1990s (e.g. Tanaka 1998, 1999, 2000; Mizoguchi 2002; Taniguchi 2002), the same phenomenon of segmental units within a settlement/cemetery became to be understood as representing lineages or clan segments. In addition to these arguments on the segmented and multiple-lineage composition of settlements/cemeteries, several researchers argue about the atypical and regional core cemeteries, such as stone circles (Tanaka 1998, 1999). They expect that such a regional core cemetery was the burial place for people originating from different clans and residing in different settlements (Sasaki 1991; Mizoguchi 2002; Tanaka 2008a).

The above results indicating that the Shimo'ota cemetery was the atypical type are consistent with the model of a regional core cemetery with inhumation of individuals selected from different clans and different settlements (Sasaki 1991; Mizoguchi 2002; Tanaka 2008a).

This kind of cemetery composition has implications for the social complexity during the Jomon Period. In recent decades, the stratification of Jomon society is one important theme of studies (e.g. Watanabe 1990; Kobayashi 1996; Nakamura 1999), meanwhile the social complexity is argued to be based on 'the overall egalitarianism' (Mizoguchi 2002, p. 111) with situational leaders (Hayashi 1998; Tanaka 2000; Mizoguchi 2002, 2013). Social stratification can be evaluated by focusing on social complexity in terms of the degree of inter- and intra-clan differentiation (cf. Tanaka 2000). As mentioned above, individuals from different settlements and different clan origins are thought to be buried in the atypical cemetery at the Shimo'ota site. If so, this type of cemetery was formed by several different clans. This multiple-clan communal composition of a cemetery signifies a lesser degree of inter-clan differentiation or egalitarian social complexity. However, the degree of intra-clan differentiation is not clear from the analysis presented here, and it remains to be examined using other, more well-preserved materials.

The society reconstructed from the content of typical and atypical cemetery types is thought to have similar organisational traits to those modelled by R. Keesing for the social and settlement organisation of tribal societies (Keesing 1975, pp. 39–43). In his model, a tribal society forms a multiple-lineage settlement which includes two cases of segmental lineages of the same clan that may or may not be dispersed to several different settlements. Atypical cemeteries and their segmental units correspond to settlements with multiple-lineage constitutions. One proponent trait of a tribal social formation involves

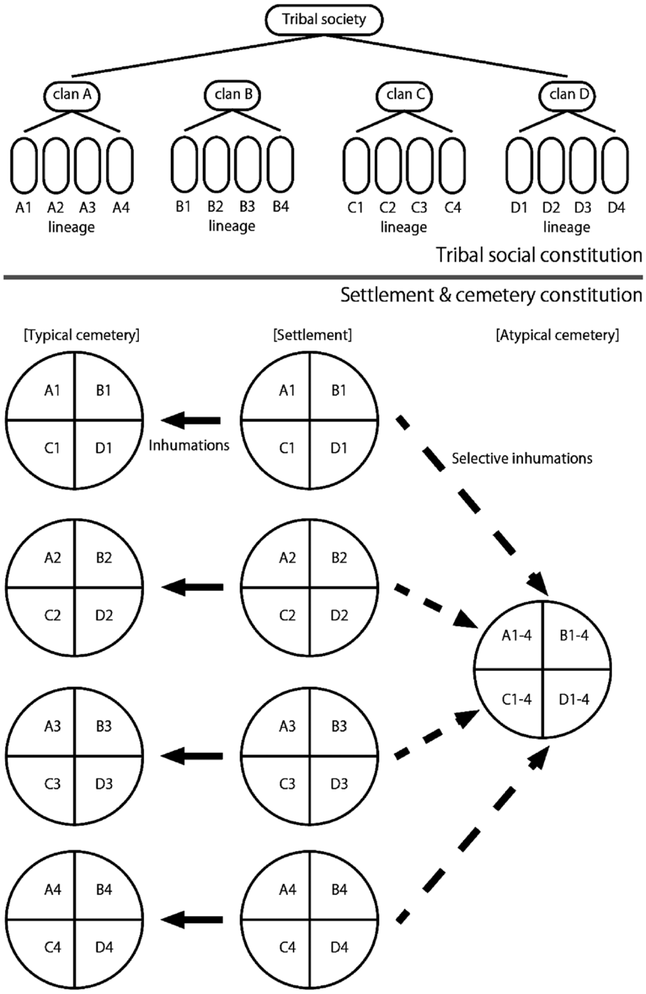

Figure 14. Constitution of tribal society and types of cemetery

the local society that is organised by both segmentation and integration of the clanship sodality (Service 1979). The atypical cemetery seen in the Shimo'ota shell mound corresponds to this social organising principle and segmentation/integration clanship sodality which integrates different clans by forming a cemetery for burying the proponent members originating from different clans dispersed among different settlements.

Based on these evaluations, the different cemetery types can be seen as reflecting the different principles of tribal social formation.

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References

Doi, N., Y. Tanaka, & K. Hunada. 1986. A method for estimation of kinship based on the tooth measurements and its application to the ancient human skeletal remains. *Anthropological Science (Japanese Series)* 94(2): 147–62. (In Japanese)

Duday, H. 2009. *The archaeology of the dead: lectures in archaeothanatology*. Oxford: Oxbow Books.

Funahashi, K. 2009. Reconstructing Jomon society as seen from skeletal remains. *Quarterly of Archaeological Studies* 56(2): 12–27. (In Japanese)

Furuhata, T. 1964. *Concise legal medicine*. Tokyo: Kanehara Press Ltd. (In Japanese)

Haglund, W. 1997. Scattered skeletal human remains: Search strategy considerations for locating missing teeth, in W. Haglund & M. Sorg (ed.) *Forensic taphonomy: The postmortem fate of human remains*: 383–94. Boca Raton, FL: CRC Press.

Hanihara, K., A. Yamauchi, & Y. Mizoguchi. 1983. Statistical analysis on kinship among skeletal remains excavated from a Neolithic site at Uwasato, Iwate Prefecture. *Anthropological Science (Japanese Series)* 91(1): 49–68. (In Japanese)

Harunari, H. 1973. The significance of ritual tooth ablations (1). *Quarterly of Archaeological Studies* 20: 25–48. (In Japanese)

Harunari, H. 1982. Arguments on the Jomon society, in S. Kato, T. Hujimoto & T. Kobayashi (ed.) *Study of the Jomon culture Volume 8 society and culture*: 224–52. Tokyo: Yuzankaku. (In Japanese)

Harunari, H. 2002. *Arguments on the Jomon society*. Tokyo: Douseisha. (In Japanese)

Hayashi, K. 1977. Mortuary practices of the Jomon Period. *Journal of the Archaeological Society of Nippon* 63(3): 1–36. (In Japanese)

Hayashi, K. 1979. The way to recognize villages of the Jomon Period. *Quarterly of Archaeological Studies* 26(3): 1–16. (In Japanese)

Hayashi, K. 1998. Is the Jomon society stratified? in H. Tsude & T. Tanaka (ed.) *Debates in ancient history, Volume 4: Power, state and war*: 87–110. Tokyo: Shogakukan. (In Japanese)

Hirata, K. & K. Hoshino. 2003. A report of the skeletal remains excavated from the

Shimo'ota shell mound, in Mobara City Board of Education (ed.) *Excavation report of the Shimo'ota shell mound*: 1–182. Chiba: Mobara City Board of Education. (In Japanese)

Ikeda, N. 2006. Post-mortem phenomena, in H. Ishizu & M. Takatsu (ed.) *Standard textbook of legal medicine and medical law*: 260–74. Tokyo: Igaku Shoin. (In Japanese)

Ishikawa, T. 2011. The social formation of the late Jomon Period in Japan: From a case of burial site of eastern Kanto Area. *Canadian Archaeological Association 44th Annual Meeting Conference Program and Abstracts*: 71–2. Halifax, Canada.

Ito, H. 1979. Double burial custom with the reburying of skeletal remains of the Takagi in Atsumi Town and the Asadani in Asahi Town, Aichi Prefecture, in T. Doi & Y. Sato (ed.) *Collection of studies on funerary and mortuary practices, Volume 1 funerary practices*: 227–80. Tokyo: Meicho Publication. (In Japanese)

Kato, H. & H. Matsumura. 2003. An estimate of kinship based on the tooth crown measurements of the Jomon skeletal remains excavated from the Shimo'ota shell mound, in Mobara City Board of Education (ed.) *Excavation report of the Shimo'ota shell mound*: 183–99. Chiba: Mobara City Board of Education. (In Japanese)

Keesing, R. 1975. *Kin groups and social structure*. New York: Holt, Rinehart and Winston.

Kobayashi, T. 1986. Primitive settlements, in Y. Kondo & K. Yokoyama (ed.) *Japanese archaeology, Volume 4, settlements and ritual*: 37–75. Tokyo: Iwanami Shoten. (In Japanese)

Kobayashi, T. 1996. *The world of Jomon people*. Tokyo: Asahi Shinbunsha. (In Japanese)

Kobayashi, T. 2004. *Jomon reflections: Forager life and culture in the prehistoric Japanese archipelago* (Edited by S. Kaner with O. Nakamura). Oxford: Oxbow Books.

Mann, R., W. Bass, & L. Meadows. 1990. Time since death and decomposition of the human body: Variables and observations in case and experimental field studies. *Journal of Forensic Sciences* 35(1): 103–11.

Matsumura, H. & T. Nishimoto. 1996. Statistical analysis on kinship of the Nakazuma Jomon people using tooth crown measurements. *Zoo-archaeology* 6: 1–17. (In Japanese)

Matsunaga, Y. 1998. Ritualistic activities in the Jomon and the Yayoi period: From a comparative point of view. *Anthropological Science* 106(12): 106.

Mizuno, M. 1968. The meaning of circular stone monuments. *Shinano* 20(14): 23–31. (In Japanese)

Mizuno, M. 1969. Basic questions for the reconstruction of Jomon settlement. *Kodai Bunka* 21(3/4): 1–21. (In Japanese)

Mizoguchi, K. 2002. *An archaeological history of Japan: 30,000 B.C. to A.D. 700*. Philadelphia: University of Pennsylvania Press.

Mizoguchi, K. 2013. *The archaeology of Japan: From the earliest rice farming villages to the rise of the state*. Cambridge: Cambridge University Press.

Mobara City Board of Education. 2003. *Excavation report of the Shimo'ota shell mound*. Chiba: Mobara City Board of Education. (In Japanese)

Nagata, S. 1979. Funerary customs of cleansing the bones of the dead and aerial burial in the Amami Oshima Island, in T. Doi & Y. Sato (ed.) *Collection of studies on funerary and mortuary practices, Volume 1 funerary practices*: 201–6. Tokyo: Meicho Publication. (In Japanese)

Nakamura, O. 1999. Social stratification in Jomon society on the basis of burial analysis, in T. Kobayashi (ed.) *The world of Jomon archaeology*: 48–60. Tokyo: Asahi Shinbunsha. (In Japanese)

Nishimoto, T., K. Shinoda, H. Matsumura, & M. Sugaya. 2001. Kindred of the population of the Late Jomon Period estimated by the DNA analysis. *Zoo-archaeology* 16: 1–16. (In Japanese)

O'Shea, J.M. 1984. *Mortuary variability*. Orlando: Academic Press.

Rodriguez, W.C. 1997. Decomposition of buried and submerged bodies, in W. D. Haglund & M.H. Sorg (ed.) *Forensic taphonomy: The postmortem fate of human remains*: 459–81. Boca Raton, FL: CRC Press.

Roksandic, M. 2002. Position of skeletal remains as a key to understanding mortuary behaviour, in W.D. Haglund & M.H. Sorg (ed.) *Advances in forensic taphonomy: Method, theory, and archaeological perspectives*: 99–117. Boca Raton, FL: CRC Press.

Sasaki, K. 1991. *History of Japan Volume 1: The beginning of Japanese history*. Tokyo: Shueisha. (In Japanese)

Service, E. 1971. *Primitive social organization: An evolutionary perspective* (2nd edition). New York: Random House.

Sugaya, M. 2000. The Shimo'ota shell mound, in Juridical Foundation of the Historical Documents Studies (ed.) *History of Chiba Prefecture, Volume of Archaeology 1*: 814–21. Chiba: Juridical Foundation of the Historical Documents Studies. (In Japanese)

Sugaya, M. 2007: Multiple-individual burials, in Y. Kosugi, Y. Taniguchi, Y. Nishida, K. Mizunoe & K. Yano (ed.) *Archaeology of the Jomon Period, Volume 9, death and funeral*: 112–21. Tokyo: Douseisha. (In Japanese)

Takahashi, R. 1991. Mortuary practices of the Jomon Period, in R. Yamagishi (ed.) *Mortuary practices of primeval and ancient Japan*: 48–84. Tokyo: Douseisha. (In Japanese)

Tanaka, Y. 1995. *A study of the kinship structure of the Kofun Period*. Tokyo: Kashiwa Shobo. (In Japanese)

Tanaka, Y. 1998. Reconsideration of the concept of descent in Japanese archaeology. *Journal of the Japanese Archaeological Association* 5: 1–18, In Japanese.

Tanaka, Y. 1999. Jomon social organization as seen from pottery. *Bulletin of Kitakyushu Municipal Museum of Archaeology* 6: 1–22, In Japanese.

Tanaka, Y. 2000. Kinship and family as seen from the cemetery, in H. Tsude & M. Sahara (ed.) *Debates in ancient history, Volume 2: Women and men, households and villages*: 132–52. Tokyo: Shogakukan. (In Japanese)

Tanaka, Y. 2001. Reconstructing final Jomon post-marital residential patterns in western Japan. *Indo-Pacific Prehistory Association Bulletin* 21: 43–8.

Tanaka, Y. 2008a. Re-examination of the cemetery in the Yamaga shell mound, in Department of Archaeology, Graduate School of Law & Letters, Ehime University (ed.) *Archaeology of region and culture.* 47–60. Ehime: The Committee for the Celebration of the Retirement of Professor Shimojo Nobuyuki. (In Japanese)

Tanaka, Y. 2008b. *Ancient family as seen from skeletal remains: Kinship and society.* Tokyo: Yoshikawa Kobunkan. (In Japanese)

Tanaka, Y. & N. Doi. 1987. The kinship structure of the cemetery during the Middle Ages in Yoshimohama site, in The Committee for the Celebration of the Retirement of Professor Takashi Okazaki (ed.) *Archaeology and history in East Asia*: 629–50. Kyoto: Dohosha. (In Japanese)

Taniguchi, Y. 2002. The circular settlement and the tribal society: The central area of the archipelago during the Early and Middle Jomon periods, in M. Anzai (ed.) *Papers in the Jomon society Volume 1*: 19–65. Tokyo: Douseisha. (In Japanese)

Twaites, R. Gold (ed.) 1896–1901 *Jesuit relations and allied documents.* 73 vols.

Ubelaker, D. 1974. *Reconstruction of demographic profiles from ossuary skeletal samples: A case study from the Tidewater Potomac*. Washington, D.C.: Smithsonian Institution.

Watanabe, H. 1990. *Jomon stratified society.* Tokyo: Rokousyuppan. (In Japanese)

Williamson, R.F., A. Clish, G.R. Clark, & S. Pfeiffer. 2003. The archaeology of the Moatfield Ossuary, in R. F. Williamson & S. Pfeiffer (ed.) *Bones of ancestors: The archaeology and osteobiography of the Moatfield Ossuary*: 133–59. Quebec: Canadian Museum of Civilization.

Yamada, Y. 1995. Significance of mortuary cases of multiple-individual burials. *Quarterly of Archaeological Studies* 42: 52–67. (In Japanese)

Yamada, Y. 2007. General argument: mortuary practices of the Jomon Period, in Y. Kosugi, Y. Taniguchi, Y. Nishida, K. Mizunoe & K. Yano (ed.) *Archaeology of the Jomon Period, Volume 9, death and funeral*: 3–17. Tokyo: Douseisha. (In Japanese)

Yamada, Y. 2008. *Mortuary practices and society of the Jomon Period as seen from skeletal remains*. Tokyo: Douseisha. (In Japanese)