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VIOLENCE AND CLIMATE CHANGE IN THE JŌMON PERIOD, JAPAN

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Introduction

There is wide agreement that climate change has significantly impacted various aspects of human life throughout history. Recent global warming, it is commonly pointed out, may result in devastating consequences including frequent droughts and the submergence of coastal areas due to rising sea-levels (IPCC, 2013–2014). Prehistoric data also suggest that past lives were strongly influenced by climate change. Almost all scholars agree that lower sea-levels during the last glacial period allowed humans to migrate into previously uninhabited environments, to enter the Japanese archipelago and the New World, for example. Climate change has also caused fundamental societal changes (Dougals et al., 2015; Hoggath et al., 2016); for Japan, a vast amount of literature suggests that climate change has modified lifestyle elements and created challenges that inspired technological innovations such as pottery and stone projectile points (e.g., Anzai, 2014; Kawahata et al., 2017; Morisaki et al., 2015; 2018; Sato and Morisaki, 2011).

Climate change can be an important causal factor for change in human social activities. Some researchers have argued that climate change and warfare have also been closely connected over time and they predict that violent responses will be common in the future (e.g., Ember and Ember, 1992; Hsiang et al., 2011; Keeley, 1996; Meyer et al., 2015; Otterbein, 2004; Scheffran et al., 2012; Zhang et al., 2007). One postulated mechanism involves a lack of food; climate change alters local environments, potentially leading to shortages in environmentally dependent food sources. The transition from the cool, dry climate of the last glacial period to the warm interglacial period has been blamed for the extinction of large mammals, although recent studies suggest that the spread of *Homo sapiens* was the main cause of global size-biased extinction (Smith et al., 2018). Otterbein (2004, pp. 66–68) argued that such a decrease in numbers of big game was an important cause of an increase in violence among prehistoric hunter-gatherers. Meyer et al. (2015, p. 11221) also suggested that frequent warfare found in the LBK culture of Neolithic Europe had been caused partly by climate change events such as drought. Keeley (1996, p. 140, italics added) seems to consider climate change a dominant cause of the frequent occurrence of warfare, saying, "it is becoming increasingly certain that *many* prehistoric cases of intensive warfare in various regions correspond with hard times created by *ecological and climatic changes*." While it is clear that some recent civil conflicts have been strongly influenced by global

climate change and climate change can promote or contribute to warfare in industrialized societies (Hsiang et al., 2011), it should be noted that different socio-cultural systems react differently under similar environmental conditions.

This chapter aims to investigate the effect of climate change in Japanese prehistory, especially on Jōmon culture and society. We review and summarize research on the effect of climate change on Jōmon culture and society in the Japanese archipelago, showing that climate change was probably relevant to many aspects of Jōmon society, especially to decreases in population and the number of large settlements at the end of the Middle Jōmon sub-period. We then demonstrate there is very little evidence for violent behavior during the Jōmon period based on exhaustive bioarchaeological data, suggesting that climate change did not promote violence in the period. Finally, we discuss why climate change was not a significant cause of violent behavior in this period.

Climate change in the Jōmon period

After a brief introduction to the basic character of the Jōmon period, this section summarizes the climate change of this period and its effect on Jōmon culture and society. In particular, we argue that climate change was probably relevant to decreases in population and large settlements in eastern Japan, which started at the end of the Middle Jōmon.

The subsistence system in the Jōmon period (13,000–800 cal BC) was based on hunting and gathering, though Jōmon populations were not stereotypical foragers in having a certain level of sedentariness (especially after the late phase of the Incipient Jōmon sub-period) and in making pottery (Habu, 2004; Imamura, 2000; Matsumoto et al., 2017). The Jōmon was preceded by the Paleolithic period and followed by the Yayoi (800 cal BC–AD 250), an agricultural period when warfare (or large-scale intergroup conflict) probably began in the Japanese archipelago (Nakagawa et al., 2017, n.d.; Sahara, 1986; Hashiguchi, 2007). The Jōmon period is composed of six sub-periods: Incipient (13,000–10,000 cal BC), Initial (10,000–5000 cal BC), Early (5000–3500 cal BC), Middle (3500–2400 cal BC), Late (2400–1250 cal BC), and Final (1250–800 cal BC). Because this chapter aims to explore the relationship between climate change and violence in terms of bioarchaeology, but no human skeletal remains have been found for the Incipient Jōmon, we skip that sub-period in the following discussion.

Climate change as estimated for the Jōmon period generally parallels global trends. During the Holocene Climatic Optimum (9000–5000 BP), warming climate and rising sea-levels created a productive environment for hunter-gatherers in the Japanese archipelago in which large settlements and shell middens formed from the latter half of the Initial Jōmon to the early phase of the Middle Jōmon. Kudo (2012, pp. 109–110) suggests a cooling climate ensued after the latter half of the Middle Jōmon, possibly leading to the 4.2 ka event, a globally identified severe cooling period (deMenocal, 2001). The effects of climate change on sociocultural and ecological aspects of this period have been a major issue in Japanese archaeology, including changes to material culture like pottery-making, projectile point production, population growth or decline, and degrees of sedentism (e.g., Anzai, 2014; Habu, 2004; Habu and Hall, 2013; Kawahata et al., 2017; Kosugi et al., 2009; 2010; Kudo, 2012; Matsui, 2005; Morisaki et al., 2015, 2018; Sato and Morisaki, 2011).

The Jōmon period has received much attention from scholars because climate change in that period was particularly dramatic. First, due to rising sea-levels after the Last Glacial Maximum, the Japanese archipelago was completely separated from the Eurasian continent in the Incipient Jōmon. Subsequently, the sea level fluctuated three to four meters throughout the Jōmon period; however, the timing and degree of sea-level changes were extremely varied across the

Table 20.1 Koyama's (1984) population estimation. Numbers in parentheses are population density per km^2.

Phase	*Initial*	*Early*	*Middle*	*Late*	*Final*
Tohoku	2,000 (0.03)	19,200 (0.29)	46,700 (0.07)	43,800 (0.65)	39,600 (0.59)
Kanoto	9,700 (0.30)	42,800 (1.34)	95,400 (2.98)	51,600 (1.61)	7700 (0.24)
Hokuriku	400 (0.02)	4200 (0.17)	24,600 (0.98)	15,700 (0.63)	5100 (0.20)
Chubu	3000 (0.10)	25,300 (0.84)	71,900 (2.40)	22,000 (0.73)	6000 (0.20)
Tokai	2200 (0.16)	5000 (0.36)	13,200 (0.94)	7600 (0.54)	6600 (0.47)
Kinki	300 (0.01)	1700 (0.05)	2800 (0.09)	4400 (0.14)	2100 (0.07)
Chugoku	400 (0.01)	1300 (0.04)	1200 (0.04)	2400 (0.07)	2000 (0.06)
Shikoku	200 (0.01)	400 (0.02)	200 (0.01)	2700 (0.14)	500 (0.03)
Kyushu	1900 (0.05)	5600 (0.13)	5300 (0.13)	10,100 (0.24)	6300 (0.15)
Total	20,100 (0.07)	105,500 (0.36)	261,300 (0.89)	160,300 (0.55)	75,800 (0.26)

archipelago (Habu, 2004; Kudo, 2012; Tomioka, 2010). For instance, the Kanto area saw a 2.5-meter peak above the present sea level around 4000 cal BC, sea-level rise peaked at 1.5 meters around 1550 cal BC at Matsushima bay in Tohoku, and Okayama in the Chugoku district saw a 3-meter fluctuation in sea level from 2050 to 1000 cal BC (Fujimoto, 1990; Hitoki, 2012; Kudo 2012; Suzuki, 2005).

Such dramatic changes directly affected activities in Jōmon society. For instance, the significant marine transgression in areas such as Kanto in the Initial and Early Jōmon sub-periods (sometimes called the "Jōmon Transgression") is associated with an accelerated use of marine resources (Uetsuki, 2010). Under the warming climate, boreal conifer forests receded to the north and higher altitudes while deciduous broadleaf and evergreen forests expanded, providing a wider variety of seeds and nuts (Habu, 2004). Although evergreen forests covered most of the western part of the Japanese archipelago and advanced in the eastern part of the archipelago during the climatic optimum (Tsuji, 2009), deciduous broadleaf forests dominated in the eastern part of the archipelago on the whole. Population size increased significantly and sedentary settlements developed in the deciduous broadleaf forests of the eastern part of the archipelago; the western part did not experience population growth, intensification of subsistence, and social complexity in the same way, which some have speculated was related to the thick evergreen forest ecosystem (Matsumoto et al., 2017).

Climate cooled at the end of the Middle Jōmon, corresponding to a decline in population size and the collapse of large settlements in the eastern part of the Japanese archipelago. According to Koyama's (1978; 1984) calculation of the number of sites in the Jōmon period, a peak in site numbers—and thus inferred population sizes—is seen in the eastern part of the archipelago in the Middle Jōmon, followed by a radical decline after that sub-period (see Table 20.1). Imamura (1997) also counted the number of dwellings in the Kanto and Chubu areas of the Jōmon period to investigate population dynamics more closely; the results are consistent with Koyama's calculation (see Figure 20.1).

In the eastern part of the archipelago, large settlements such as the Sannai Maruyama site (see also below) disappeared at the end of the Middle Jōmon (Abe, 2008; Kanno, 2017; Matsumoto, 2018a). Based on these observations, climate change has been blamed for population size declines and the collapse of large settlements at the end of this period (e.g., Kodama, 2003; Okada, 2003; Yasuda, 1989); however, a considerable amount of climate data suggest sea levels

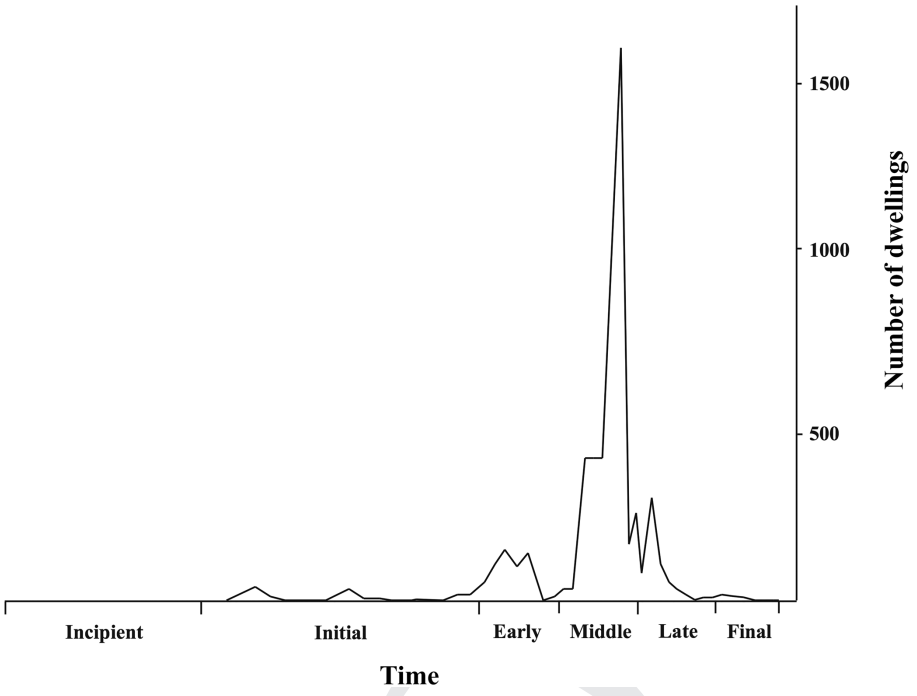

Figure 20.1 The number of dwellings in the southeastern Kanto area per 100 years. From Imamura, 1997.

had regressed and the climate was already much cooler than the Initial and Early Jōmon subperiods (e.g., Habu, 2004; Tsuji, 2009).

Habu (2008; Habu and Hall, 2013) has proposed a more specific relationship between population decline and cooling climate in the late phase of the Middle Jōmon. She focuses especially on the Sannai Maruyama site, located in the northern part of Aomori prefecture, which continued from the middle phase of the Early to the late phase of the Middle Jōmon subperiod. Her analysis of the stone tool assemblage, the number of dwellings, and clay figurines at the site suggested an overdependence on a particular plant food resulted in a loss of variety in subsistence and an increase in vulnerability, so that a short-term fluctuation in climate may have significantly impacted the population and society (Habu, 2017). The stone tool assemblage had become dominated by grinding stones and the numbers of dwellings and clay figurines decreased in the latter half of the Middle Jōmon (*c.* 4800 cal BC), significantly earlier than the 4.2 ka event. A similar explanation could account for population size declines and large settlement collapses in other parts of the Japanese archipelago in the late phase of the Middle Jōmon.

Social factors were certainly partly responsible for the major declines in population and large settlement numbers at this time. A certain level of social stratification for Jōmon society has been assumed (e.g., Hayden, 1995; Sasaki, 2000; Taniguchi, 2017; Watanabe, 1990). It has also been suggested that tension between two conflicting social norms—common ownership and family ownership—helped trigger the social collapse at the end of the Middle Jōmon (Sasaki, 2000). While we would need more evidence to support such a hypothesis for social change, it should be noted that this possibility does not contradict previous claims for the effect of climate

change in the late phase of the Middle Jōmon sub-period. Current evidence supports a role for climate change in changing human activities of the Jōmon period, though we should continue to investigate more specific mechanisms to explain how climate change influenced culture and society. Next, we consider whether climate change also affected violent conflict in the period.

Skeletal remains in the Jōmon period

There is little bioarchaeological evidence for violence during the Jōmon period, suggesting that while climate change corresponds to visible changes in population size, organization, subsistence practices, and material culture for the period outlined above, violence is not a foregone conclusion for human communities facing extreme changes in environmental circumstances. Detailed bioarchaeological data during the period were summarized by Yamada (2006), who examined over 2500 skeletal remains to estimate age at death, mortuary positioning or posture, and skeletal injuries. Using Yamada's exhaustive data set, Nakao et al. (2016a; b) calculated the rate of injured skeletal remains (see Table 20.2 and supplementary data in Nakao et al., 2016a, for details) and plotted these data on a map of the Japanese archipelago (see Figure 20.2). Results of that analysis indicate the rate of injured skeletal remains is much lower than the rates calculated in previous studies including relevant data in different areas (e.g., Bowles, 2009; Keeley, 1996; Pinker, 2011), and that sites with injured skeletal remains were spatiotemporally scattered. Nakao et al. (2016a, b) argued that violence was not frequent during the hunting and gathering period in the Japanese archipelago and this low rate of violent conflict was relatively stable over the Jōmon period.

Bioarchaeological data for the Yayoi period provide context for assessing Nakao and colleagues' (2016) claim. As already mentioned, it has been commonly pointed out that warfare or inter-group violence began in the Yayoi period (e.g., Hashiguchi, 2007; Matsugi, 2007; 2017; Sahara, 1986). Nakagawa and colleagues (2017; 2019) and Nakagawa (2020) used the same method as Nakao and colleagues (2016) to calculate the rate of injuries among the Yayoi period skeletal remains and statistically compared them (for details see Table 20.3 below, and the supplementary data in Nakagawa et al., 2017). The results show a statistically significant increase in evidence for violent conflict over time, supporting Nakao and colleagues' (2016) claim that violence was low for the hunting and gathering period in the Japanese archipelago.

The bioarchaeological data for the Jōmon period, and the lack of fortifications or other evidence for violent interactions (e.g., Sahara, 1986; Matsugi, 2007; 2017), suggest that significant

Table 20.2 Estimates of mortality attributable to violence over the Jōmon period (see also Nakao et al., 2016a).

Phase	*Total*	*Adults*	*ID*	*ID without children*	*ID/total (%)*	*ID without children/adults(%)*
Initial	113	39	1	1	0.89%	2.56%
Early	216	117	0	0	0.00%	0.00%
Middle	371	172	5	5	1.35%	2.91%
Late	944	470	7	7	0.74%	1.49%
Final	932	471	10	10	1.07%	2.12%
Total	2576	1269	23	23	0.89%	1.81%

ID: injured individuals.

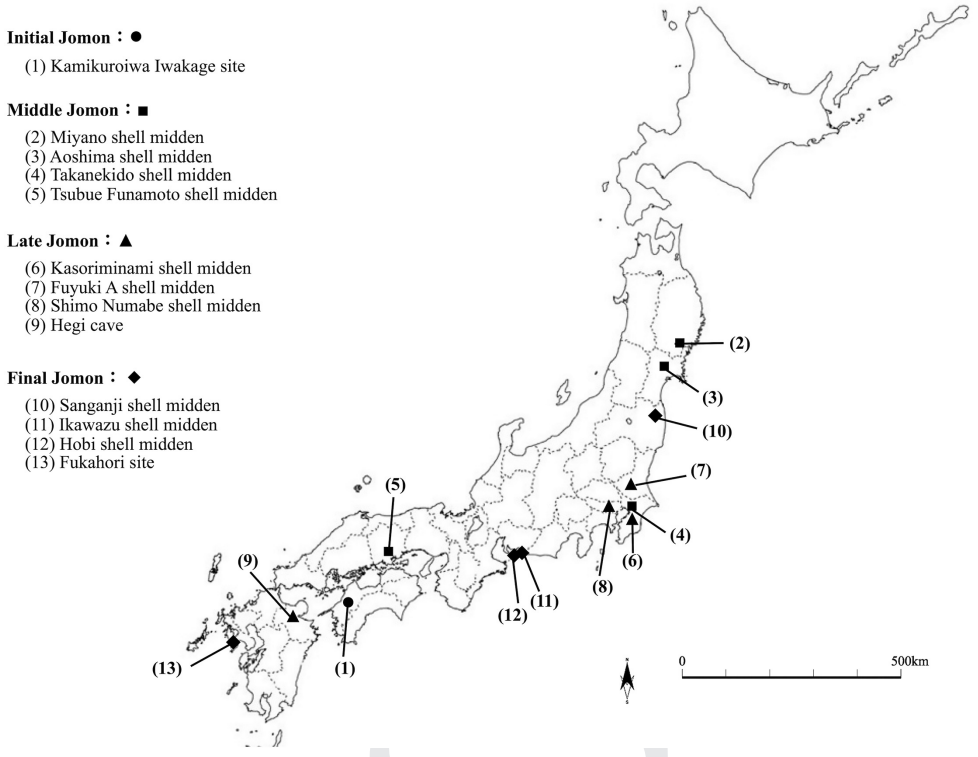

Figure 20.2 Sites with injured skeletal remains in the Jōmon period.

Table 20.3 Estimates of mortality attributable to violence over the Yayoi period (see also Nakagawa et al., 2017)

Phase	*Total*	*Adults*	*ID*	*ID without children*	*ID/total (%)*	*ID without children/adults(%)*
Incipient	27	25	6	6	22.22%	24.00%
Early	233	156	7	7	3.00%	4.49%
Middle	2,347	1,794	70	66	2.98%	3.68%
Late	691	420	17	17	2.46%	4.05%
Total	3298	2395	100	96	3.03%	4.01%

ID: injured individuals.

climate change over this period did not lead to an increase in violence and the Jōmon case, therefore, stands as a counterexample to previous claims that climate change and warfare have been closely connected (e.g., Ember and Ember, 1992; Hsiang et al., 2011; Keeley, 1996; Meyer et al., 2015; Otterbein, 2004; Scheffran et al., 2012; Zhang et al., 2007). Combined with other chapters in this volume, this conclusion deserves considered attention from the human security field, which has for decades argued a strong relationship between climate changes, resource scarcity and competition, and increased migration or violent interaction (see Robbins Schug et al., 2019).

Closer examination of some examples

The broad pattern of bioarchaeological data suggests climate change was not relevant to the frequency of violent conflict in the Jōmon period. By focusing on some important sites, this section aims to provide additional perspectives for considering the effect of climate on violence. First, we look at sites chronologically close to the catastrophic event at the end of the Middle Jōmon. If climate change promoted violent behavior in the Jōmon period, we should expect to find this effect more clearly when the climate cooled from the late phase of the Middle Jōmon to the early phase of the Late Jōmon. Indeed, the rate of injured skeletal remains is slightly higher for the Middle Jōmon than for other sub-periods; however, sites with injured skeletal remains are spatially dispersed and no sites have multiple injured skeletal remains except for the Aoshima shell midden in Miyagi Prefecture, which extended mainly from the Middle to the Late Jōmon sub-periods. A total of 25 skeletal remains were found at that site, including two suspected cases of violent injury: an adult male and female with stone projectile points around the thorax and ilium, respectively (Editorial Committee for the History of Minamikata Town, 1975). We have no further evidence to link such a slight increase in the rate of injury to a cooling climate.

It should also be noted that there are sites with significant numbers of skeletal remains but no evidence of violence in the early phase of the Late Jōmon. The Kitamura site in Nagano Prefecture and the Nakazuma shell midden in Ibaraki Prefecture have 190 and around 100 skeletal remains, respectively, belonging to the early phase of the Late Jōmon sub-period (Archaeological Research Center of Nagano Prefecture, 1993; Nakazuma Kaizuka Hakkutsu Chosadan, 1995; Suzuki and Suzuki, 1979). Although preservation of the bones at Kitamura is poor, no injured individuals were found. Pit A at Nakazuma, which contained the bones of about 100 individuals, is estimated to have been made more than 200 years after the abandonment of large settlements in the area (Matsumoto 2018a). It was a secondary burial containing mostly skulls and long bones, and no signs of trauma have been reported. Thus, based on the above evidence, it is unlikely that climate change from the late phase of the Middle Jōmon resulted in violent conflict.

Second, we examine sites of the Final Jōmon sub-period, when the largest number of injured skeletal remains are observed. It has been inferred that repeated cooling occurred during the Final Jōmon (Imamura and Fujio, 2009), which may explain the low population density in eastern Japan. Seven injured skeletal remains have been found at the Ikawazu midden on the Atsumi Peninsula in Aichi Prefecture (e.g., Atsumi Town Board of Education, 1995; Tahara City Board of Education, 2017; Team for Excavation of Ikawazu Site, 1988). This is the largest number of injured individuals known for any site in the Jōmon period. One other injured individual has been found at the Hobi shell midden, located on the same peninsula. Many skeletal remains are known for the Atsumi Peninsula from sites of this time—at Yoshigo, Ikawazu, and Hobi—suggesting a relatively high population density in the area. This is also indicated by the number of contemporaneous sites on the peninsula, which as seen in Table 20.4 are more numerous for the Late and Final Jōmon than in previous sup-periods (Tahara City Board of Education, 2017). While more work is needed to test the hypothesis, the cooling climate in the Late and Final Jōmon possibly promoted tidal flats to form; these are rich in shellfish, which is a valuable food source. This environmental change may have promoted a population increase on the peninsula, and the high population density, in turn, may have triggered violent conflicts. Although a more detailed examination of the environmental and social contexts is needed to understand the precise relationship between putative climatic, environmental, and

Table 20.4 Numbers of sites on the Atsumi Peninsula used in the Jōmon period. Thick lines indicate "probably used" and dotted lines "possibly used" (based on Tahara City Board of Education, 2017).

Phase		Incipient	Initial	Early	Middel	Late	Final
遺跡名	Site						
保美貝塚	Hobi shell midden	▬	▬			▬	▬
長代貝塚	Nagashiro shell midden	┈	┈				▬
宮西貝塚	Miyanishi shell midden	▬	▬	▬			▬
雁合貝塚	Gango shell midden	▬	▬	▬			▬
山崎遺跡	Yamasaki site	▬	▬	▬			┈
吉胡貝塚	Yoshigo shell midden				▬	▬	▬
伊川津貝塚	Ikawazu shell midden					▬	▬
青津前田遺跡	Aotsumaeda site			▬			┈
平野貝塚	Hirano shell midden			▬			
北屋敷貝塚	Kitayashiki shell midden				▬		
川地貝塚	Kawaji shell midden				▬	▬	▬
八幡上貝塚	Hachimanue shell midden					▬	
籠田遺跡	Kagota site	▬	▬	▬			┈
西南代遺跡	Nishinandan site		▬				
下地貝塚	Shimoji shell midden			▬			▬
羽根貝塚	Hane shell midden					┈	┈
佐藤遺跡	Sato site	▬					
黒河遺跡	Kurokawa site	▬					┈
清水遺跡	Shimizu site						┈
下畑遺跡	Shimohata site						┈
田原城惣門跡	Tawarajo somon site					▬	
柏坪遺跡	Kashiwatsubo site						┈
小今口遺跡	Koimaguchi site					▬	
坂井戸遺跡	Sakaido site	▬				┈	┈
比留輪原	Hiruwabara	▬					
	Max.	10	5	3	3	9	17
	Min.	9	5	3	3	7	8

social changes, it is remarkable that evidence for violence on the Atsumi Peninsula remained low, with only eight injured individuals among 514 skeletal remains in total.

Summing up, although there remains a possibility that climate change increased social tensions in the Late and Final Jōmon in some way, no evidence suggests increased violence. It is also unlikely that the relatively high rate of injured skeletal remains in the Middle Jōmon period could be explained in terms of climate change. Nor do we find evidence for an effect of climate change on violence during other sub-periods. Accordingly, in contrast with previous studies arguing that climate change can promote violent behavior such as warfare, we conclude that climate change had a limited influence—if any—on violence in the Jōmon period.

Discussion

There are some limitations to using bioarchaeological data to test the assertion that climate change and violent conflict are related. We have argued that since the rate of violent conflict was stable during the Jōmon period, there is no association between climate change and increased violent interactions. Note that our claim is based on a lack of evidence, which cannot conclusively prove a lack of violent behavior. Future evidence for violence, such as discoveries of

additional evidence for injuries in skeletal remains, could challenge the argument made in this chapter. Moreover, a possible bias should be noted for the bioarchaeological data set, because human skeletal remains are more vulnerable to soil conditions than other material remains; in other words, the data do not directly reflect the actual population of the time. Further empirical and theoretical studies are required to reconstruct past societies from bioarchaeological data.

Second, if climate change had no significant effect on violent behavior in the Jōmon period as we assert, we need to ask why. One possible answer is that they managed conflicts *without* resorting to violence (e.g., Matsumoto, 2018b). Ethnographic data show many cultural mechanisms for avoiding violent conflict, such as instilling values that abhor physical violence and coercion in favor of nurturance and affiliation (Dentan, 1968, 2008; Miklikowska and Fry, 2010; Robarcheck, 1977). It has also been reported that some hunter-gatherers tend to hide from potential opponents and thereby avoid violent conflict (e.g., Marlowe, 2010; Nakao, 2015; Nakao and Machery, 2012). Although it is difficult to infer such cultural values or practices based on archaeological data, ritualistic objects found at Middle Jōmon sites in the Chubu and Kanto regions, consisting of female figurines, miniature pottery, and highly decorated pottery, seem to focus on women, production, and reproduction (Matsumoto, 2011). Also, fissioning of villages has been reported as a cultural mechanism for limiting the occurrence of violence among the Hopi of Northern Arizona (Schlegel, 2004). The abandonment of large settlements at the end of the Middle Jōmon, followed by a period of smaller, scattered settlements in the eastern part of the Japanese archipelago (Imamura, 1997; Kanno, 2017), may indicate the management of economic and social stress by a similar fissioning of villages. The representations of figurines change from the Middle Jōmon to the Late Jōmon, probably indicating that adjustment at a symbolic level also occurred (Ikawa-Smith, 2002). Further examinations of the relevant data are needed, however, for assessing these or other possible reasons.

Conclusion

This chapter reviewed research on the effects of climate change on Jōmon society and culture. The summary suggests that climate change affected culture and society in many ways, especially around the Middle Jōmon sub-period. Also, we summarized the bioarchaeological data for the Jōmon and Yayoi periods and argued that climate change did not promote violent conflict in the Jōmon period. Further investigations on regional diversity in the effects of climate change on violence, or diversity in strategies for responding to resource scarcity in Jōmon society, may be fruitful for enhancing our understanding of the interrelationships between climate change and human responses.

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