

Chapter 15

State and Perspectives of Submerged Sites in Japan

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Previous Research on Submerged Prehistoric Sites in Japan

A chance discovery at Lake Suwa in Nagano Prefecture in 1908 sparked the interest of the Japanese archaeological community in submerged archaeological resources. Lake Suwa, located in a basin surrounded by mountains, is relatively shallow, averaging only 6 m deep. Several stone arrowheads were discovered at the point known as Sone, approximately 300 m from the shore. After the finds were published in 1909, archaeologists debated over the site formation processes involved at this location. A number of underwater sites, including prehistoric sites, have been identified in Lake Biwa, the largest lake in the country. The 1924 identification of the Tsuzura Ozaki Lake site in the northern part of Lake Biwa was a landmark discovery. The significance of the site was first noted by Oye Yoshio, a pioneer of underwater archaeology in Japan (Oye 1970, 1982). Artifacts were found on a steep slope from 50–70 m in depth (Akita 1997, p. 12). A few artifacts were collected, dating to diverse periods ranging from the prehistoric period to the ninth century. Lake Biwa also has been the focal point of submerged cultural heritage management in Japan. After the lakefront renovation plan was enacted in 1972, a total of 114 sites were investigated (Shiga Prefectural Association for Cultural Heritage 2010, p. 41).

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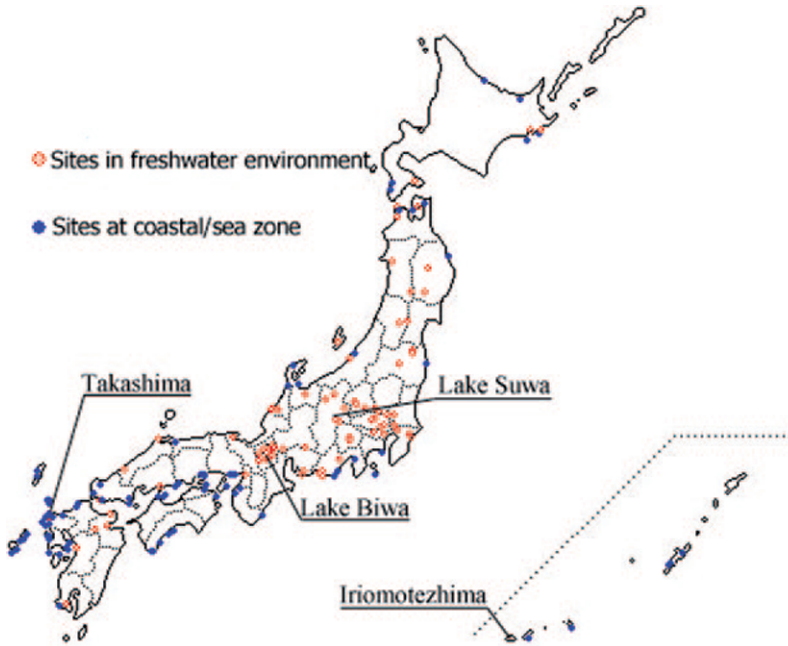


Fig. 15.1 Location of the underwater sites, plotted based on the survey of the Agency for Cultural Affairs. (Map by Jun Kimura)

Following underwater survey by divers, almost all of these sites were excavated by inserting cofferdams around the sites and pumping the water out to allow the “dry land” excavation (Shiga Prefectural Association for Cultural Heritage 2010, p. 19). A tremendous amount of information was collected through these rescue excavation projects (Shiga Prefectural Association for Cultural Heritage 2010, p. 23).

Between 1989 and 1991, the Agency for Cultural Affairs conducted a project to examine underwater cultural heritage in Japan in cooperation with the Kyusyu Okinawa Society of Underwater Archaeology (presently named the Asian Research Institute of Underwater Archaeology, or ARIUA). This included conducting a questionnaire with local municipalities in the country to understand the current status of research and distribution of underwater sites in Japan (Agency for Cultural Affairs 2000). All 3,245 municipal offices in Japan at the time were targeted in the survey. Of them, 2,356 offices indicated the possible presence of underwater sites or artifacts recovered from their waters. A total of 216 sites were regarded as significant for further investigation. As a result of this secondary survey, the details of the sites including the recovered artifacts, the location, time periods, and brief context were reported. Of the 216 sites, 109 sites were located at sea or in coastal areas, and 88 sites were found in inland waterways, such as lakes and streams (Kimura 2009) (Fig. 15.1). A larger number of marine sites are located in southwestern Japan while more fresh water sites are found in eastern and northern Japan. Reported sites range from simple scatters of artifacts to submerged features, structures, and shipwrecks.

Among these reported sites, eight sites are from the Paleolithic period, and 70 sites date from the Jomon Period. Less than ten dated later than the Jomon period. More than 70 sites did not date to any specific period. Only 44 sites had been excavated at the time. Fourteen of the 44 sites date to the Jomon Period, and 2 sites are identified as Paleolithic in age. The results illustrate a great potential for the Jomon Period research. The distribution of sites suggests that the Jomon people utilized inland waters extensively; however, more coastal sites should be investigated to refine the maritime adaptation pattern of the past. It is also important to note that a number of sites dating from the Jomon Period have been excavated since the study was conducted, especially at Lake Biwa.

In recent years, the previously mentioned ARIUA emerged as a leading institute in Japan for the study of submerged archaeological sites. ARIUA started the Comprehensive Survey of Japanese Underwater Cultural Heritage Project in 2009, funded by the Nippon Foundation. The purpose of the project is to locate known and unknown underwater sites nationwide, including submerged prehistoric sites, and to create a database for further studies. The members of ARIUA recognize the importance of the Underwater Cultural Heritage management, and protection of underwater cultural heritage as proposed by the 2001 UNESCO Convention. This project serves as a foundation upon which future works will be conducted. In early 2011, the online database created by ARIUA provided information on 124 Jomon Period underwater sites.

Prehistoric Environments and Archaeological Sites in Japan

The prehistory of Japan, beginning with the initial peopling of Japan, is connected to the fluctuation of sea level and climate change. For most of Japanese prehistory, sea level was at least 40 m below the current level; during glacier advances, sea levels were much lower, perhaps 120 m below that of today (Bailey and Flemming 2008, p. 2153). Sea levels show rapid and irregular fluctuations after 75,000 years ago, preventing the formation of stable ecosystems that early humans could exploit. The change in sea level was relatively stable between 49,000–33,000 years ago, allowing lagoons and swamps, rich in exploitable resources, to form (Pope and Terrell 2008, p. 8). Although not completely dry at the time, the 100 km wide Tsushima Strait, which separates Japan and Korea, was much narrower. People only had to cross 50 km or less of water in order to reach Japan from Korea (Pope and Terrell 2008, p. 5). No research has been conducted to locate Paleolithic sites along the “Tsushima land bridge,” but the importance of such sites when discovered will be grave.

The Paleolithic population of Japan is thought to have hunted megafauna. Along with such subsistence, they hunted large sea mammals but did not collect small fish and clams based on the presence of harpoons, and the absence of fish hooks from Paleolithic sites (Abe 2008a, pp. 15–16; Sato 2010, pp. 5–6). The climate started

to change to warmer weather around 15,000 years ago and the megafauna began to die off; humans had to adapt to a changing environment and exploit new resources, namely fish and other marine species (Toizumi 2008, p. 120). A plethora of evidence indicates that people began to collect marine resources intensively during the Incipient Jomon, which started around 16,000–14,000 years ago (Pope and Terrell 2008, p. 14). The Jomon culture is marked by the beginning of pottery use, intensive foraging, and a more sedentary way of life. Perhaps one of the first pieces of direct evidence for the use of marine resources is from the Maeda Kochi site in Tokyo, where a salmon jawbone was identified (Sato 2010, p. 12). It is believed that people captured salmon that were swimming upriver to spawn. There are other examples of early exploitation of marine resources, including the Yugura Cave site of Takayama Village in Nagano Prefecture (Toizumi 2008, p. 120). Nevertheless, it is shell midden sites that characterize the Japanese use of marine resources.

It is usually understood that during the Younger Dryas period (12,800–11,500 B.P.) the climate of Japan was slightly cooler and generally dry, as the weather was directly influenced from the continent. This occurred because the Tsushima Strait was closed, thus blocking the warm Tsushima current from flowing into the Sea of Japan (Sato 2010, p. 4). The forests in Japan were mainly composed of coniferous trees, but after 12,000 years ago, they were largely replaced with nut bearing deciduous trees (Pearson 2006, p. 239). The sea level was much lower than today, but around 9,000 years ago or earlier, sea level began to rise (Ishiga et al 2000, p. 223). It is difficult to ascertain the precise relationship between the rise of sea level and the climate, but it is generally believed that rainfall increased when the Tsushima current started to flow into the Sea of Japan (Lutaenko et al. 2007, p. 387). The warming trend was somewhat delayed on the Pacific side, attesting to the introduction of warm currents to the Sea of Japan, creating an oceanic warming trend (Lutaenko et al. 2007, p. 387). Lake sediments from many locations exhibit deposits of enriched organic matter and nutrient salts, suggesting a developed fluvial system and rainy conditions after 9,000 years ago (Ishiga et al. 2000, p. 233). The appearance of the first shell midden in Japan around 10,000 years ago is thought to be associated with this warming trend; it is considered an important marker for the beginning of intensive marine resource exploitation (Pope and Terrell 2008, p. 14). The majority of shell middens from this period, which are comparably smaller than later middens, are found in the Kanto plain in eastern Japan where many lagoons and brackish lakes formed. These environments may have been favorite locations for the Jomon inhabitants to gather marine resources (Ishiga et al. 2000, p. 224). The middens are usually full of discarded artifacts, including fish hooks, harpoons, and manos and metates, which exhibit the complex and extensive array of existing subsistence systems (Abe 2008b, p. 20). People exploited a range of marine resources, including fish and shell species from inland and offshore, suggesting an already well-established tradition (Toizumi 2008, p. 121). The warming trend continued through the Early and Middle Jomon, accompanied by a rapid rise in sea level (Lutaenko et al 2007, p. 343). This event is known as the Jomon Transgression; it reached a maximum stage in Tokyo Bay around 6,500–5,300 years ago (Lutaenko et al. 2007, p. 347). By 6,500 years ago, trees such as *Quercus* (oak) and

Castanopsis began to spread rapidly (Lutaenko et al. 2007, p. 347). Analysis of the available tool kit and midden waste indicates marine resources were an important component of subsistence activity (Toizumi 2008, pp. 122–123). During this period, shell middens located in different ecological zones across Japan usually produced different sets of species. For instance, coastal sites exhibit a majority of small coastal fish while sites located inland exhibit more reliance on small inland fish species (Komiya 2005, pp. 119). Komiya (2005), however, suggests that some coastal fish species were found even in inland shell middens, suggesting that populations living inland utilized boats to travel extensively to catch fish, or perhaps they had a seasonal camp near the coast. The Middle Jomon is thought to be the time when the Jomon way of life fully matured. The number and size of shell middens grew during the early part of the Middle Jomon when climate was optimal (Lutaenko et al. 2007, p. 365). This corresponds to population booms at large and permanent settlements, such as Sannai-Maruyama in northern Japan. Significant cooling of the climate took place around 4,500 to 4,000 years ago and sea levels began to drop, eventually reaching the current level (Lutaenko et al. 2007, p. 387). In general, there appears to be two types of shell middens during this period: the village (or hill) midden and the coastal midden (Uetsuki 2008). A village midden, as the name suggests, is associated with a village, and can be seen as a disposal site for locally produced trash. Village middens, like the well-known Kasori shell midden (Toizumi 2008, p. 123), usually contain various types of used artifacts and a large variety of food resources (Uetsuki 2008, pp. 24–26). Coastal middens formed as a result of the intensive exploitation of a small number of species, perhaps by occupants of seasonal camps. The Nakazato shell midden is characteristic of the coastal type; the site was used as a shell processing area (Toizumi 2008, p. 124). The number of shell middens, as well as average midden size, rapidly decreased during the Late and Final Jomon, corresponding to the disappearance of resource-rich lagoons and brackish lakes (Suzuki 2008, p. 40). Some shell middens date to the Yayoi Period (3,300–1,750 years ago); however, the represented resources are limited to near-shore or inland lagoon species (Toizumi 2008, p. 126). During this period, innovative fishing techniques appeared and regional variations in styles of fishing and use of resources became more prominent (Toizumi 2008, pp. 126–127).

The Study of Site Formation Processes

The study of site formation processes has been one of the major focal points of submerged archaeology in Japan. Although some terrestrial sites may have been deliberately submerged by modern development work, the site formation processes of many submerged sites in Japan are likely to be caused by two main physical events. The first includes earthquakes, land uplift or subsidence, as well as mudslides that changed the context of the site rapidly. Another factor is a long-term process of climate change and subsequent alteration in water levels. Cultural factors may also impact submergence and include past religious and ceremonial practices, such as

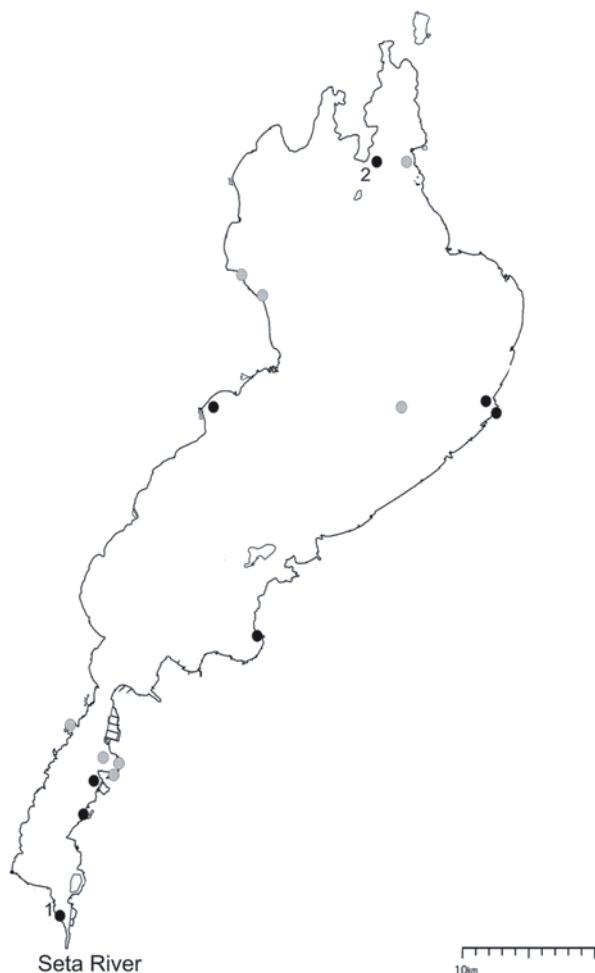
dedicating objects into sacred waters where they would remain in a more intact condition. These and other factors must be taken into consideration when determining how a particular site was formed. To illustrate the differences in site formation processes, case studies of several sites are discussed below.

Sites Around Lake Biwa

Lake Biwa, the largest inland lake in Japan, has 240 km of coastline and has been an important waterway for trade and a source of food for thousands of years for the people who lived in central Japan. Over 100 submerged sites exist along the shores ranging from the prehistoric to the historic periods. These include midden sites of the Jomon Period and medieval residential remains. It is suggested that the formation of submerged sites of the Jomon Period around Lake Biwa is partly related to active tectonic processes (Akita 1997). Some historical documents record that in the past, residences along the foreshore of the lake were significantly damaged by periodic tectonic movements. It is presumed that during the Jomon Period, earthquakes occurred occasionally. A terrestrial site in the vicinity of Lake Biwa, known as the Kitoge Nishi Kaido site dating back to the periods of the Jomon and Yayoi, shows evidence of soil liquefaction from an earthquake that occurred around 3,000 years ago (Sangawa 2009).

The tectonic processes, including earthquakes, do not explain the cause of the submergence of all the sites in Lake Biwa. Akita (1997, p. 270) suggests the impact of water-level change on the site formation processes. Over 100 waterlogged sites, including both prehistoric and historic sites, in Lake Biwa are positioned around an altitude of 81–84 m. Sites dating to the Early Jomon tend to be positioned at lower altitudes than sites dating to the later periods. This suggests that the water level during the Jomon Period was lower where the change in water level took place across the lake. Earthquakes may have caused some sites to submerge, but those tend to be localized events and the depth or altitude would be different from site to site. The water level appears to have changed several times in different periods and people gradually moved their settlements to higher locations. The change of water level is regarded as a primary factor that formed the submerged sites in Lake Biwa; however, the process of inundation at each site requires detailed investigation. The reason for the change in water level at Lake Biwa must be investigated further. The increase in the amount of rainfall at the beginning of the Jomon Period does not fully answer this question (Tsuboi 1994, pp. 156–158). A most notable characteristic of Lake Biwa is that it only has one drainage point, at the Seta River located at the southern tip of the lake (Fig. 15.2). It has been suggested that the silt accumulation in the Seta River or perhaps a localized uplift along the river may have changed the drainage rate of Lake Biwa (Akita 1997, p. 23). When there is uplift at this small drainage point, Lake Biwa would be blocked and the water level would have slowly begun to rise (Shiga Prefectural Association for Cultural Heritage 2010, p. 44).

Fig. 15.2 Submerged sites around Lake Biwa: 1 Awazu submerged site; 2 Tsuzua Ozaki submerged site; *black dots* Jomon sites; *checkered dots* Yayoi and historic sites. (Map by Randall Sasaki)



The exact mechanism of when and how the uplift or silt accumulation changed the drainage pattern has to be investigated. To explain the site formation processes of the submerged sites in Lake Biwa, the impact of multiple factors, such as the change of the drainage system as well as long-term climate change, needs to be considered.

The Lake Suwa Site

As mentioned above, the Sone archaeological site in Lake Suwa was one of the earliest sites in Japan where artifacts were discovered underwater. Archaeologists continued searching for artifacts in the 1920s and again in the 1960s; however, they

Fig. 15.3 A photograph showing Tokonami harbor excavation. (Photo courtesy of Asahi Shinbun)



were merely collecting objects and the vertical and horizontal extent of this site was never recorded. Today, it is believed that the Sone area was once connected to the present shore, but became isolated as the land began to subside gradually. The change in water level at Lake Suwa occurred over thousands of years. The recovered artifacts have been dated between the late Paleolithic and the Incipient Jomon; it can be assumed that it was around this time that the site was abandoned, possibly due to the rising water level.

The Takashima Underwater Site

Takashima in Nagasaki Prefecture is well known as a historical battle site, where a number of Kublai Khan's Yuan Dynasty ships were lost during the attempted invasion of Japan in 1281 AD (Delgado 2008). What is less known is that artifacts from the Incipient Jomon were discovered at an elevation of -25 m beneath the stratum from the Mongolian invasion period (Takashima Board of Education 1993). The fact that the prehistoric site was discovered underwater in Japan has been briefly mentioned in an English resource (Flemming 2004, p. 1228). While the detailed state of the remaining site has not been ascertained due to the poor condition of the waters, the recovered artifacts are most likely to have been identified in situ. An underwater archaeological rescue excavation off the Tokonami harbor in southern Takashima revealed a number of artifacts including Jomon earthenware, lithic tools, bones, ceramics, a stone anchor stock, and wooden remains (Fig. 15.3). A total number of 251 fragments of Jomon pottery constitute the majority of the discovered artifacts (Fig. 15.4). Almost all of them were dated to the Incipient Jomon. The date of the Jomon sherds assemblage appears to correspond with the results from radiocarbon dating on two different species of intertidal shells, *Lunella coronata coreensis* (8630 ± 105 B.P.) and *Monodonta (Modonta) labio* (8410 ± 105 B.P.) (Takashima Board of Education 1993, pp. 75–97). The discovery of the Incipient Jomon sites at such a depth is quite unusual. Although a few Jomon sites have been previously dis-

Fig. 15.4 A photograph of Jomon pottery found at Takashima. (Photo by Kenzo Hayashida)



covered underwater, they are positioned in shallow waters with an elevation of less than -10 m. Identifying the specific site formation processes at this site has been highlighted as the most critical issue. According to the study by Nagaoka Shinji in the site report, there is no clear evidence of mudslide that occurred locally based on the result of the survey of the sub-bottom profiler. Tectonic movements that would have caused mass subsidence of 20 m within 8,000 years are unlikely, since there is no indication of tectonic movements such as active faults around the concerned area (Takashima Board of Education 1993, pp. 105–110). Instead, the submergence of the site probably can be explained by the rise in sea level. The Imari Bay where Takashima is located shows a relatively shallow depth of 60 m on average. The bay was almost dry when the sea level was the lowest around 15,000 years ago. Later, the sea level gradually increased, and the site formed on dry land perhaps around an estuary of the ancient Tokonami River close to the shoreline. Around 8,500 years ago, the sea level reached a current altitude of around -25 m, and the site was inundated with water. Compared with other submerged sites in the region, the beginning of inundation of Takashima around 8,500 years ago is reasonably confirmed; a consistent sea-level rise from the melting of ice caps in the polar areas that occurred between 14,000 and 6,000 years ago has been recorded (Nakada et al. 1994). It is also suggested that hydroisostasy and asthenospheric viscosity affected the submergence of sites located along the west coast of Kyū su Island (Nakada et al. 1994, 1998).

The Katsuura Midden Site, Iriomote Island

The Katsuura midden site is located on Iriomote Island in Okinawa. Okinawa is the southernmost prefecture located in the subtropical climate zone. Iriomote Island is a part of the Sakishima (or Yaeyama) Archipelago, further south of the main island of Okinawa. The Katsuura midden site is identified in very shallow water with a depth of 1.5 m in the estuary of the River Urauti. The details of the site are

Fig. 15.5 Shell mound of the Katsuura midden site at the mouth of the River Urauti. (Photo by Jun Kimura)



available in a Japanese archaeological site report (Excavation team of the Amitori site and Katsuura site 2007). A few shell mounds and artifacts remain in an area of approximately $50 \times 12 \text{ m}^2$ (Fig. 15.5). Fifty percent of the shell species was identified as *Geloina coaxans*. The site has been dated to the seventh century AD by the characteristics of a grind stone and several shells from the midden mounds that have a small hole on the surface. This perforation is said to be a part of the decoration of ornaments, and similar products have been identified from other midden sites in this region. The result of radiocarbon dating on an animal bone seems to correspond with the time period estimated from the artifacts. The time period of the site is likely to be classified into the “pre-historic periods” in Okinawa’s history where their society substantially relied on a hunter-gatherer system, distinctive from mainland Japan. During this period, it is believed that the people of the islands utilized marine resources extensively.

The result of trench excavations at the site indicates that the current state of the Katsuura midden does not represent an *in situ* deposit. One reason for this hypothesis is that the shell mounds are exposed on the riverbed and form a very thin layer. Apart from the small number of the abovementioned artifacts, there are no specific remains, such as plant remains that are typically identified in well-preserved submerged midden sites. Contemporary shell mounds are preserved inland around the estuary of the River Urauti, near the current Katsuura midden shell mounds. Although a detailed mechanism of how the site formed is not known, it is believed that the shift of the waterway caused the site to be submerged.

The Tsuzura Ozaki Site

The Tsuzura Ozaki site located in Lake Biwa is considered to be an important underwater site in discussing site formation processes because of its unique feature. The majority of artifacts found were mostly complete Jomon pottery (Akita 1997,

Fig. 15.6 A scene from the recent research at Tsuzua Ozaki submerged site using ROV. (Photo courtesy of Kenichi Yano)



p. 262). Combined with the fact that the site is located at a greater depth compared to other sites in Lake Biwa, it is believed that most of the artifacts were deliberately deposited by a cultural factor. Perhaps, Jomon people offered pots filled with offerings at this location. A few remote sensing surveys and sediment sampling have been conducted here, yet no systematic excavation has been undertaken. The water depth and strong lakebed currents have prevented archaeologists from accessing the site; however, a team of researchers from Ritsumeikan University used a ROV and was able to locate and record artifacts in situ (Sakagami 2011) (Figs. 15.6 and 15.7). This ongoing research may reveal a clearer picture of site formation processes once extensive studies are conducted.

Fig. 15.7 A photograph captured by the ROV of possible Jomon Pottery from Tsuzua Ozaki submerged site. (Photo courtesy of Kenichi Yano)



The Contribution of Submerged Sites to a Larger Archaeological Community

There are many advantages of exploring submerged archaeological sites; however, perhaps the most significant contribution that such sites can provide for the better understanding of the Japanese prehistoric way of life is the fact that waterlogged sites often contain well-preserved organic materials that typically do not exist in a terrestrial context. This is because Japan is located in one of the most active volcanic zones and the soil is predominantly acidic in nature and therefore detrimental for the preservation of organic materials (Hongo 1989, p. 334). For instance, many shell middens produce a large number of small fish, suggesting that people used nets (Nishino 2008, pp. 30–31). Many net weights were found beginning in the Initial Jomon (Maeyama 2010, p. 32). Nets, made of organic materials, rarely survive in archaeological records, and archaeologists must rely only on net weights to infer how people in the past used nets (Tainaka 2010, p. 155). In other words, our understanding of the method of net fishing is far from complete (Komiya 2005, p. 133). A wide gap exists between our knowledge of lithic and pottery technologies and that of technologies based on organic materials, such as basketry or weaving. A large amount of basketry was discovered at a partially inundated Higashi-Myo site in Saga Prefecture dating from the Initial Jomon, and it appears that such trade was already well developed before 7000 B.P. (Bleed and Matsui 2010, pp. 362–363). Such technologies need to be explored and analyzed, but the real potential for submerged sites is that such sites can tell more about past subsistence patterns.

In Japan, 2,375 Jomon shell midden sites were reported in 2007. This number illustrates the importance of middens for the Japanese archaeological community (Mizunoe 2008, p. 58). However, the data that can be collected may be skewed considering differential preservation conditions (Yoshida 2008, p. 51). Bailey and Flemming (2008, pp. 2156–2157) note that “even the astronomical numbers of shells in the largest postglacial shell mounds are not evidence of economies dominated by

shell food or even of marine specialists.” A recent study of stable isotope analysis of human skeletal remains suggests that the Jomon people had an extremely diverse diet but relied more heavily on plant products, despite the fact that most of the shell middens are void of plant materials (Yoshida 2008, p. 53). This study indicates that the Jomon’s subsistence pattern was more complex and diverse than previously thought; however, the study of midden sites on land alone cannot reproduce this sophisticated way of life. The investigation of waterlogged midden sites is, thus, necessary to comprehend the Jomon culture.

Two submerged sites, the Awazu and Torihama submerged midden sites, produced valuable information regarding the early plant utilization by the Jomon people. The submerged Awazu site is located close to the southern tip of Lake Biwa where the lake narrows at the only outlet, Seta River (Tsuboi 1994 p. 42). Three shell middens were analyzed, and the smallest midden, dating to the Middle Jomon, or around 4500 B.P., has been fully excavated and another two middens are preserved in situ (Matsui and Kanehara 2006, p. 263). The other middens date to the Incipient and Early Jomon (Shiga Prefectural Association for Cultural Heritage 2010, p. 148). The site, distributed across 370 × 400 m, was excavated on “dry land” by using a cofferdam to drain off the water (Tsuboi 1994, p. 44). The shell midden consisted of thick layers containing plant remains between the layers of shells, and another layer of plants in between (Matsui and Kanehara 2006, p. 263). It is suggested that plants were discarded during the fall and shells in the spring, thus making an annual layer (Tsuboi 1994, p. 52). Such layering has not been seen on any other midden sites in Japan. Chestnuts and acorns were the major component of the plant remains. Surprisingly, the plants discovered included beans (*Vigna spp.*), gourds (*Lagenaria siceraria*), and edible burdock (*Lappa major*) (Matsui and Kanehara 2006, p. 264). These plants are considered to have been cultivated, making the Awazu site one of the earliest sites that exhibits evidence of extensive plant utilization in the country. The reconstruction of diet from the Awazu site indicates that the subsistence patterns of the Middle Jomon people were diverse. Vegetables or plants comprised about 50% of their diet, while fish or marine resources contributed about 40%, and the remainder of their diet came from land animal sources (Shiga Prefectural Association for Cultural Heritage 2010, p. 155). Not only edible plants but also such utilitarian species as Urushi or lacquer tree (*Rhus verniciflua*), considered to be native plants of China, were found (Noshiro 2010, pp. 94–97). The cultivation and utilization of Urushi require extensive knowledge of the tree, and why and how the Jomon population came to possess such a comprehensive understanding of a single species of tree needs further research and explanation (Noshiro et al. 2007).

Another waterlogged site located just north of Lake Biwa, in Fukui Prefecture is the Torihama site at Wakasa Bay; the area the site is located was a cape extending into an ancient lake, and the shell midden was formed by people disposing garbage into the lake (Hongo 1989, pp. 333–334). The excavation began in 1962 (Matsui and Kanehara 2006, p. 262). The site was occupied during the Incipient and Early Jomon, and then again after a hiatus, from the Final Jomon to the beginning of the Yayoi Period. The shell midden is about 120 m across (Hongo 1989, p. 334). No

fish hooks were found, but the presence of net weights and part of a logboat indicate that the people used nets from watercraft (Hongo 1989, p. 349). The people who lived at Torihama collected tidal species of mollusks along with fish, and the catchment analysis suggests that people collected resources close to the site, perhaps within a 5–8 km radius (Akazawa 1981, p. 249). During the Late Jomon, more reliance on game meat is evident (Hongo 1989, p. 352). Archaeologists learned a great deal about the exploitation of marine resources from the Torihama site; however, it was the analysis of plant remains that revolutionized or reconceptualized the understanding of the Jomon in Japan (Taniguchi 2010, p. 25). The excavation and analysis became the model of later research for plant or animal and environmental studies (Toizumi 2010, pp. 4–5). Plants such as the beefsteak plant (*Perilla frutescens*), egoma (*Perilla cymoides*), paper mulberry (*Broussonetia papyrifera*), flax (*Cannabis sativa*), and gourd were discovered, all dating between 6000 and 5220 B.P. (Matsui and Kanehara 2006, p. 263). Analysis of the wooden remains points to the fact that different tools were made with different wood species suggesting that the people knew the specific properties of the timber and utilized them accordingly (Noshiro 2010, p. 91). The most prominent plant remains found at the site were kuri or sweet chestnut (*Castane spp.*); it consisted of up to 80% of all the wood species found at the site (Noshiro et al. 2007, p. 92). The use of kuri may have been the most important tree that Jomon people utilized. Selective management of trees is suggested because kuri does not grow as a single forest in nature, but the Jomon people utilized this single type of tree intensively; people may have cut down other trees to encourage the growth of kuri forest (Taniguchi 2010, p. 8). The size of the kuri nuts was smaller during the Early Jomon compared to that of the Middle or Late Jomon (Noshiro 2010, pp. 92–94). The estimated growth rate of kuri trees using annual tree rings from samples found from archaeological sites was compared to that of natural kuri trees. The results suggest that the kuri trees found in an archaeological context exhibit faster growth rates than the trees found in nature, suggesting human intervention (Toizumi 2010, p. 11). The kuri tree is easy to cut down, strong against decay, and it is one of the fastest growing trees in Japan. These properties may be part of the reasons why the Jomon people utilized the tree extensively (Noshiro 2010, pp. 92–94).

Conclusion

The preceding represents a summary of the current state of research on submerged prehistoric sites in Japan. Only a small number of sites have been investigated in the country, and thus *any* new discoveries would change the content of this chapter. The potential for further research in this field is extremely promising, and the authors hope that this chapter is of use as an initial effort to bring more focus on the subject. The climate, environment, and sea-level changes affected the lifestyle of ancient Japanese people, as is most prominently visible in the formation and disappearance of shell midden sites. The island nation of Japan has always been affected

by changes in sea level, and the adaptive strategy of the people who lived along the coasts should be carefully studied. Site formation processes is one of the topics that underwater archaeologists in the country have been discussing for many years, and the complexity of the processes should not be taken lightly. Several inundated sites have already exhibited the potential for telling archaeologists of the diverse and ingenious adaptive strategies of the ancient Japanese people; an intensive investigation across sites located in various environments is overdue.

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