PEOPLE, PLANTS, and LANDSCAPES

Studies in Paleoethnobotany

Edited by Kristen J. Gremillion

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CHAPTER 5

Anthropogenesis in Prehistoric Northeastern Japan

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Paleoethnobotany in Japan has a relatively young history, especially with respect to intensive flotation sampling and interpretation of resulting data in the context of culture historical, processual, and other issues. Today, nearly fifty sites from a variety of periods have been examined by a handful of researchers using flotation. Recovery of plant remains from wet sites, which are relatively common in Japan, has also been emphasized in recent years. Although important data on cultigens are often derived from this work, they tend to be interpreted rather loosely, that is, without reference to taphonomic and depositional issues. In contrast, my own research has concentrated on recovering carbonized plant remains from dry sites in northeastern Japan and investigating them using a rigorous analytic framework. This chapter examines prehistoric anthropogenesis in northeastern Japan, an issue that has become increasingly well defined during the past two decades because of an ever-improving comparative data base. After first setting out a brief overview of the importance of anthropogenesis, I review perspectives on this issue in Japan. I present data from sites in northeastern Japan that serve to illustrate the human impact on the environment there, using weeds as an indicator of anthropogenesis for the sake of this discussion. The carbonized seed data are extensive and span a period from about 8000 B.P. to 1000 B.P. Subsistence regimes range from foraging in the earliest periods to relatively substantial agriculture by 1200–1000 B.P. I consider patterns consistent with four phases of subsistence and anthropogenesis: Initial Jomon (9500–7500 B.P.), Early through Late Jomon (7500–3000 B.P.), Zoku-Jomon (2300–1600 B.P.), and Yayoi-Ezo (after 1600 B.P.).

Anthropogenesis

Anthropogenesis is the process by which human beings impact their environment. The resulting effects are manifested in nonequilibrium ecological states characterized by spatial and temporal patchiness (Reice 1994). Disturbance is the main factor involved in nonequilibrium ecological states. By removing organisms such as trees from a habitat, human beings set in motion processes that change the character of the ecosystem. This disruption, if relatively severe, takes the system back to less mature successional stages. An extreme example is monocrop agriculture; in contrast, a single tree-fall exemplifies a minimal, localized effect on an ecosystem. Young successional stages are characterized by rapid reproductive rates, short life cycles, and a high ratio of production to respiration, resulting in high net production and high gross production in relation to standing biomass (Odum 1971). These characteristics mean that greater quantities of fruit and vegetal materials, as well as greater numbers of animals such as deer and rodents, thrive in disrupted ecosystems. Thus ecological disruption can be detrimental in some forms, of course, but the advantages to human beings, at least in the short term, are obvious. Anthropogenesis is a critical factor in the success of human cultures. Ecological disturbance as a normal part of ecosystems must also come to be acknowledged in environmental policy development (Reice 1994).

Evidence for anthropogenic impact may be detected in paleosols, pollen profiles, wood charcoal assemblages, carbonized seeds, and the like. Of course, one must distinguish intentional activities such as field preparation from processes that produce similar effects, although not primarily intended to create new plant communities (e.g., extraction of construction materials, village periphery and interior disturbance). McCorriston and Hole (1991), for example, argue for the role of anthropogenesis in conjunction with other factors in the origin of agriculture in southwestern Asia. They argue that each region where agriculture began should be elucidated in its own terms (1991:10) as do many of the authors in Gebauer and Price (1992). In similar fashion, this chapter examines anthropogenic conditions correlating with the development of food production in prehistoric Japan. In addition, anthropogenesis contributes to our understanding of the remarkable success of the Jomon in northeastern Japan. I examine the evidence for human impact on vegetation, components of which became part of human subsistence. The body of data is carbonized plant remains from northeastern Japanese occupation sites spanning some 7,000 years. I pay special attention to herbaceous weeds, particularly annuals that colonize disturbed habitats, produce large numbers of seeds, and have rapid growth and high phenotypic plasticity.

Yarnell (1963) and others have argued for the importance of the concept of reciprocity in human ecology. This perspective is not common in Japanese research, which generally views people as relatively passive recipients of the naturally rich resources of the archipelago. Human impact on the environment is also seen as a unidirectional process of environmental modification to facilitate agriculture. However, a process of adjustment to changes implemented unintentionally, as well as intentionally, should be examined. Nearly a decade ago, I found evidence for Jomon people taking advantage of what appeared to be anthropogenic communities (Crawford 1983). This study expands upon my earlier discussion.

Prehistory and Vegetation History: An Overview

The culture history of Holocene northeastern Japan is complex. The view of a linear progression from earliest Jomon foragers to the Ainu, their presumed descendants in Tohoku and Hokkaido, is no longer accepted. Ainu culture is an outcome of several thousand years of northeast-southwest interaction, the results of which include the development of extensive food production throughout most of the northeast by 1000 B.P. (Crawford 1992; Crawford and Takamiya 1992; Crawford and Yoshizaki 1987; Howell 1994). This culture history sits within a backdrop of relatively well-defined vegetation and climate history. Most of the environmental history has been interpreted from pollen evidence, although other types of information, such as mollusk distribution, contribute to regional environmental reconstruction. These studies tend to view human beings as passive players on the prehistoric Japanese stage, at least until the advent of rice paddy agriculture in southwestern Japan about 2400 B.P.

From 8500 to 3500 B.P., a warm period is associated with the development of deciduous hardwood forests in the northeast and broadleaf evergreen forests in the southwest (Yasuda 1978). Agriculturally induced changes in vegetation are continuous in southwestern Japan starting about 3200 B.P. (Tsukada et al. 1986). There is some evidence for ear-

lier forest clearance, for example, in the Ubuka Bog area, by 7700 B.P. (Tsukada et al. 1986) and at the Torihama Shell Mound, where extensive forest destruction is argued to have occurred about the same time (Yasuda 1978). Although preceded by these early impacts, the advent of rice agriculture left an indelible mark on the Japanese landscape. Beginning in the Yayoi (ca. 2400 B.P.), floodplain and hillside forests were extensively cleared (Yasuda 1978:242). Pine trees increased in abundance at the same time, apparently because of successional processes. These vegetation history interpretations tend to view forest clearance for agriculture as the primary detectable form of anthropogenesis. Regional pollen profiles are not normally able to elucidate the local effects of human communities. As a result, pre-Yayoi anthropogenesis is difficult to assess from regional pollen profiles. Fortunately, many projects routinely include the analysis of pollen from habitation sites. Sitespecific pollen records such as from the Yagi site, for example, indicate that pollens of grass and knotweed (Polygonaceae), among other herbaceous weedy groups, have a significantly higher influx rate than those of arboreal taxa (Davis 1979).

Nishida (1980, 1981, 1983) examined nut remains and wood charcoal from wet sites in southwestern Japan. He proposed that Jomon people created orchards of nut trees near sites such as Torihama and Kuwagaishimo. The nut cultivation model has gained popularity in recent years and is another version of the contention that Jomon plant food was comprised mainly of nuts. This is an oversimplification that, while acknowledging the potential role people played in affecting the character of local habitats, does not address the broader range of environmental interactions during the Holocene in Japan.

Weed Occurrence Patterns in Sites in Northeastern Japan

At least four types of plant remains assemblages seem to correspond with general cultural developments in northeastern Japan. The first appears in a relatively small set of samples taken from Initial Jomon contexts at Nakano B in Hakodate (figures 5.1 and 5.2). The second is associated with the subsequent Early through Late Jomon phases (figure 5.2). The Zoku-Jomon is a third pattern (figure 5.3). The fourth is associated with the agriculturally oriented Yayoi and Ezo/Heian of Aomori and Hokkaido (figures 5.4 and 5.5).

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Figure 5.1. Map of northeastern Japan showing location of sites.

The interpretation of anthropogenesis at archaeological sites in northeastern Japan must, of course, hinge on a number of assumptions. Foremost among these is that plants indicative of ecological disruption attributable to human beings can be identified in the archaeological record. Plants that colonize human-disturbed habitats may also prefer habitats disturbed by natural influences such as tree-falls, riverine and coastal erosion, forest fires, and typhoons, which result in local plant communities of varying ages and stages of succession. In the following discussion, I limit interpretations to patterns shared by groups of sites. The patterns involve the relative abundance of annual weeds (indicative of regular, short-term disturbance) and perennial weeds (indicative of early successional stages that would be associated with forest edge or village edge communities). The frequency and intensity of disruptive activities represented by these plants encompass short-term disruptions, as well as actions that would maintain disequilibrium because of continual disturbance. Under these circumstances, ongoing human presence inhibited ecological succession. I do not assume that the weeds are nec-



🔟 Kazahari (LJ) 🔟 Usujiri B 🗾 Tominosawa (MJ) 📓 Hamanasuno 🗐 Yagi 2 🔲 Nakano B

Figure 5.2. Bar chart illustrating relative quantities of plant taxa for the Initial through Late Jomon. LJ = Late Jomon component; MJ = Middle Jomon component; IJ = Initial Jomon component; Yagi 2 = Yagi excluding "Other Grass." Bars are arranged chronologically from Initial Jomon (right) to Late Jomon (left).



Sapporo Station (K135) Esan

Sapporo Station (K135) Kohoku

🔟 Mochiyazawa

Figure 5.3. Bar chart illustrating relative quantities of plant taxa (excluding nuts) for the Zoku-Jomon in Hokkaido.





Figure 5.4. Bar chart illustrating relative quantities of plant taxa at six Ezo-Haji/Satsumon sites in Hokkaido and the Yayoi component of the Kazahari site. SK = Sakushu Kotoni River; KG-II = Kawshiwagi-Gawa-II.



Figure 5.5. Pie charts illustrating the relative proportions of weed seeds from the Sakushu Kotoni River site, Hokkaido.

essarily a result of human influence. I argue, however, that this appears to be the case.

Initial Through Late Jomon (ca. 9500 to 3000 B.P.)

The Initial Jomon spectrum of plant remains is dominated by the "other" category of plants that comprises tree fruit including Amur corktree (*Phellodendron amurense*) and walnut (*Juglans ailanathifolia*) (figure 5.2) (Crawford 1983). Annual weeds and knotweed are barely present in the samples. Initial Jomon sites were communities with pit houses, but the hamlets/villages were usually much smaller and less densely occupied than those of subsequent Jomon communities. I am not inclined to interpret the nut procurement regime as anything other than harvesting from naturally occurring stands of walnut trees. Elsewhere I have argued that the evidence does not necessarily point to the nut tree management that Nishida (1980, 1981, 1983) proposes for central and southwestern Japan (Crawford 1992). The plant remains are consistent with a low degree of local ecological disturbance.

In contrast to the Initial Jomon pattern, the subsequent Early through Late Jomon pattern attests to a much greater degree of anthropogenesis. The plant remains assemblages from six sites are relatively consistent. Annual and perennial weedy plants range from about 36% to more than 50% of the seed assemblages (figure 5.2). Grasses, which have not been identified in the Initial Jomon samples, comprise a significant proportion of Early and subsequent Jomon assemblages. Most of these grass seeds are from a single genus, Echinochloa (barnyard grass). The other weed forming a high percentage of Jomon assemblages is the knotweed (Polygonum). Usually three or four species of Polygonum are present. Also present, particularly in the Middle and Late Jomon, is the closely related sheep sorrel (Rumex sp.). Then, by Late Jomon times, several cultigens, rice (Oryza sativa), foxtail millet (Setaria italica ssp. italica), broomcorn millet (Panicum miliaceum), and possibly buckwheat (Fagopyrum esculentum), were available in northeastern Japan in some quantity (Crawford 1992; D'Andrea 1992). One or two of these cultigens may have been present earlier (Crawford 1983; Crawford and Takamiya 1992), but they have not been recovered in the quantity that they have from the Late Jomon. The low of 36% weeds comes from Kazahari, the Late Jomon site with cultigens. A half dozen seeds of foxtail grass (Setaria sp.) in the Late Jomon assemblage at Kazahari, although not particularly striking, are consistent with the interpretation

that cultivation was taking place. Foxtail grass is more common in flotation samples from the later agricultural phases in the northeast compared with its presence in the Initial through Middle Jomon phases there.

Small scale gardening may have taken place from the Early Jomon onward in northeastern Japan. Thus anthropogenesis in the form of clearing for gardens likely is responsible for some of the weed assemblage in the Late Jomon and may also account for some of these remains in sites as early as the Early Jomon. Besides gardening, clearing land for settlements, construction, firewood collection, and possibly burning may account for most of the anthropogenic influences upon plant communities that are reflected in the paleoethnobotanical record. Ecological disruption, then, developed as a consequence of the many activities associated with long-term village occupation and not necessarily or entirely in conjunction with gardening.

For now, we have not modeled how newly established communities procured their resources. In southwestern Hokkaido, for example, Jomon sites are quite large, often multicomponent, and number more than 90 within an area of less than 40 to 50 sq km of coastal terrace. Suitable resources, particularly those created by human influences, were likely not far away at any time (Bleed et al. 1989). Primary and secondary products of gardens likely provided some insurance for lean years as did secondary wild resource choices. Very few nut remains have been recovered from any of these sites.

Jomon people seem to have affected significantly the productivity of their terrestrial environment (Crawford 1983). Anthropogenic communities were sufficiently productive to encourage a de-emphasis on nut procurement. Nut remains from Jomon sites in southwestern Hokkaido decrease in density to the extent that, by the Middle Jomon, nuts are present but not regularly recovered in flotation samples. At Usujiri B they are barely present and at Tominosawa, too, acorn and walnut are present only in a few flotation samples (Crawford 1983; D'Andrea 1992). Acorn and walnut remains are commonly recovered from the Late Jomon and Yayoi components at Kazahari, however (D'Andrea 1992). Why nuts become more common late in the sequence when gardening becomes more intensive is a problem. Increasing human population density and increased clearance may be factors. Nut trees are more productive along forest edges and in openings, and nuts may have been valued more than they had been previously as a result of the investment

of efforts in plant husbandry, which is a relatively risky undertaking because of the possibility of crop failure. Nuts, along with other gathered foods, would have cut these subsistence risks substantially. Plant husbandry could have been a factor in changing local ecology to suit human needs as early as the middle Holocene in northeastern Japan. In general, the Jomon cannot be assumed to have been passive extractors from local habitats.

Zoku-Jomon (ca. 2300 to 1600 B.P.)

The Zoku-Jomon, a phase between the Final Jomon and Ezo-Haji/ Satsumon of Hokkaido and a contemporary of the Yayoi, exhibits considerable variation in its seed assemblages. Three occupations representing two periods of this phase have been extensively sampled at the Sapporo Station (K135) and Mochiyazawa sites (Crawford 1992; Crawford and Takamiya 1992). The plant remains from these occupations are dominated by walnut and acorn (Quercus sp.). In general, perennial plants and other taxa are relatively common, more so than in the preceding Jomon periods (figure 5.2). They are probably more abundant than the chart indicates because one of the knotweeds, Polygonum cuspidatum, is a perennial. Annual plants such as grasses and knotweeds vary considerably in relative proportions. There is some question about the role food production played at each of these Zoku-Jomon sites (Crawford and Takamiya 1992; D'Andrea 1992). Cultigens are present at Mochiyazawa and Sapporo Station (K135). Barley (Hordeum vulgare) is represented by one specimen at Sapporo Station while twentyone grains of rice, barley, foxtail millet, and broomcorn millet occur at Mochiyazawa. Mochiyazawa also has the highest percentages of weedy annuals and the only substantial representation of weedy grasses among the three Zoku-Jomon components reported here. None of these sites shows evidence of substantial house construction; thus although repeated occupation is evident, long-term continuous occupation of the sites may not have occurred. Mochiyazawa is one of many occupations in a 1 sq km area representing earlier Jomon phases as well as the more recent Ezo-Haji/Satsumon. Such repeated and long-term use of a limited area likely affected the local ecology. The pattern is difficult to interpret at the moment. One possibility is that the Mochiyazawa population was involved in food production, which would have been largely responsible for the weed communities there.

Food-Producing Phases (Postdating 1600 B.P.)

Four populations of substantial food producers are identified in the archaeological record of northeastern Japan: the Tohoku Yayoi, Ezo-Haji, Satsumon, and Heian. Heian is only tentatively identified at sites such as Uchiebisawa and Hachinohe. Their occupants may have been Ezo, although their material culture shared much with that of contemporary *wajin* (protohistoric Japanese) settlers in Tohoku. The Tohoku Yayoi are thought to have practiced rice production as did the Yayoi of southwestern Japan. However, this agricultural venture appears to have failed, although occupation of the area continued after adjustments were made to production methods. Instead of rice, Tohoku Yayoi populations came to rely on crops such as wheat, barley, and millet (Crawford and Takamiya 1992). The descendants of these people appear to be the Ezo, who are likely the ancestors of the Ainu. The Ezo relied on dryland food production (Crawford and Takamiya 1992; Crawford and Yoshizaki 1987).

' Plant remains from the Tohoku Yayoi and Ezo-Haji are comprised of cultigens to a greater extent than those from any of the periods discussed so far (figures 5.4 and 5.5). Cultigen seeds usually represent more than 40% of these assemblages, including the Yayoi component at Kazahari, with the exception of the Botanical Gardens site where they comprise only 5% percent of the collection. The pattern of annual and perennial weeds is similar to that of the Early through Late Jomon in that grasses and knotweeds are common, but their relative abundance is lower because of the significant quantities of cultigen seeds. Goosefoot (Chenopodium sp.) and sheep sorrel (Rumex sp.) are common annuals, as they are in some Jomon assemblages. Sumac (Rhus sp.) and fleshy fruit-bearing bushes are also well represented. Differences include a greater diversity of archaeological grasses compared with those in Jomon collections. Barnyard grass (Echinochloa crus-galli) is present, but the most common of the weedy grasses is usually a foxtail grass (Setaria sp.). Very few of the knotweeds are Polygonum sachalinense, which is common in the Jomon samples; instead, they are usually P. densiflorumtype or P. lapathifolium.

The Grasses

Details of some of the archaeologically recovered grasses suggest further insights into anthropogenesis in prehistoric northeastern Japan.

Grasses are an extremely diverse plant family (Gramineae or Poaceae). Assemblages from the sites in question, however, are marked by very few grass species. The predominant representatives among the archaeological grasses in northeastern Japan belong to the tribe Paniceae, a group known for its economic value to people. The common members of the Paniceae in the Japanese samples are barnyard grass and barnyard millet (Echinochloa crus-galli and E. utilis, respectively) and foxtail grass and foxtail millet (Setaria italica ssp. viridis/glauca and S. italica ssp. italica, respectively).

Barnyard Grass (Including Rice Paddy Weed) and Barnyard Millet

Barnyard grass and barnyard millet are two species of *Echinochloa* that appear to have a long history of association with people in Japan. The first species is a weed (barnyard grass, *E. crus-galli*) with two distinct forms, dryland (*E. crus-galli* var. *crus-galli*) and rice paddy-associated varieties (*E. crus-galli* var. *oryzicola*). The second species is a cultigen (barn-yard millet, *E. utilis*). The three taxa belong to the same genome, one that does not include the South Asian cultigen (*E. frumentacea*) (Yabuno 1966). Researchers grow about 120 cultivars of barnyard millet at the National Northeast Agricultural Experiment Station in Tohoku, Japan (Yabuno 1987:486). *Echinochloa crus-galli* is a successful weed for a number of reasons, including its production of large numbers of seeds per plant, seed dormancy, and its capacity to grow on a wide variety of soil types and textures (Maun and Barrett 1986).

Jomon, Yayoi, Ezo, and Ainu plant remains assemblages clearly evidence several types of human-*Echinochloa* associations that represent distinct activities. The identification of these associations depends on our ability to distinguish the three taxa in archaeological plant remains assemblages. The cultigen caryopses (grains) are significantly larger than those of weedy *Echinochloa*. The dorsal surface of the cultigen has a distinct hump at the point where the steeply inclined embryo terminates near the middle of the grain, whereas weedy *E. crus-galli* var. *crus-galli* grains have a flat dorsal surface and the seeds are markedly smaller than the cultigen grains. The grains of *E. crus-galli* var. *oryzicola* are slightly larger and two to three times more massive than the dryland weed grains (Maun and Barrett 1986). The embryo of *E. crus-galli* var. *oryzicola* caryopses extends the whole length of the seed rather than terminating at half to three-quarters the length of the seed as it does in *E. crus-galli* var. *crus-galli*. Scanning electron microscope examination of the epidermal surface of the grains and the fruit has so far provided no other characters that distinguish the three forms.

Barnyard millet (*E. utilis*) has been identified in substantial quantities from a 400-300 B.P. Ainu house in Nibutani, western Hokkaido. A few grains of barnyard millet have also been tentatively identified from one or two Ezo sites dating from 1200 to 800 B.P. These Ezo sites generally have quantities of broomcorn millet grains, which are similar to barnyard millet grains in size and general shape. One site with thousands of grains of broomcorn millet (Sakushu Kotoni River) may have many barnyard millet seeds as well, but this finding is difficult to confirm. At the Megumi site in Yonago city, southwestern Japan, barnyard millet seeds have been identified in both Yayoi and Final Jomon components (Kasahara et al. 1986:121). In any case, barnyard millet grains are being identified in contexts that, on the basis of other archaeological evidence, are known to be agricultural.

Echinochloa crus-galli var. oryzicola is a rice-associated weed that developed as a rice-plant mimic (Barrett 1983, 1987). The rice mimic is associated only with paddy-field agriculture. Until recently, no examples of seeds of this plant had been located in the archaeological record. In the past few years the situation has changed. The Okawa site, located on the Sea of Japan coast of Hokkaido in Yoichi, has yielded a number of clear examples of E. crus-galli var. oryzicola, as well as a few grains of cultigen barnyard millet (E. utilis). In addition, rice grains have been recovered from the same site in several localities. A radiocarbon date on the rice from Okawa is 780 \pm 200 B.P. (TO-1999), and another date on broomcorn millet grains from the site is 1160 ± 80 B.P. (TO-1998). Calibrated ages for these materials are A.D. 1280 and A.D. 890, with calibrated age ranges at the 68.3% confidence interval falling between A.D. 1028 and 1400 and A.D. 782 and 984, respectively (using CALIB 3.0, Stuiver and Reimer 1993). The houses here are not characteristically Ezo in style, so Okawa may be a wajin occupation. A small collection of Ezo pottery has been retrieved from Okawa, however. Seeds of E. crusgalli var. oryzicola have been recovered from only one other site in the study area. Forty-one grains come from pits at Mochiyazawa, a Zoku-Jomon site. Thirteen of these grains are measurable, with an average size of 1.9 (1.8–2.2) mm long, 1.3 (0.8–1.7) mm wide, and 1.1 (0.7–1.7) mm thick (D'Andrea 1992).

Rice has been recovered from three Ezo period sites, including

Okawa, as well as from the preceding Zoku-Jomon Mochiyazawa site in Hokkaido. The rice-paddy weed is also found at two of these sites. At the moment, distinguishing whether rice was grown at, or imported to, these sites is difficult to determine. No plant parts other than the grains have been found. If the rice was imported, the rice-mimic barnyard grass seeds likely came with it. Nonetheless, rice may well have been grown at Okawa and Mochiyazawa; the presence of the paddy weed is circumstantial evidence that the rice was locally produced.

Barnyard grass seeds (E. crus-galli var. crus-galli) are present at most sites with grass remains, including Jomon and later sites. Small numbers are present at Early Jomon sites, while larger quantities are found at Middle and Later Jomon sites, and the fully agricultural components of the period 1600-1000 B.P. in Hokkaido have abundant barnyard grass remains. The most detailed study of archaeological barnyard grass is the analysis of specimens from the Hamanasuno and Usujiri B sites on the Kameda Peninsula in southwestern Hokkaido (Crawford 1983). Three hundred twenty-one grains from the Early and Middle Jomon periods have been identified in flotation samples from the two sites. Only thirty-three samples from Hamanasuno are from floor or pit/hearth contexts. Except for one specimen, the barnyard grass seeds are all from pit/hearth flotation samples. The majority (139 seeds) came from a post hole in House 72 at Hamanasuno. The Tominosawa site samples are only from house floors and features, so the occurrence of the grass in other contexts cannot be ascertained. At Usujiri B most of the shallower levels at the site had been destroyed before the excavation began, so any stratigraphic variation in the occurrence of the grass seeds can also not be explored. Barnyard grass seeds occur in floor, pit, burial, and deep house fill (Level X3: the stratum normally immediately overlying the few centimeters of floor fill) contexts. In addition, a carbonized mass adhering to a Middle Jomon pot sherd contained Echinochloa seeds. In general, barnyard grass seeds occur only in low densities except at one or two locations at these sites. Their regular occurrence at the sites and their associations primarily with pits, hearths, floors, and, in one case, residue in a pot support the contention that the seeds were collected and used, likely as food, by the site inhabitants.

The *Echinochloa* seeds are not particularly abundant at any of the sites (in fact, densities for seeds of all taxa are low). However, despite the apparent nonintensive use of this grass, indications are that a phenotypic change had occurred by 4000 B.P. (Crawford 1983). The mean

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size of the grains increased about 20% by the end of the Middle Jomon (ca. 4000 B.P.). Furthermore, nearly one-quarter of the *Echinochloa* seeds from the Middle Jomon Usujiri B site are larger than any of the grains found at Hamanasuno. Only one specimen from Hamanasuno is longer than 2 mm, but it is relatively narrow. Finally, the frequency distributions of the grain measurements indicate at least two modes and therefore two populations of *Echinochloa* distinguishable by grain size (Crawford 1983). I will be examining the details of the archaeological *Echinochloa* variation elsewhere (Crawford, forthcoming).

A specimen not included in the statistical analysis of the Jomon *Echinochloa* grains came from the carbonized mass attached to a rimsherd recovered from a house floor adjacent to a hearth. The specimen is a nearly complete grain with palea and lemma attached. The grain size is outside the range of weedy *Echinochloa* and within the range of *Echinochloa utilis*, the cultigen barnyard millet. The grain also has the distinctive hump in the central region of the dorsal surface found in the cultigen but not in the weed.

The large grains from Usujiri B are within the size range of both the rice paddy-mimic and cultigen species of *Echinochloa*. The sixty varieties of barnyard millet have variable grain size. The length varies from 1.6 to 2.8 mm and the width varies from 1.7 to 2.3 mm. Experiments show that *Echinochloa* caryopses shrink by as much as 10% during carbonization (Crawford 1983:31). Thus more than 25% of the Usujiri B barnyard grass grains are within the range of the cultigen species. The embryo shape of all the grains and the dorsal surface contour on the well-preserved specimen are not at all like the respective features of the rice paddy-mimic form of barnyard grass. The grains are very similar to the cultigen species of *Echinochloa*.

Two cultigen populations in North America, sunflower (*Helianthus annuus*) and sumpweed (*Iva annua*), exhibit an increase in seed/achene size through time (Asch and Asch 1978; Black 1963; Yarnell 1972, 1978). Such an increase in seed size often accompanies domestication of a species (Schwanitz 1967:14-24). The characteristics of the Japanese *Echinochloa* grains indicate that phenotypic variation attributable to selection processes leading to domestication were under way in Hokkaido.

Other Millets: Foxtail and Broomcorn

About a half-dozen grains of a spherical grass grain were recovered from a flotation sample at Usujiri B. They are morphologically identical to domesticated *Setaria italica* ssp. *italica*, foxtail millet. No other foxtail millet grains have been recovered from the site, so their meaning is difficult to assess. They have not been recovered from the only other extensively sampled and analyzed Middle Jomon site in northeastern Japan, Tominosawa (D'Andrea 1992). Two possibilities may be entertained. First, the grains may be intrusive from a later period. Some examples of Final Jomon pottery occur in shallow house fill levels. Ainu material, including a burial, has been found at Usujiri B. However, none of these is associated with the sample in question. No other cultigen remains characteristic of Ezo or Ainu subsistence occur at Usujiri B. Second, the specimens may be Jomon. If so, they are further corroboration of the presence of cultigens in northeastern Japan during the Jomon.

The only other known examples of millets from northeastern Jomon sites come from the Kazahari site in the Aomori prefecture. D'Andrea (1992) has identified both foxtail millet (*Setaria italica* ssp. *italica*) and broomcorn millet (*Panicum miliaceum*) from the Late Jomon component of the site. Rice comes from the same component and has been dated using the accelerator mass spectrometry technique to the early third millennium B.P. (D'Andrea et al. 1995). The evidence is building for gardens being present during the Jomon of northeastern Japan.

There is no evidence that either foxtail millet or broomcorn millet was domesticated locally. However, a few examples of foxtail grass, probably green foxtail (Setaria italica ssp. viridis) and panic grass (Panicum sp.) are found in Jomon flotation samples, although they are relatively rare. Two specimens of probable panic grass have been recovered from Hamanasuno site floor and pit samples (Crawford 1983:35). Only one probable foxtail grass has been found in samples from the Kameda Peninsula Jomon; this was found in a Middle Jomon house (House 62) at Hamanasuno. D'Andrea (1992) reports a similar single occurrence of foxtail grass from the floor of House 87 at Tominosawa. D'Andrea also found one unidentifiable Paniceae seed from the same house floor. In the Late Jomon contexts at the Kazahari site in the Aomori prefecture are the six foxtail grass seeds mentioned earlier. Wild foxtail grass (likely green foxtail) and probable panic grass are well represented in assemblages from later sites such as Sakushu Kotoni River, which have ample evidence of crops. Quite likely in this last case these grasses are field weeds, and the same may be true for the Late Jomon Kazahari occupation. Green foxtail, in particular, is a very common grain-field weed

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(Douglas 1985). Two weedy taxa of panicoid grasses, *Echinochloa* and *Setaria*, are common in Ezo period sites. They are likely garden weeds, and the seeds are found in very low densities compared with the occurrence of cultigens from the same sites.

Other Grasses

At least twenty other grass taxa occur in the Kameda Peninsula Jomon samples. Not all have been identified, however. Rye grass or wheat grass seeds (*Elymus* sp. or *Agropyron* sp.) occur in samples from the Yagi site in southwestern Hokkaido. Ninety-four seeds have been found, and most come from one sample, an occupation floor within the fill of House 3. The grains are quite large (3.8-4.4 mm long). Also in the Yagi samples are more than a thousand yet unidentified small (1.0-1.5mm) grass seeds. Most of these are from House 3, and their occurrence has a strong positive correlation with the occurrence of the *Elymus* or *Agropyron* seeds. A different type of small grass seed occurs in a hearth of House 60 and in House 30A at Hamanasuno (Crawford 1983:35).

Discussion

Comparison of carbonized plant remains assemblages spanning some seven millennia in northeastern Japan provides evidence of four weed associations: one for the Initial Jomon, another spanning the Early through Late Jomon, a Zoku-Jomon pattern, and a clear agricultural pattern during the Yayoi and Ezo-Haji/Satsumon. Localized processes of anthropogenesis are distinguishable in the archaeological sequence much earlier than regional pollen studies suggest. Early through Late Jomon exhibits a relatively consistent pattern of annual and perennial weeds while the subsequent periods, the Zoku-Jomon and Yayoi-Ezo, have weed assemblages consistent with wet rice production and dryland plant husbandry, as well as seeds of domesticated species/plant staples. Evidence points to plant domestication and cultivation earlier than the Late Jomon and certainly by the end of the Late Jomon in northeastern Japan.

The weedy grasses from the Jomon are consistently represented by *Echinochloa*. With the advent of intensive food production, *Echinochloa* is still present, but *Setaria italica* ssp. *viridis* is found in significant quantities. When rice is found in abundance at sites, the rice mimic, *E. crusgalli* var. *oryzicola*, is also present. The one exception is the Late Jomon

occupation at the Kazahari site where rice is associated with foxtail millet and broomcorn millet but with no evidence of paddy-field production methods. Weedy grasses are low in diversity at these sites, as they are in the Jomon. Although these grasses are higher in density than in the preceding Jomon samples, their proportion in relation to other seeds is low because of the quantities of cultigen grains. *Echinochloa* and *Setaria italica* ssp. *viridis* are likely weeds of tilled fields and represent contamination of grain harvests (barley, wheat, millet) rather than purposeful gathering.

By the end of the Middle Jomon, *Echinochloa crus-galli* grains appear to undergo a change to a form that is indistinguishable from the cultigen species, *E. utilis*. So far, evidence for this form comes from only one site, but flotation sampling at Middle Jomon sites is still rare. Furthermore, grasses were apparently part of a harvesting regime during the Jomon. It is within this context that domestication may have been occurring.

At the outset I argued that anthropogenesis is an issue that must be examined if we are to have any understanding of the longevity of the Jomon and the changes that led to the beginning of plant husbandry as a significant aspect of aboriginal life in northeastern Japan. Systematic research during the past twenty years on plant assemblages in northeastern Japan is helping us come to an understanding of these issues. Pollen analysis is but one component of the research focusing on human-plant interactions in Japan. Assemblages of plant remains recovered by flotation provide a much more localized indication of the ecological contexts that were useful to people. With continued research we will be able to develop a much clearer picture of the reciprocal relationships that obtained between human beings and plants in Japan and the roles that people played in the biodiversity of this Asian archipelago.