Notes

Late Jomon cultigens in northeastern Japan

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The subsistence basis for Japanese civilization has always been intensive rice cultivation. What was grown there before the introduction of paddy technology? A glimpse of the plant cultigens in the later Jomon begins to tell.

Investigations of the possible role horticulture played in Jomon cultures, despite discussion over several decades (e.g. Crawford 1983, 1992b; Kotani 1981; Nakao 1966; Sasaki 1971; Tsukada *et al.* 1986; Ueyama 1969), have been hindered by a lack of radiocarbon-dated cultigen remains. Sporadic occurrences of domesticated plants are reported from sites inhabited as early as the Initial Jomon (TABLE 1) (see Crawford 1992a for a review). At the very least, small-scale horticultural activities appear to have been practised by some Jomon groups. Before the nature and economic importance of these activities can be evaluated, the cultigens must be placed in a proper cultural context. Until now, none of these remains has been directly dated. Atomic Mass Spectrometry (AMS) dating of two rice grains (*Oryza sativa* var. *japonica*) from the floor of a Late Jomon pithouse at the Kazahari site in northeastern Honshu (FIGURE 1) are the first such dates obtained on cultigens that confirm their Jomon association. From the same floor, two other crops, foxtail (*Setaria italica* ssp. *italica*) and broomcorn millet (*Panicum miliaceum*) have been identified (TABLE 2).

Historical		**1250–present**
Kofun	Final	1300–1250
	Late	1500–1300
	Middle	1600–1500
	Early	1700–1600
Yayoi	Late	1900–1700
	Middle	2100–1900
	Early	2300–2100
Jomon	Final	3000–2300
	Late	4500–3000
	Middle	5600–4500
	Early	7500–5600
	Initial	9500–7500
	Incipient	13,000–9500
Late Palaeolithic		32,000–13,000

TABLE 1. *General cultural chronology for Japan (BP) (after Barnes 1988; Ikawa-Smith 1980).*

The conservative view holds that, following the initial introduction of rice to Kyushu at the beginning of the Early Yayoi (*c.* 2300 BP), rice cultivation moved slowly northeastwards after a rapid spread into southwestern Honshu, not reaching northern Tohoku until the Late Yayoi (*c.* 1900 BP) (Akazawa 1982; 1986). This model has been revised since the recovery of several Early Yayoi rice paddy fields in northern Tohoku (e.g. Murakoshi 1988; Suto 1988), which indicate the swift dispersal of rice paddy field technology to Tohoku from its initial adoption in Kyushu (Barnes 1993; Crawford 1992b; Suto 1988). In southwestern Japan, non-paddy rice growing may have been practised many centuries before paddy production. Lack of adequate archaeobotanical studies in Tohoku, however, has hindered our understanding of prehistoric human-ecological is-

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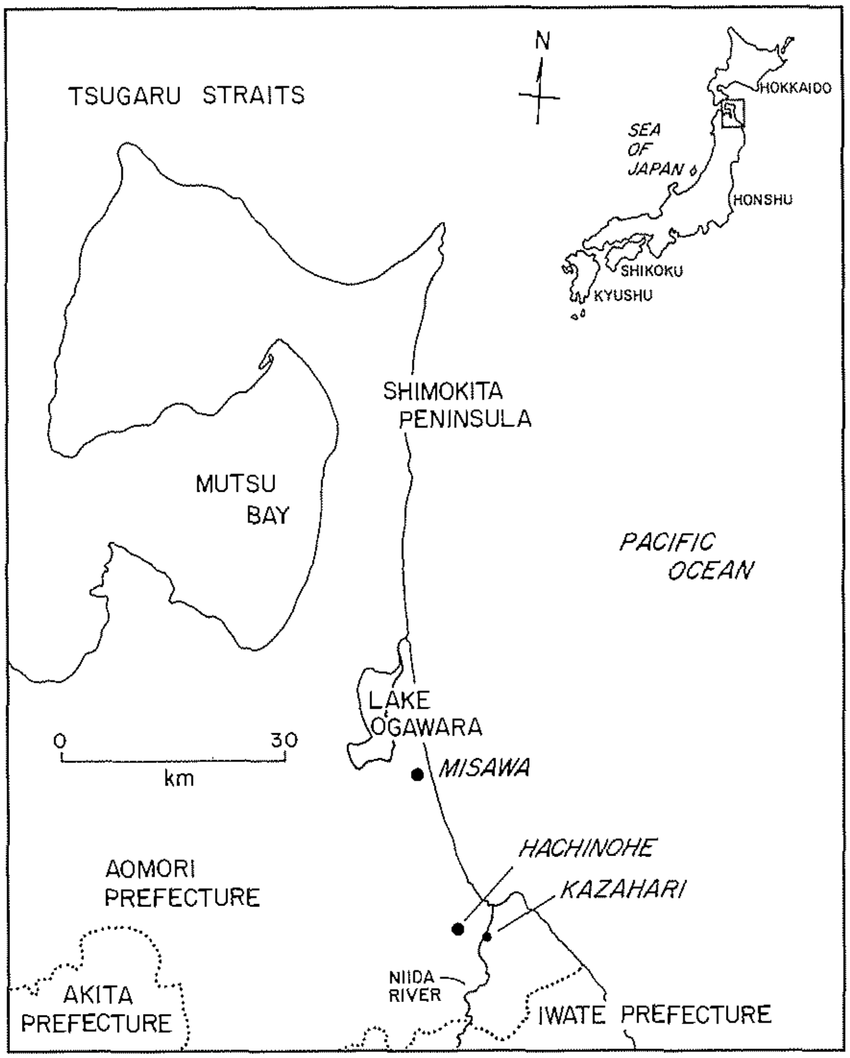

FIGURE 1. *Kazahari site location.*

sues there. Study of the samples reported here, the first to be recovered in Tohokn systematically by flotation, supports not only the hypothesis for a more rapid northeastward spread of rice and its presence as a non-paddy product of Jomon horticultural activities in Tohoku, but confirms the hypothesis of a pre-Yayoi introduction of rice to Japan.

The Kazahari site

The Kazahari site is located near Hachinohe City, on the southern edge of the Sanbongi Uplands in southeastern Aomori Prefecture (FIGURE 1). Occupations began during the Late Jomon and continue into the Historical period (TABLE 1). The site is on a ridge-top location overlooking the former flood plain of the Niida River, which is now covered with rice paddies. Along the higher margins of the valley, secondary forests are presently dominated by oaks, especially *Quercus dentata* (D'Andrea 1992).

Structures at Kazahari date to an early (Tokoshinai I) and later (Tokoshinai IV) phase of the Late Jomon, the Final Jomon–Tohoku Yayoi (Fukurashima) and Heian periods. The rice was recovered from the floor of Pithouse 32, a circular dwelling measuring about 16 x 15 m located at the southern end of the site (FIGURE 2). The sampled floor deposits produced exclusively Tokoshinai IV phase ceramics which date, by seriation, to the end of the Late Jomon (*c.* 3000 BP). More detailed discus-

common name	scientific name	subgrid (cultigens only)	number (weight)	percentage of total no.
cultigens				**4**
broomcorn millet	*Panicum miliaceum*	75	1	
foxtail millet	*Setaria italica* ssp. *italica*	69, 133, 147	7	
rice	*Oryza sativa* var. *japonica*	66, 72	7	
weedy annuals				**26**
knotweeds	*Polygonum*		3	
	P. lapathifolium		5	
	P. lapathifolium-type		34	
	P. type 1		10	
	P. type 3		2	
grass family	Poaceae		8	
barnyard grass	*Echinochloa crusgalli*		10	
foxtail grass	*Setaria*		2	
green foxtail	*Setaria italica* ssp. *viridis*		4	
panicoid grass	Paniceae		13	
goosefoot	*Chenopodium*		2	
sheep sorrel	*Rumex*		1	
fleshy fruits				**11**
elderberry	*Sambucus*		31	
silver vine	*Actinidia*		7	
bramble	*Rubus*		1	
grape	*Vitis*		1	
other seeds				**1**
legume	Fabaceae		1	
prickly ash	*Zanthoxylem piperitum*		3	
unknown			3	**1**
unidentifiable			211	**57**
nuts				
walnut shell	*Juglans ailanthifolia*		(123·39*)	
acorn (cotyledon)	*Quercus*		(6·06*)	

* estimated

TABLE 2. *Plant remains identified from Pithouse 32 at the Kazahari site, Aomori Prefecture.*

sions on sampling, processing and analysis are presented in D'Andrea (1992).

Sampling and flotation processing

A 0·5-m grid subdivided the 5-cm thick floor deposits of Pithouse 32 into 208 subunits (FIGURE 2). Approximately 37% of the floor fill (76 subunits) was sampled for flotation. Subunits were chosen systematically to cover the entire area of the floor, and to avoid certain areas containing large stones and ceramic vessels that required more delicate excavation. The southwest floor portion was not sampled because the sterile substrate had been exposed prior to excavation. In addition, 50% of 21 pits (K–U), 100% of 10 postholes (A–J), and a small part of the central hearth area were sampled (D'Andrea 1992).

The soil samples were processed using two SMAP-type devices (Watson 1976). One apparatus, modified to our own specifications in 1986, is useful for large-sample processing (20 l or more). A smaller version of our SMAP-type device, 'Project Seeds Model Type-1', is designed to process soil samples of less than 20 l. In each case, the light fractions are recovered in a 0·425-mm geological sieve, while the screen employed to collect the heavy fractions has a mesh opening of 1·5 mm.

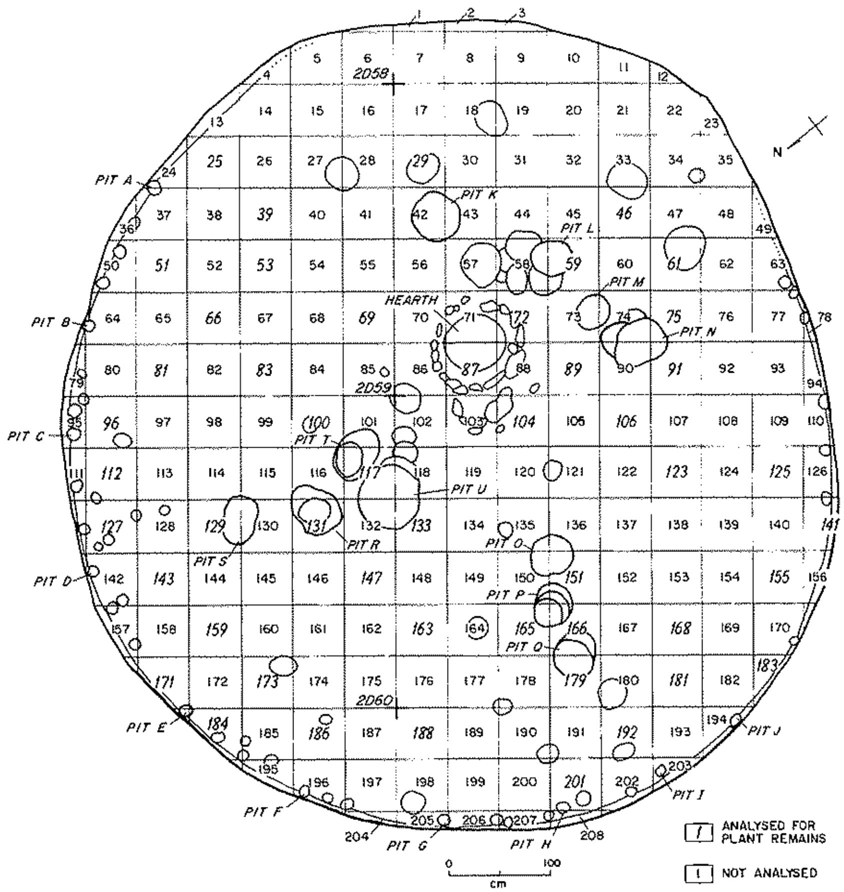

FIGURE 2. *Kazahari Pithouse 32.*

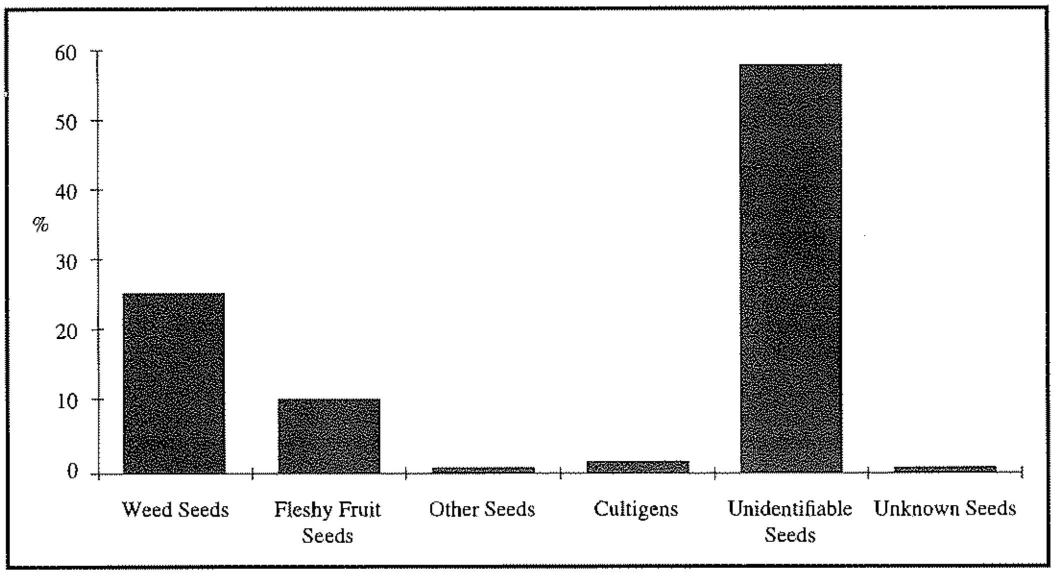

FIGURE 3. *Kazahari Pithouse 32: major seed categories as percentages of total seed count.*

Results

The archaeobotanical data from Pithouse 32 contexts (Tokoshinai IV) are summarized in FIGURE 3 and TABLE 2. The flotation samples produced 367 seeds in total, averaging 0·2 seeds/l (range 0–1.1 seeds/l). A total of 15 genera have been identified, three of which represent domesticated plants. Rice (FIGURE 4), foxtail millet and broomcorn millet total 15 grains (TABLE 2). The range of wild and weedy plants represented by this collection is found throughout the well-studied late Early and Middle Jomon of southwestern Hokkaido (Crawford 1983; 1992b). However, the relative density and abundance of weedy annuals, particularly the foxtail, barnyard, and Paniceae grasses, compare more closely with collections recovered from the dry-land food producing Ezo-Haji phase (proto-historic) in northern Tohokn and Hokkaido (Crawford in prep.).

Prior to this study, rice was not known to be present in Tohoku until the Final Jomon Obora A phase, contemporary with the Early Yayoi of western Japan (Suto 1988). Broomcorn and foxtail millet were previously unknown in the Tohoku Late Jomon (Crawford & Takamiya 1990). Although the context of the Kazahari cultigens seems secnre, to test the Tokoshinai IV association of the rice in particular, two rice caryopses were radiocarbon-dated at the University of Toronto IsoTrace Radiocarbon Laboratory. The resulting determinations, 2540±240 b.p. (787 BC) (TO-2202) and 2810±270 b.p. (925 BC) (TO-4086), are more consistent with Tokoshinai IV than late Fukurashima. The dates appear slightly younger than expected for Tokoshinai IV, although by only one or two centuries (TABLE 1). These are the only radiocarbon dates available for Kazahari.

Late to Final Jomon (undated by radiometric means) rice is present in western Japan at sites such as Kuwagaishimo (Nishida 1976), Uenoharu (Kotani 1972) and Nabatake (Kasahara 1982; 1984). In addition, rice phytoliths have been identified at several Middle through Final Jomon sites (Tsukada 1986: 50; Yoshizaki 1995). The Kazahari specimens are, therefore, younger than evidence for rice in southwestern Japan. Broomcorn millet, known in Ezo-Haji contexts in southwestern Hokkaido, has not been previously identified in 3rd-millennium BP contexts in Japan (Crawford 1992a).

FIGURE 4. Oryza sativa *var.* japonica *caryopsis from Pithouse 32, Kazahari.*

The foxtail millet from Tokoshinai IV contexts at Kazahari provides additional evidence for the early presence of this cnltigen in the northeast. Foxtail millet grain is known from 4000–3800 b.p. Middle Jomon levels at Usujiri B (Crawford 1992b), and possible millet-like pollen has been recovered in Late Jomon levels (3000 BP) at Ukinuno Pond (Tsnkada *et al.* 1986). Barnyard millet (*Echinochloa utilis*) is also present at Usujiri B (Crawford 1983; in prep.), but the barnyard grass caryopses from Kazahari represent wild forms. The only other evidence for Late Jomon domesticates in the northeast is buckwheat pollen from the Kyunenbashi site, Iwate (Yamada 1980).

The case for plant husbandry at Kazahari

Evidence from Tokoshinai IV phase contexts is not sufficient to demonstrate that crops were either imported to, or grown at, Kazahari. However, the ecological requirements of rice, foxtail and broomcorn millet, as well as ethnohistoric records of farming in China and adjacent regions, do not preclude the possibility of local plant husbandry (D'Andrea 1992; in prep.). Foxtail and broomcorn millet, domesticated in northern China, in addition to Japanese barnyard millet, can tolerate rather extreme ranges in environmental conditions. Broomcorn and Japanese barnyard millets may have the lowest water requirements of any cultivated cereal. These species are also well adapted to both semi-arid and high altitude conditions with low precipitation and poor soils. Foxtail millet is not as tolerant to drought, but it can survive a wide range of soil conditions (Chang 1983; Purseglove 1972). Other millets also mature quickly, and in general, these crops require less tending than many cereals (Chang 1983).

In many ways, rice also is an adaptable plant. It is able to tolerate a wide range of soils but requires plentiful water and high growing-season temperatures (a summer monthly mean of 20°C) (Trewartha 1965). These requirements, however, do not severely restrict its range (Bray 1984; Grigg 1974). These conditions are present today in northern Tohoku and Hokkaido. Some of the highest yields of rice in Japan are produced in Nagano Prefecture and northern Honshu where the climate is not subtropical. Rice, particularly the Japonica type, benefits from the long photo period of northern regions (Trewartha 1965).

Prehistoric paddy fields have not yet been identified in the Kazahari site vicinity, so wet-rice husbandry cannot be demonstrated to have taken place here. However, ethnography has demonstrated the existence of numerous methods of rice cultivation that do not require irrigation technology, many of which are not easily categorized into traditional 'wet' and 'dry' systems. For example, swamp rice is grown in low-lying marshlands fed by rainfall. Various techniques of swidden rice-growing are also known, with fields located in marshes or on hillsides. Methods such as these are relatively widespread in Southeast and South Asia (Lambert 1985).

Irrigated rice paddy agriculture is a relatively modern development. Large-scale irrigation works involving terracing did not exist in China before 700 BC (Chang 1983; Ho 1977), and transplanting seedlings into constructed paddies was not practised before the Han Dynasty (200 BC–AD 220). However, the earliest evidence for rice in China dates to at least *c.* 7000 BP (Chang 1986), indicating that other methods of cultivation were employed for thousands of years. Chinese historical literature documents the practice of seeding rice by broadcast into low-lying natural ponds and swamps, and this technique may have been used in prehistoric times (Ho 1977). Similar practices, however, are not mentioned in early Japanese texts. Nevertheless, the origins of wet-rice paddy agriculture clearly is a separate issue from the origins of rice cultivation. This certainly appears to be the case in China, and by inference in Japan as well. In this light, small-scale rice cultivation in addition to the gardening of millet, buckwheat and other crops, may well have been practised by later Jomon inhabitants of Kazahari.

Conclusion

The first flotation results from a Late Jomon structure in Tohoku have produced a small, but significant data set. These results should encourage archaeologists to look beyond the marine-focused subsistence that they have viewed as being the norm for the region. Furthermore, we should assume that the use of crops through exchange or local gardening continued into the Final Jomon, by the end of which more intensive plant husbandry was in place. The Hachinohe area encompasses numerous habitats where plant cultivation could have flourished along with the procurement of marine resources. Although the plant remains from Kazahari do not demonstrate unequivocally that rice and millets were grown on site during the Tokoshinai IV phase, ecological, historical, and ethnographic evidence do not contradict the hypothesis that horticulture was undertaken locally at this time.

Data from Kazahari and other sites in the Tohoku area show that by the following Final Jomon and Tohoku Yayoi periods, wet-rice and millet farming were established in the region. Although southwestern influences are apparent in the later development of the Yayoi culture in Tohoku, the Kazahari data provide evidence that crops (at least rice, broomcorn and foxtail millets) were present as early as the Late Jomon. This indicates that by the time Yayoi technological changes were introduced to northern Tohoku, the local inhabitants already had been familiar with domesticated plants for quite some time.

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References

AKAZAWA, T. 1982 . Cultural change in prehistoric Japan: receptivity to rice agriculture in the Japanese archipelago, in F. Wendorf & A.E. Close (ed.), *Advances in world archaeology* 1: 151–211. New York (NY): Academic Press.

1986. Hunter–gatherer adaptations and the transition to food production in Japan, in M. Zvelebil (ed.) *Hunters in transition*: 151–66. Cambridge: Cambridge University Press.

BARNES, G.L. 1988. *Protohistoric Yamato*. Ann Arbor (MI): Museum of Anthropology, University of Michigan. Anthropological Papers 78.

1993. Miwa occupation in wider perspective, in G.L. Barnes & M. Okita (ed.), *The Miwa project*: 181–92. Oxford: Tempvs Reparatvm. BAR international series 582.

BRAY, F. 1984. Agriculture, in J. Needham (ed.), *Science and civilisation in China* 6: *Biology and biological technology*: part II. Cambridge: Cambridge University Press.

CHANG, K.C. 1986. *The archaeology of ancient China*. 4th edition. New Haven (CT): Yale University Press.

CHANG, T.-T. 1983. The origins and early cultures of the cereal grains and food legumes, in D.N. Keightley (ed.), *The origins of Chinese civilization*: 65–94. Berkeley (CA): University of California Press.

CRAWFORD, G.W. 1983. *Paleoethnobotany of the Kameda Peninsula Jomon*. Ann Arbor (MI): Museum of Anthropology, University of Michigan. Anthropological Papers 73.

1992a. Prehistoric plant domestication in East Asia: the Japanese perspective, in C.W. Cowan & P.J. Watson (ed.), *Agricultural origins in world perspective*: 7–38. Washington (DC): Smithsonian Institution Publications in Anthropology.

1992b. The transitions to agriculture in Japan, in A.B. Gebauer & T.D. Price (ed.), *The transitions to agriculture*: 117–32. Madison (WI): Prehistory Press.

In preparation. Anthropogenesis in prehistoric northeastern Japan.

CRAWFORD, G.W. & H. TAKAMIYA. 1990. The origins and implications of late prehistoric plant husbandry in northern Japan, *Antiquity* 64: 889–911.

D'ANDREA, A.C. 1992. Palaeoethnobotany of Later Jomon and Yayoi cultures of northeastern Japan: northeastern Aomori and southwestern Hokkaido. Ph.D thesis, Department of Anthropology, University of Toronto, Canada.

In preparation. Later Jomon palaeoeconomy and agricultural dispersals into northeastern Japan: new evidence from Aomori.

GRIGG, D.B. 1974. *Agricultural systems of the world*. Cambridge: Cambridge University Press.

HO, P.-T. 1977. The indigenous origins of Chinese agriculture, in C.A. Reed (ed.), *Origins of agriculture*: 411–84. Paris: Mouton.

IKAWA-SMITH, F. 1980. Current issues in Japanese archaeology, *American Scientist* 68: 134–45.

KASAHARA, Y. 1982. Nabatake Iseki no Maizo Shushi no Bunseki Dotei Kenkyu [Analysis and identification of ancient seeds from the Nabatake site], in Tosu-shi Kyoiku Iinkai (ed.), *Nabatake*: 354–79. Tosu-shi: Tosu-shi Kyoiku Iinkai

1984. Maizo Shushi Bunseki ni Yoru Kodai Noko no Kensho 2 — Nabatake Iseki no Sakumotsu to Zasso no Shurui o Yobi to Rai Keiro [Examination of ancient agriculture from the perspective of archaeological seed analysis 2 — species and routes of introduction of crops and weeds at the Nabatake site], in *Kobunkazai-Henshu Iinkai* (ed.), *Kobunkazai no Shizen-Kagakuteki Kenkyu*: 617–29. Tokyo: Dotosha.

KOTANI, Y. 1972. *Economic bases during the latter Jomon periods in Kyushu, Japan: a reconsideration*. Ann Arbor (MI): University Microfilms International.

1981. Evidence of plant cultivation in Jomon Japan: some implications, in S. Koyama & D.H. Thomas (ed.), *Affluent foragers*: 201–12. Osaka: National Museum of Ethnology. Senri Ethnological Studies 9.

LAMBERT, D.H. 1985. *Swamp rice farming*. Boulder (CO): Westview Press.

MURAKOSHI, K. 1988. Sunazawa Iseki [The Sunazawa site], in H. Kanaseki & M. Sahara (ed.), *Yayoi Bunka no Kenkyu [Research on the Yayoi culture]*: 211–13. Tokyo: Yuzankaku.

NAKAO, S. 1966. *Saibai Shokubutsu To Noko No Kigen [Cultigens and the origin of agriculture]*. Tokyo: Iwanami Shinsho.

NISHIDA, M. 1976. Shokubutsu Shushi no Dotei [Seed identification], in B. Tsunoda & M. Watanabe (ed.), *Kuwagaishimo Iseki [The Kuwagaishimo Site]*: 244–9. Kyoto: Heian Hakubutsukan.

PURSEGLOVE, J.W. 1972. *Tropical crops: monocotyledons*. London: Longman.

SASAKI, K. 1971. *Inasaku izen [Pre-rice cultivation]*. Tokyo: NHK Books. No. 147.

SUTO, T. 1988. The Jomon–Yayoi boundary in the Tohoku region, *Kikan Kokogaku* 23: 23–9.

TREWARTHA, G.T. 1965. *Japan*. Madison (WI): University of Wisconsin Press.

TSUKADA, M. 1986. Vegetation in prehistoric Japan, in R.J. Pearson (ed.), *Windows on the Japanese past*: 11–56. Ann Arbor (MI): Centre for Japanese Studies, University of Michigan.

TSUKADA, M., Y. TSUKADA & S. SUGITA. 1986. Oldest primitive agriculture and vegetational environments in Japan, *Nature* 322: 632–4.

UEYAMA, S. (ed.). 1969. *Shoyojurintai bunka 1 [Laurel forest culture 1]*. Tokyo: Chuokoronsha.

WATSON, P.J. 1976. In pursuit of prehistoric subsistence: a comparative account of some contemporary flotation techniques, *Midcontinental Journal of Archaeology* 1: 77–100.

YAMADA, G. 1980. Iwate-ken Kitakami-shi Kyunenbashi Iseki no Kafun Bunseki ni Tsuite [Analysis of pollen from the Kyunenbashi site, Kitakami City, Iwate Prefecture], in Kitakami Board of Education (ed.), *Kyunenbashi Iseki [The Kyunenbashi site]*: 63–75. Kitakami: Kitakami Bunkazai Chosa Hokoku.

YOSHIZAKI, M. 1995. Nihon ni Oderu Saibai shokubutsu no Shutsugen [The appearance of domesticated plants in Japan], *Nihon no Kodaishi no Saizensen: Hakkutsu Repouto 1995*. Bessatsu [Supplement].