

INITIAL COLONIZATION, AND SUBSISTENCE ADAPTATION PROCESSES IN THE LATE PREHISTORY OF THE ISLAND OF OKINAWA

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ABSTRACT

The date of the initial settlement of Okinawa is considered in the light of various models for the successful colonization of islands and demographic growth patterns. It is likely that any Pleistocene inhabitants either became extinct or left Okinawa as rising sea levels isolated it from continental Asia, and that successful re-colonization only took place in the Late Jomon period when rapid population growth occurred for the first time in the pre-history of Okinawa. Flotation of soil from the Nazakibaru site near Naha City yielded remains of some cultigens from the later part of the Yayoi-Heian Period, the oldest so far known from Okinawa.

INTRODUCTION

Of the numerous small islands distributed across the Pacific (or across the world for that matter), some of the most extensive and detailed archaeological work has been carried out on the island of Okinawa and its satellite islands (Figure 1). For instance, 25 sites were excavated in 1993 and at least 24 in 1992 (Okinawa Koko Gakkai 1992, 1993). In addition to the large number of sites excavated each year, relatively large site areas are usually excavated. Consequently the culture history of the island is much better understood than it was twenty years ago - certainly better than in many other islands in the Pacific.

While we have a good understanding of the island's time-space framework little is known of its colonization (Takamiya, Hiroto 1993). Although Okinawa has yielded more than a dozen Pleistocene human remains, it is not clear at all if Pleistocene people successfully adapted to the island environment or whether successful coloniza-

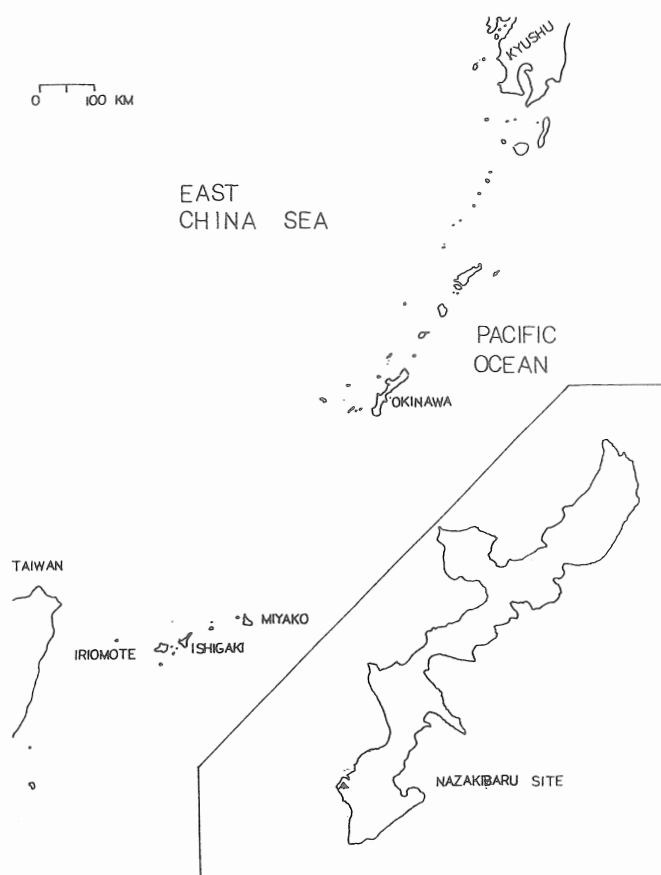


Figure 1: The location of Okinawa and the Nazakibaru site.

tion only took place at a later period. What was the adaptation strategy during the colonization period and afterwards?

The purpose of the present paper is two-fold. Firstly, it will examine the timing of successful colonization of Okinawa. Secondly, the paper will introduce preliminary analysis of paleoethnobotanical samples from the Nazakibaru site, a late Yayoi-Heian period site in Naha city. The data provide the earliest direct evidence of food production in Okinawa.

ISLAND COLONIZATION - THE THEORETICAL BACKGROUND

Any initial settlers to an island must overcome a series of challenges. The most immediate ones are adjustment of subsistence economy and maintenance of population size. It is likely that the new island environment did not provide identical food items to the homeland of the colonizing population (see Keegan and Diamond 1987). For example, assuming that the initial colonizers came from Japan to Okinawa, they would have found only seven mammal species there, compared with 107 in Japan (Yasuma 1983). Whereas fairly large animals, such as deer, inhabit Japan, the largest mammal in Okinawa is the wild boar. The other mammal species present in Okinawa are much smaller, such as rats and bats. For the colonizing population to survive, they would have had to adapt to the environment of the island and establish a subsistence economy accordingly.

The second challenge is to maintain the population. It is probably safe to assume that an initial colonizing group in prehistoric time would have been small in size and extremely vulnerable to natural disasters and endemic diseases. For example, a population of five can easily be wiped out by *tsunami*, typhoon or malaria. Even if they could obtain sufficient food and avoid extinction, this does not guarantee the continuation of the island population, which must consist of an adequate number of both sexes capable of reproduction (McArthur *et al.* 1976). It is not until these two challenges are overcome in the new environment that successful adaptation to an island would take place.

Once an initial population overcomes the immediate challenges, its size is likely to grow exponentially until it approaches the carrying capacity of the environment (Kirch 1984; Keegan and Diamond 1987: 74). This pattern of population growth has been observed in ants and other animal species (Pianka 1978; Diamond 1977a and b). Diamond explains the resulting logistic population curve in terms of the r-selected and k-selected reproductive strategies of MacArthur and Wilson (1967). The former is suitable in an unstable environment and characterized by reproduction of many offspring; the latter is

seen among organisms inhabiting a stable environment who reproduce small numbers of offspring.

Diamond (1977a and b) believes that an r-selected reproduction strategy would be desirable for the initial human colonizers to an island. As the group adapted to the environment, a k-selected strategy should be employed. The result would be rapid population growth during the initial colonization period and slower population growth as the group became more familiar with the environment. This would produce an S-shaped population growth curve.

While the concept of r-/k-selected reproduction strategies as applied to human colonizing populations is still in question (Kinjo pers. comm. 1993), a logistic model of population growth is expected once a population successfully colonizes an island. For example, Kirch's (1984) reconstruction of population history in Hawaii between AD 800 and 1700 produced an S-shaped population growth curve, as did his reconstruction of the population history of Kahoolawe island between AD 1000 and 1600.

However, human island populations do not seem to maintain equilibrium after the population saturation level is reached. Kirch (1984) proposes three hypothetical population growth curves: overshoot ('crash'), oscillating, and 'step curve'. The overshoot (crash) model suggests that populations increase beyond the carrying capacity of the environment and subsequently become extinct. On the other hand, the oscillating model hypothesizes that the population level is maintained around the carrying capacity. Keegan and Diamond (1987: 78) report that evidence to support this model is 'scanty'. The third model, the step curve, is expected if a higher level of carrying capacity is obtained by technological innovation or intensification.

Kirch stresses the importance of population dynamics to an understanding of the colonization process and resulting adaptational success or failure for an island:

Since adaptedness in the sense of persistence of the group or population is a matter of reproductive success, it is evident that population growth, stability, or decline are significant indicators of a population's state of adaptedness and of the process of adaptation over time. (Kirch 1980:143)

Thus, in order to understand the process of colonization of Okinawa, the prehistoric Okinawan population trajectory must be reconstructed if adequate data are available. The paper will first discuss the possibility of successful colonization during the 'Paleolithic' period and then examines the Jomon-Gusuku periods.

THE 'PALEOLITHIC' IN OKINAWA

The earliest evidence of human activity in Okinawa comes from the Yamashita-cho cave site in Naha city, which has been radiocarbon dated to 32,000 BP. In addition, several other 'Paleolithic' sites have been excavated, including the well known site of Minatogawa (Ginowan shi 1993). The most diagnostic feature is that many Paleolithic sites have yielded human skeletal remains, some of which have contributed substantially to an understanding of the evolution of the Japanese population (Hanihara 1993). Although this period is called 'Paleolithic', no unequivocal stone tools and no distinctive artifact types have been recovered. Instead, numerous modified deer bones are associated with the human skeletal remains. Some scholars (Tokunaga 1936; Takamiya and Takemoto 1986) believe that they are humanly modified bones; others, especially Kato (1977), argue that they were modified by deer chewing activity.

Did the Pleistocene *Homo sapiens sapiens* successfully adapt to the island? Some archaeologists seem to believe that they did and that more 'Paleolithic' sites will be discovered in the future on the island or in the ocean surrounding Okinawa, since many of them must have been submerged due to sea-level rise.

However, this may not be the case. Firstly, there are only six sites identified as 'Paleolithic', which date between 40,000 and 10,000 BP. The scarcity of sites makes one wonder if a human population continuously occupied the island. Secondly, although *Homo sapiens sapiens* was there during this time, the latest geological studies indicate that Okinawa was not an island but part of the continent between 200,000 and 18,000 B.P. (Kimura 1991). Following the last glacial maximum, sea level rise might have caused a rapid decline in the carrying capacity with consequent population extinction. Indeed, so far no sites which date to between 18,000 and 7000 BP. have been located.

What happened on King and Flinders Islands off the northern coast of Tasmania is likely to have occurred also on Okinawa. According to Jones (1977), there is evidence of human activities on the Bass Strait islands when they were joined by a land bridge to the enlarged Australian continent. However, as sea-level rose, the human populations on King and Flinders Islands either became extinct or moved elsewhere. In contrast, Tasmania was continuously occupied. Jones (1977) concludes that Tasmania was large enough for a hunter-gatherer population to survive, but King and Flinders Islands, a little larger than Okinawa, were not. These lines of evidence strongly suggest that the 'Paleolithic' human population of Okinawa became extinct or did not successfully adapt

to the shrinking post-glacial-maximum island environment.

THE JOMON - GUSUKU PERIODS

The post-Paleolithic prehistoric sequence in Okinawa is usually divided into three major periods; Jomon, Yayoi-Heian and Gusuku (Tables 1 and 2). The earliest sites in Okinawa during this time period date back to the Initial Jomon. Many, if not all, archaeologists seem to believe that the island has been continuously occupied since the Initial Jomon period. In order to test this belief, I have attempted to reconstruct the population history of the island.

MAINLAND JAPAN		OKINAWA	
PALEOLITHIC		"PALEOLITHIC"	
JOMON		JOMON	SHELL MIDDEN PERIOD
INITIAL		INITIAL	
EARLY		EARLY	} INITIAL
MIDDLE		MIDDLE	
LATE		LATE	EARLY
FINAL		FINAL	MIDDLE
YAYOI / HEIAN	} /	YAYOI / HEIAN	LATE
GUSUKU			

Table 1: Cultural terminology for Japan and Okinawa

Although archaeological work on Okinawa dates back to 1904 (Takemoto and Asato 1993; Takamiya, Hiroe 1993), Tomoyose (1969) has been the only scholar to make estimates of the prehistoric population. Since no pre-Late Jomon site was known at that time, he calculated population levels for the Late Jomon, Final Jomon and Yayoi-Heian periods. Based on several assumptions, he estimated a population of 1200 for the Late Jomon, 2480 for the Final Jomon, 11,710 for the early part of the Yayoi-Heian Period, and 36,750 for the later part of this period (Figure 2). The shape of the resultant population growth curve is exponential, which seems unlikely according to the models of island growth set out earlier in

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"PALEOLITHIC"	At least 30,000 years
JOMON	
INITIAL	Possibly 3,000 years
EARLY	1,000 years
MIDDLE	1,000 years
LATE	1,000 years
FINAL	600 years
YAYOI/HEIAN	1,200 years
GUSUKU	400 years

Table 2: Cultural durations in Japan and Okinawa

this paper. Indeed, although his attempt is admirable, Tomoyose's results cannot be used since his estimation is based on several assumptions which automatically would increase population exponentially.

Many methods have been applied in archaeology to reconstruct past populations, based on calculations from food residues, numbers of artifacts, numbers of residential sites, numbers of houses/rooms in a site, site sizes (see Hassan 1981) and also radiocarbon dates (Rick 1987). Probably the most reliable method is the one based on the number of residential sites, as with Kirch's work in Polynesia (Kirch 1984), but this cannot be used in this case since only a few of the sites which have been excavated on Okinawa have yielded house structures. Other possible methods were considered but the only approach found to be appropriate in Okinawan conditions is one based on site numbers. Fortunately, most local government authorities in Okinawa have conducted site surveys over the last ten years, and the Okinawa Prefectural Board of Education produced a site distribution map for Okinawa in 1977. Thus, the number of archaeological sites is well documented. Assuming that the number of sites by time period reflects population history in Okinawa, I have counted all identified sites in Okinawa and its satellite islands (Figure 3).

So far, a total of 756 sites has been reported for mainland Okinawa; 337 from the Gusuku period and 419 from the Jomon and Yayoi-Heian periods. Figure 3 indicates that although people colonized the island during the Initial and Early Jomon periods, rapid population growth, as in west Hawaii and Kahoolawe (Kirch 1984), did not occur immediately. Indeed, the population may have become extinct or abandoned the island, since no unequivocal Middle Jomon sites have been reported on Okinawa. On the other hand, rapid population growth obviously did take place during the Late Jomon.

A similar result is obtained when site frequencies are considered for the satellite islands. As seen in Figure 4, only a small number of sites have been reported there during the Initial, Early and Middle Jomon periods and no single island appears to have been continuously occupied at this time. During the Late Jomon period, however, the number of sites again rapidly increases. The only difference between Okinawa and its satellite islands as seen in Figures 3 and 4 is that while the number of sites in Okinawa continued to increase during the Gusuku, they decreased at this time in the smaller islands (Figure 5). However, this interpretation may be misleading since the durations of the periods being considered are not the same. Table 1 shows the duration of each period generally agreed among Okinawan archaeologists.

In order to deal with this problem, I have attempted to calculate the number of sites per 100 years for each period. Figure 6 shows the result of this procedure for Okinawa. It shows rapid population growth in the Late Jomon, with continuing increase in the Final Jomon. For some reason, however, the number of sites decreased during the Yayoi-Heian period. This is an unexpected result since it is generally believed among Okinawan archaeologists that site numbers continuously increased at this time. In the following Gusuku period, the number of sites rapidly increased again. When the same procedure is carried out for the satellite islands, exactly the same pattern is obtained (Figure 7). Since the same patterns have been obtained from both Okinawa and its satellite islands (Figure 8), a similar adaptation process appears to have been taking place in this region. Based on this study, the following two interpretations are proposed:

Firstly, the site frequency histograms strongly indicate that *successful* colonization of Okinawa and its satellite islands took place during the Late Jomon period. It is possible that human populations adapted to the island environment during the late part of the Middle Jomon and the early Late Jomon period. Secondly, if the results (Figure 8) are seen as a long term adaptive process, the

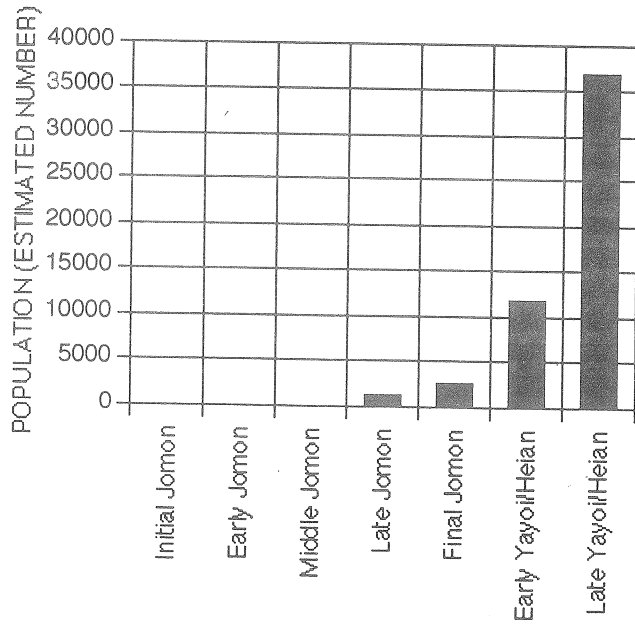


Figure 2: The prehistoric population of Okinawa as estimated by Tomoyose (1969).

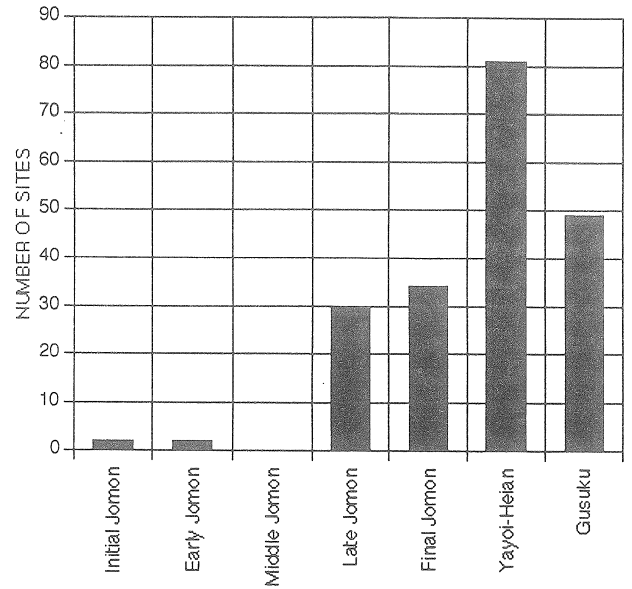


Figure 4: The number of archaeological sites on the satellite islands of Okinawa by major cultural period.

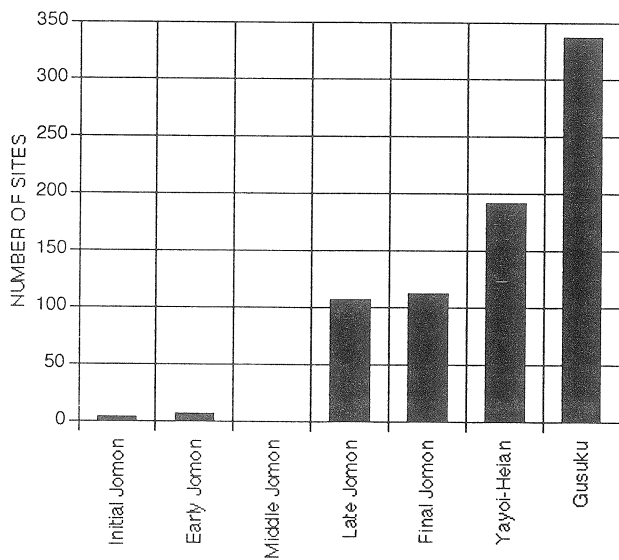


Figure 3: The number of archaeological sites on Okinawa Island by major cultural period.

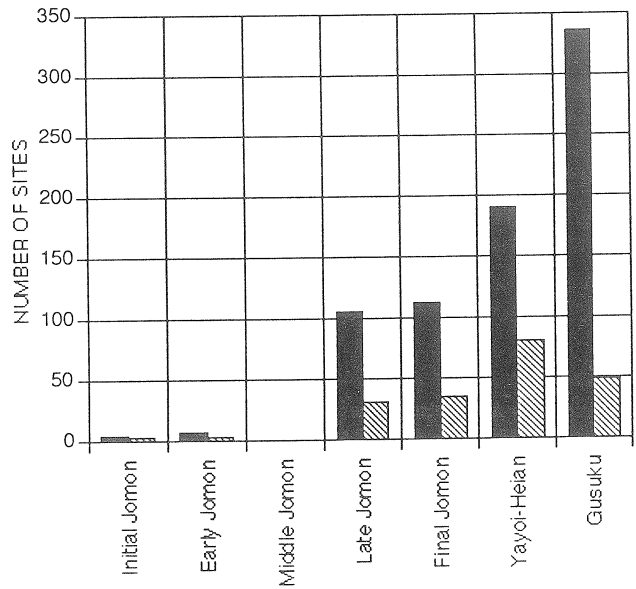


Figure 5: The number of archaeological sites on Okinawa and its satellite islands compared, by major cultural period (Okinawa in black, other islands hatched).

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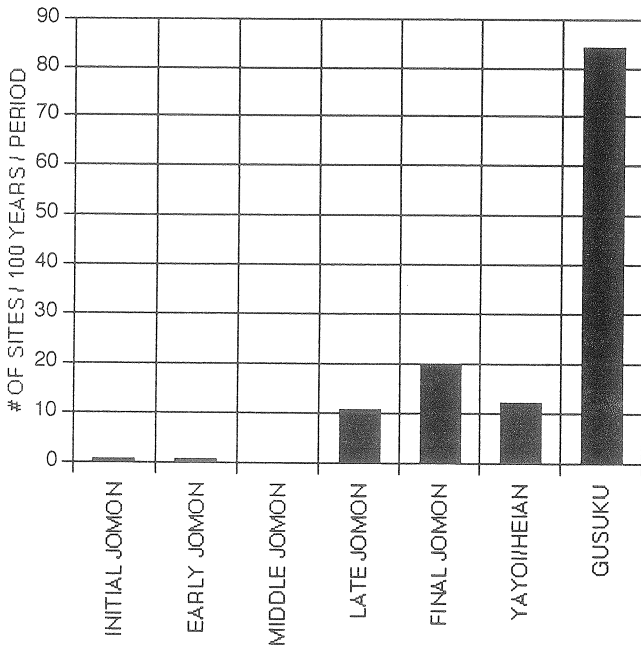


Figure 6: The number of archaeological sites per 100 years on Okinawa, within the major cultural periods

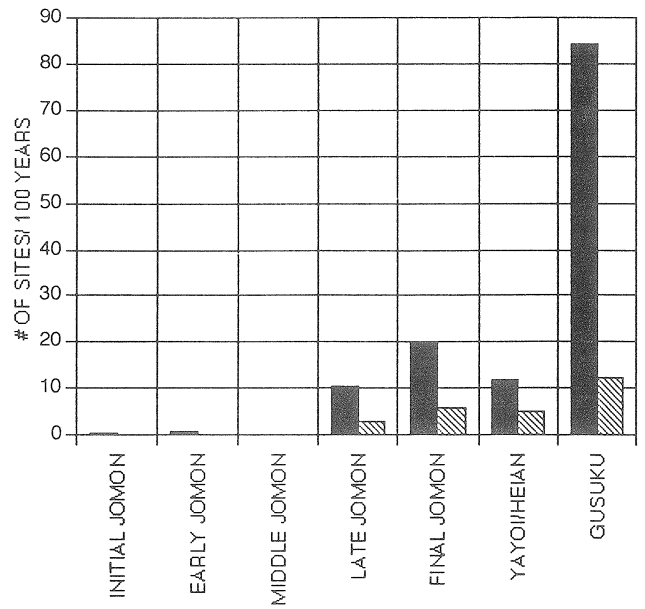


Figure 8: The number of archaeological sites per 100 years on Okinawa and its satellite islands, compared (Okinawa in black, other islands hatched).

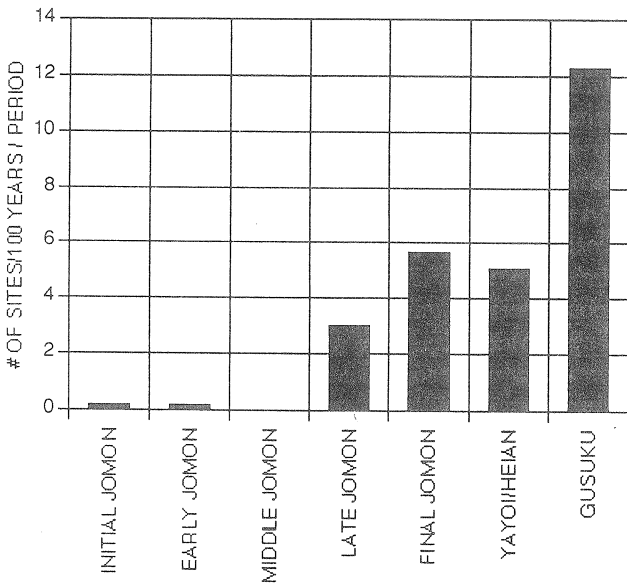


Figure 7: The number of archaeological sites per 100 years on the satellite islands of Okinawa, within the major cultural periods

population growth curves (site frequency curve) show what Kirch (1984) calls a step growth model.

Our job as anthropological archaeologists is to establish the subsistence adaptation process in Okinawa. What kind of subsistence strategy was employed by the prehistoric Okinawans? The next section will introduce the subsistence adaptation process of the later part of the Yayoi-Heian period, based on a preliminary analysis of paleoethnobotanical remains from the Nazakibaru site.

THE SUBSISTENCE ADAPTATION STRATEGY OF THE YAYOI-HEIAN PERIOD

As seen in Figures 3-8, the Okinawan population seems to have rapidly increased during the Gusuku period, which is characterized by the local beginnings of food production and the emergence of ranked societies. Several Gusuku sites have yielded remains of cultigens such as wheat, barley and rice. Did food production begin in the Gusuku period, or was it undertaken prior to this time? There is no easy answer to this question because no cultigens have yet been recovered from pre-Gusuku sites. This is probably because appropriate methods have not been employed to extract plant remains from these sites. A few archaeologists have used the water separation method. But as Pearsall (1989) and others (e.g. Wagner

1989) strongly state, flotation, not water separation, is the best method to use. Since 1992, the Okinawa Prefecture Board of Education, the Naha City Board of Education, the Ginowan City Board of Education, the Chinen Village Board of Education, the Yomitan Village Board of Education and the Ginoza Village Board of Education have kindly provided me the opportunity to collect soil samples from the prehistoric sites for flotation.

One of the sites I was able to collect soil samples from was the Nazakibaru site, which is located in Naha City (Figure 1). The site belongs to the later part of the Yayoi-Heian Period, possibly dating to the 10th century AD or as early as the 8th century (Shima 1992 pers. comm.). It was excavated by the Naha City Board of Education from July to December 1992. Nazakibaru has yielded few artifacts compared with other sites in the region and features from which macrobotanical remains would be expected, such as house structures, were absent. The only features which would be expected to yield plant remains were five small so-called 'burnt soil areas'. Accordingly, the soil sampling strategy was to collect all the burnt soil from these and adjacent areas. A total of 145 soil samples comprising 1687 liters of soil were collected and floated. Of the light fraction samples ('flot') obtained, 50 have so far been microscopically analyzed.

As noted, Nazakibaru has yielded only a small number of artifacts and features. This statement is also applicable to the light fractions, which are extremely small. So far, the heaviest sample weighs only 5.54 g and the lightest 0.04 g (average 0.81 g per sample). The scarcity of light fraction and fire- and consumption-activity related features implies that Nazakibaru may not have been the best site to elucidate the subsistence adaptation process of the later part of the Yayoi-Heian period. However, although the samples are extremely small, they have yielded exciting results. First and foremost, the samples have yielded the oldest evidence of cultigens so far recovered in Okinawa. Amongst the plant remains analyzed, two rice grains (*Oryza sativa*) and one wheat grain (*Triticum aestivum*) have been identified. In addition, a bean which may or may not be a cultigen has also been recovered. So far, these are the only cultigens identified, and they may be the only ones present in the 145 flotation samples from the site. However, two lines of paleoethnobotanical reasoning suggest that this evidence could represent the earliest food production in Okinawa.

Firstly, no nut remains were found in the samples. Many archaeologists have suggested that nuts may have been an important food source prior to the Gusuku period and these are the only plant remains obtained from the pre-Gusuku sites. Absence of nuts implies that this food

source may have been replaced by something else, possibly cultigens (e.g. Crawford 1983; Hastorf 1980). Secondly, the samples contain several grass species. Some of them, according to Hatushima and Amano (1977), grow in open and/or marsh areas (see also Ikehara 1984).

The paleoethnobotanical data from the Nazakibaru site, although extremely scanty, imply the presence of agriculture in Okinawa at least two centuries earlier than previously thought. The intensification of subsistence strategy implied by these findings perhaps triggered rapid population growth in the Gusuku period.

CONCLUSION

This paper has examined the possible timing of the successful colonization of Okinawa. My impression is that many archaeologists believe that Okinawa was continuously occupied by human populations, either from the Paleolithic or at the latest from the Initial Jomon. The latest geological study hypothesizes that Okinawa may not have been an island, but what Keegan and Diamond (1987: 64) call a 'land-bridge island' during the Late Pleistocene. Comparing Okinawa with the case of the Bass Strait islands, it is likely that the Paleolithic human population of Okinawa either became extinct or moved elsewhere with rising sea levels.

In order to test the second possibility, the population history of Okinawa and its satellite islands was reconstructed from the archaeological record. The results strongly indicate that successful colonization of the island took place only during the later part of the Middle Jomon or the earlier part of the Late Jomon, but not prior to this time.

The estimation of prehistoric population sizes based on site numbers shows a rapid increase during the Late Jomon and Gusuku periods, with the population growth curve indicating a step model. In order to understand why population grew so rapidly during the Gusuku period, a study was carried out at the Nazakibaru site (Yayoi-Heian period) in Naha City. Preliminary analysis of floated plant remains from the site has yielded fragments of a few cultigens (rice, wheat and possibly a bean), these being the earliest evidence yet found of agriculture in Okinawa. There are also grass seeds. Additionally, the lack of nut remains in the Nazakibaru light fraction samples, these being so common in earlier sites, implies the presence of food production during this period.

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