Prehistoric Japanese Populations: A Subsistence-Demographic Approach

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Introduction

Quantitative measurements of the populaion are important in reconstructiong a prehistoric society because size, density, and aggregation may have many social correlates. Obtaining such data is difficult, however, because only indirect evidence such as archaeological remains and ethnological records of current societies are available. Nevertheless, various scholars have attempted to estimate the population size of prehistoric societies.

One of the possible methods is a subsistence-demographic approach, particularly for the hunter-gatherer stage (Baumhoff 1963 , Koyama 1981). It is clear that the size of population of a society is determined by the amount of food supply. Food stuffs are exploited from a given environmemt. Therefore, the quality of the environment helps determine the population of a given society.

How much a society can exploit available food stuffs depends upon the efficiency of its technology. Therefore it is not the environment itself but the techno-environment which determines the population size. Japan may be a good area to test this proposition. Because It consists of islands, for which land size as well as ecological zones are easy to define. Also, in Japan ecological and archaeological information is abundant and well-organized.

I have calculated the size of the prehistoric population in the Japanese archipelago for the hunter-gatherer Jomon period and the agricultural Yayoi periods by using a number of sites (Koyama 1978), then adjusted it by using a simulation model (Koyama and Sugito 1984). Later, I estimated the Paleolithic population through ethnographic records (Koyama 1989).

The results suggest that the last 60,000 years of population change can be expressed in a logistic curve (fig. 1). There are three distinctive curves for the Paleolithic, Jomon, and Yayoi respectively. Distribution patterns are also different for each period (fig. 2).

This paper discusses the demographic characteristics of the Japanese prehistoric peoples in relation to their strategies for adapting to specific environments.

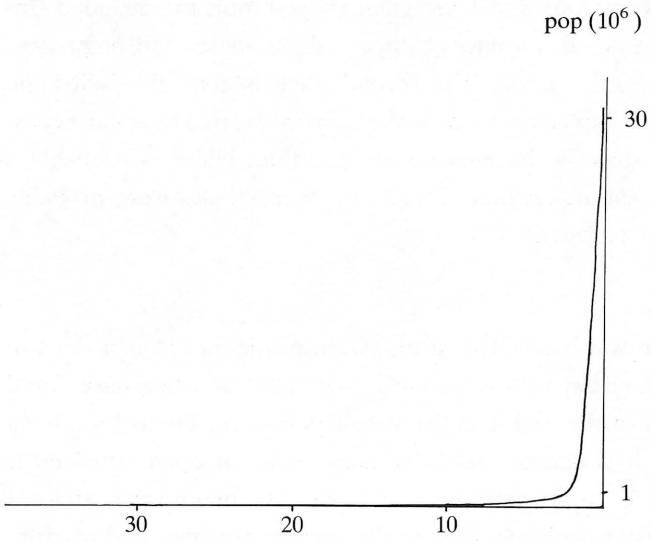
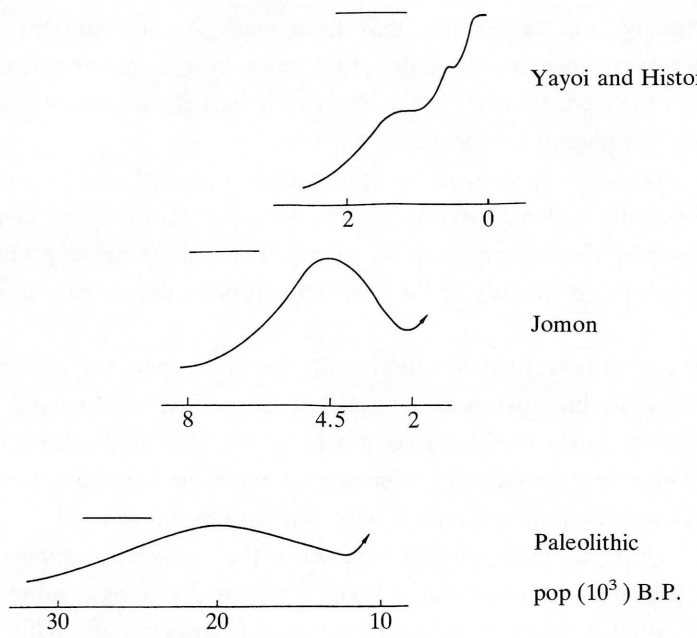


Fig.1 Population Increase in the Japanese Archipelago

Fig.2 Population curves for the Paleolithic, Jomon, and Yayoi



I. The Paleolithic period

1. Tool traditions

The Paleolithic period is divided into three stages. The earliest stage is not yet clearly defined in Japan; generally it includes any stone tool complex some of which are controversial which dates before 30,000 B.P. The consensus of Japanese archeologists so far is that traditions with roughly shaped heavy tools and very small, irregular shaped tools are included (Inada 1988). The Levalloi-like technique which produces sharper edged blades and points was introduced from the Continent during this period. The second stage is generally called the Knife-blade tradition. These were small implements which were probably used as spear heads, as well as for knife blades. The last stage is the micro-blade tradition, which is probably a part of the North Asia and Subarctic cultural region. These tiny micro-blades were probably spear points which were attached to long shafts.

2. Environment

During the last glacial period, Japan was connected to the Asian continent through the Korean peninsula and Sahalin. At that time Japan was primarily separated into two basic floral zones: the sub-arctic coniferous forest in the east and the subtemperate deciduous broad-leaf forest in the west (fig. 3). Generally it is known that subsistence value of open grassland is higher than dense forest area because it fosters large game animals. The major open areas of Paleolithic Japan were (1) The Shimokita peninsula area of the present northern end of Honshu Island, where basically tundra-swamp field was surrounded by peripheral open grassland and sparse forests. (2) The present Kanto plain area where large open grassland was intermingled with tundra swamps and surrounded by sparse forests. (3) The central Alpine area

where mosaic open lands, dense and sparse forests were scattered over mountains and valleys. Though these open areas were limited in size, they attracted hunters because abundant fauna were well-sustained by the mosaic flora. (4) The present Seto Inland Sea was swampy lowland surrounded by sparse forests. (5) What is today Northern Kyushu was then steppe grassland which extended out to the present Tsushima Island and over to the present Korean peninsula.

3. Site distribution

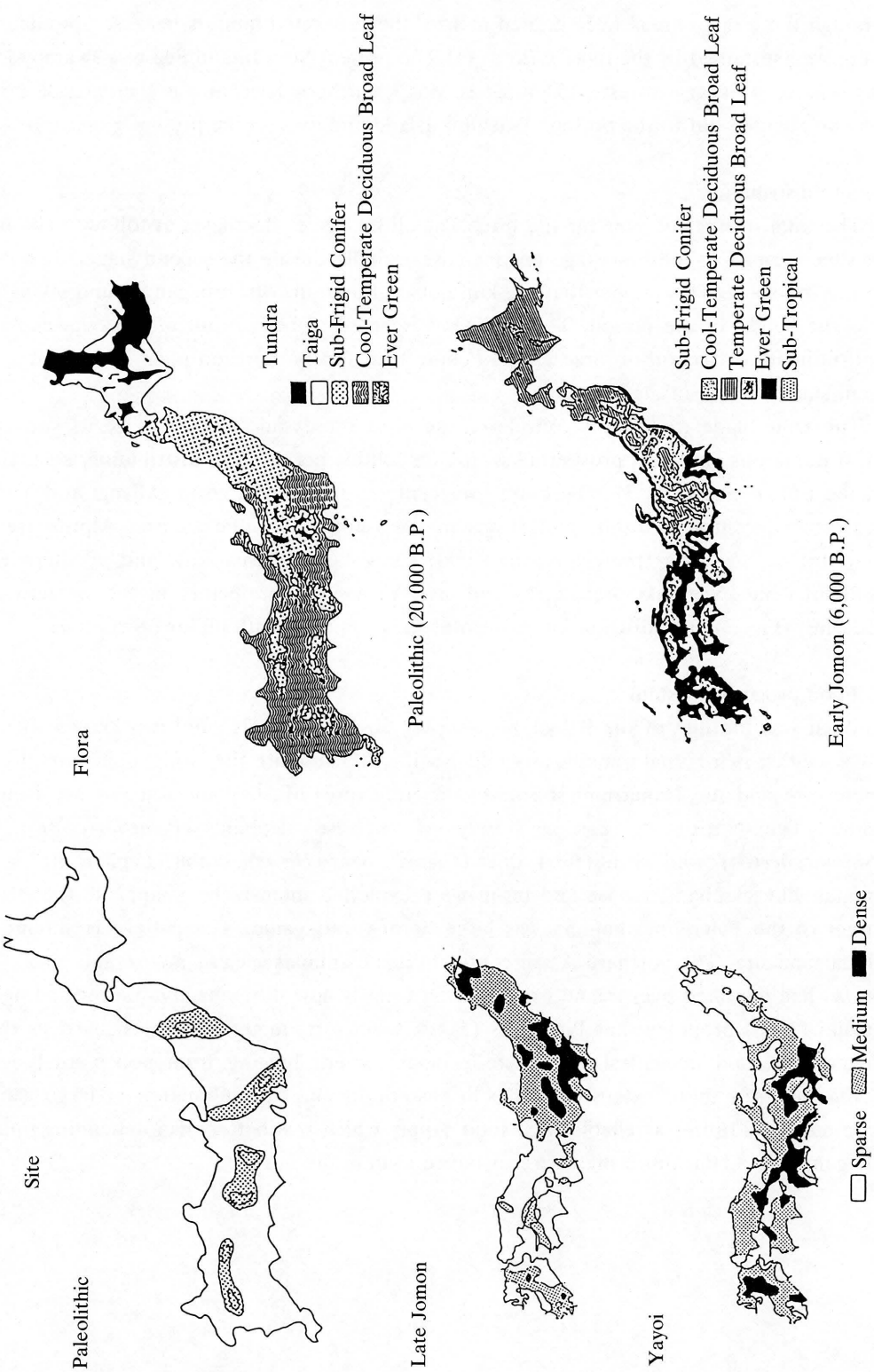
The total number of sites for the three Paleolithic stages fluctuates as follows: The number of sites is small in the first stage but increases rapidly during the second stage, then declines in the last stage. This implies that the knife-blade tradition, which began around 30,000 B. P., was the height of the period. The decline is inferred to be a result of the over-exploitation and ultimate extinction of large game. People had to rely more on plant foods and less efficient smaller game in the last stage.

The knife-blade tradition is considered the most successful stage, because its sites are the most numerous and most prosperous of the Paleolithic period. The distribution is summarized in the isobar map (Fig. 3). There are four centers: northern Honshu (Miyagi and Yamagata prefecture), central Honshu (prefectures in the Kanto plain and Central Alpine area), the Seto Inland Sea area (prefectures in Kinki, Chugoku and Shikoku), and northern Kyushu (Fukuoka and Nagasaki prefectures and also Yamaguchi prefecture at the western end of Honshu) (Fig. 3). The distribution pattern of sites coincides with major open areas.

4. Food procuring system

What was the diet of the Paleolithic people? So far there are only two known sites which have yielded rich faunal remains as well as artifacts. These are the Nojiri Lake site of Nagano prefecture and the Hanaizumi site of Iwate prefecture. Most of the remains are from large game. The Nojiri site has a variety of species: elephant (*Palaeoloxodon*), moose (*Sinomegaceros*), wild cattle (*Bos*), deer (*Cervis*), bear (*Ursus*), rabbit (*Lepus*), etc. but large animals like elephant, moose and bison were exploited intensively. It appears that the main target of the Paleolithic hunters was large herbivorous game. The pattern is similar in the Hanaizumi site. The northern Asian continent game animals such as moose and bison (*Leptobison*) had migrated over a land bridge across what is now the Soya and Tsugaru straights. C. Suzuki (1988) proposes that Pine nuts (*Pinus koraiensis*) might have been used as the supplementary food in central and western Japan, where judging from pollen analysis *Pinus koraiensis* grew more extensively than in eastern Japan. A combination of large game and pine-nuts could offer a reliable, rich food supply which was better than depending upon simple game diet. Thus more sites were sustained than in the north.

Fig.3 Site and Floral Distribution in the Japanese Archipelago



5. Food crisis

The main game target shifted during the Paleolithic, offering us a clue for understanding resource deterioration. Large game had migrated into the Japanese Archipelago from the Asian continent while land bridges existed. Many theories on the condition of these bridges have been presented to explain a series of migrations. General agreement is that two routes, a northern route to Hokkaido and a southern route to Kyushu, existed. Those land bridges might not have been stable even at the height of glaciation about 20,000 B.P. They are supposed to have formed only in winter when the shallow water was frozen. This implies that migration of game resources was not continuous. Even the unstable influx disappeared after the rise of sea level, a result of the warmer climate which eventually insulated the Archipelago completely around 10,000 B.P. During this warming process, we find that large animal bones disappear from the archaelogical record, indicating over-exploitation of game. Elephant (*Paleoloxodon*) was already extinct before the knife tool tradition appeared. Bison (*Lopto*) and horse (*Equus*) disappeared by 10,000 B.P. Moose (*Sinomegaceros*) remained in the earliest Jomon stage (8,000 B.P.) but was scarce. The resource influx itself was hampered by declining numbers on the east Asian continent itself as a result of extensive hunting. It this way, large game was almost completely wiped out in Japan during the Paleolithic period.

6. Population

The knife tools show four distinct types: the Sugikubo, the Moro, the Kofu, and the Kyushu. Each has its own distribution area, through which Japan can be divided into five cultural zones, including Hokkaido where there is no knife tool tradition. I use these zones as the basis for inferring the Paleolithic population.

Judging from the sites, the population of the Paleolithic period is supposed to have been distributed more evenly over the Archipelago, in contrast with that of the Jomon which was concentrated in the East. The data of the sites, however, are still statistically insufficient to calculate convincing population figures or measures of its fluctuation. Thus I would like to employ contemporary ethnographic data of Australian aborigines and compare them with the above mentioned five cultural zones of the knife tool tradition during the height of the Paleolithic period.

Aborigines of Arhnem Land in northern Australia are huntergatherers. A few families with several relatives or hangers-on live together as a group. This group of 20 to 30 people is called a "hand" and forms the basic unit of daily life. A band migrates according to specific food targets. They also have larger associations based on kinship relations. The kinship association functions as a spiritual group for members sharing the same ancestor, whereas a band is a practical group for performing daily activities effectively. These kinship associations constitute a tribe which shares the same language, traditions, and customs. The tribe is the ultimate group in Aboriginal society. Average membership of a tribe is 500, though the number varies from a few hundred to over 5,000 (Tindale 1974). The size of tribal territories also varies, growing larger in harsh environments and smaller in affluent coastal areas. In some ways the tribal territories remind me of the above mentioned five cultural zones of Paleolithic Japan.

Supposing people in those five zones had similar economic patterns to those of the Australian aborigines, we could use the average figure of 500 per tribe to infer the Paleolithic population. The number would be about 2500, if all five zones had 500 people each. Howev-

er, in the abundant environment of Japan, the population might have been well over 3000 (There is no concrete evidence for this speculation so far). The maximum may exceed 1000 (which is the size of larger Australian Aboriginal tribes) in the Moro type zones, where the sites are extremely numerous. Such inference is not groundless if the number of sites for each zone at a given period is compared with the earliest stage of the Jomon (Table 1).

Table 1 Maximum Populations of Three Prehistoric Periods

	Kyusyu	West	Central	North
Paleo.	500	500	1,500	500
Jomon	5,300	4,200	205,100	46,700
Yayoi	105,000	252,500	149,800*	33,400

*Tokai region classified into West

II. The Jomon period

The Jomon period is a long-lasting tradition which began at the end of the last glaciation and lasted until about 2,500 B. P.. Although there is evidence of many cultivated plants, it is considered a hunter-gatherer economy which depended on an affluent forest and marine environment. The culture flourished particularly after 6,000 B. P.. They established large permanent villages with rich and complex material culture. Such aspects are reflected in the well-known Jomon pottery (Kidder 1968), and in the large monuments of stone and timber arrangements which would have required extensive communal cooperation.

1. Environment

The climate of Jomon was much warmer than that of the Paleolithic period. The Japanese archipelago was divided into two forest types, the warm temperate deciduous forests in the east and the evergreen forests in the west, both of which included nut-producing *Quercus* trees. There is evidence that the forests were cleared by fire (Sakaguchi 1987). The large herbivorous game of the Paleolithic were already extinct, and people had therefore shifted to medium-size game such as deer (*Cevis*), wildboar (*Sus*), antelope (*Capricornis*), and bear (*Ursus*). Rising sea levels reduced the land size but formed shallow bays and small inlets which provided rich coastal environments.

2. Food procuring system

The biggest difference in the Jomon food procuring system from that of Paleolithic period is the growing importance of nuts as a main diet resource and the exploitation of maritime resources, as seen in the formation of numerous shell mounds. The invention of pottery made such change possible.

Jomon is considered to be one of the earliest pottery cultures in the world. Radiocarbon datings in Kyushu at Fukui Cave show remains of linear-relief type pottery in Layer III at $12,700 \pm 500$, and at $12,400 \pm 350$, in Layer II. Fine-linear relief type pottery is also found at Kamikuroiwa Rockshelter in Shikoku in Layer IX dated to $12,165 + 600$. These earliest pottery types are often found with microlithic blades and cores from the paleolithic phase. On the basis of these dates it is fair to say that pottery was independently developed in Japan.

However, Japnese archaeologists in general are skeptical of this claim, probably because of the widely held commitment to cultural diffusionism.

The ecological and economic conditions of the period, as I have mentioned above, suggest why pottery was invented in Japan. Pottery vessels, it is assumed, were efficient utensils to use for extracting poison and to make hard materials softer and more digestible. Boiling may have been used as a food preservation method, and pots could also have been used for mixing foods to improve their flavor. Beside boiling, pottery vessels were useful for preserving and transporting food stuffs. In this late Pleistocene Japanese food crisis, the need for vessels seems to have been more vital than for other peoples on the Asiatic continent.

The invention of Pottery created a new dietary dependence on plant foodstuffs, especially oak acorns, which are abundant in Japanese forests. The energy output of acorns as a form of carbohydrate is extremely high. With acorns as staple food, Jomon society grew enough to establish permanent villages. Various kinds of vessels were manufactured, some of which were too elaborate for practical use.

The Jomon culture started to decline as the climate became cooler, particularly after 3000 B.P. It was almost catastrophic particularly in eastern Japan where we find a sudden and sharp decrease of sites and deteriorating cultural materials.

3. Population

The sparse yet rather evenly distributed population of the Paleolithic period expanded with the new food procuring system of the Jomon period. It was supported by a warming climate which peaked around 6000 B.P. The Jomon population then decreased precipitously as the climate cooled.

The Jomon population, which I estimated in 1983 using computer simulation, shows following characteristics: (1) The population increased and decreased in a roughly bell-shaped curve over a period of 8000 years or five stages. (2) The population reached a maximum of 260,000 in the middle Jomon period (4,500B.P.), then subsequently plummeted to about a third that size. (3) The population correlated closely with the climatic fluctuation. It increased when temperatures rose, and fell when temperatures cooled although there was a slight time lag. (4) Through the entire period eastern Japan was far more densely populated (nearly 95% of all) than the western half. The Kanto plain and Chubu mountain regions were particularly dense. Kyushu had a higher population than other areas in western Japan (fig. 3).

The maximum figure of 260,000 seems to be too large for a hunter-gather economy, unless there is an optimum environment. Thus as the climate cooled, the populaion decreased. The collapse of adequate food supply was disastrous in over-populated central Japan. Inflicted damage was far less in sparsely populated western Japan. An actual slight population increase there may imply gradual migration from eastern Japan or even from the Asiatic continent--an early flow of the later immigration. If that were so, the catastrophic decrease of population in the last stage of the Jomon period could have caused by epidemics brought by immigrants and spread though over-populated, poorly fed central Japan (Koyama 1984).

III. The Yayoi period

1. Food procuring system and bronze tools

The development of agriculture during the Yayoi period allowed new means of procuring food. The high productivity achieved through artificial management of the environment created a stable food supply. Cereals, especially rice from wet paddy fields, became the major food resource. New and effective tools of iron and bronze were brought in or aggressively imported from the Continent.

The distribution of bronze tools, especially mirrors, swords, and bells, indicates the growth of rival states in western Japan. Of those three, the sword and bell show clear contrast in the distributional areas. The center of bell distribution is in the Kinki area whereas that for swords is in northern Kyushu. The center of bell distribution changes from the Kinki region to the Chubu area after the middle period, indicating an expansion of the Kinki culture. It is my impression that the two cultures of the Kinki region and northern Kyushu show strong contrasts. The former seems to have been a more sedentary society based on agriculture, whereas the latter was a more commercial-oriented society eager to introduce advanced culture from the continent. Their active trade is mentioned in Chinese records.

2. Population

The population increased rapidly as a result of stable agricultural food supply. The new distribution pattern of population shows a concentration in western Japan (fig. 3).

The number of sites proliferated in western Japan. The population in the late stage may have exceeded one million. Hanihara (1988) suggests such a sharp increase could not be a natural growth of the indigenous population but is probably due to migration from the continent which may have amounted to more than 1. 2 million over 1000 years (from the Yayoi period through the end of the 8th century). He claims that the evidence can be seen in the physical changes of the Japanese during that time (*Hanihara and Naito this volume*), mainly in the Kinki region. It is interesting to note that the region had been sparsely populated in the Jomon Period.

IV. Changes in the Prehistoric Japanese population

The prehistoric population seems to have changed in several ways: (1) The peak of the Paleolithic period was at the knife tool stage of about 25,000 B. P., and the population was approximately 3000. People relied on big game hunting. The population, however, declined in the last stage micro-blade complex due to the extinction of large game through overexploitation. (2) New food procuring systems focusing on plant food developed during the following Jomon period permitted the population to grow. The Jomon lived mostly in eastern Japan. The population reached its maximum of nearly 300,000 about 4000 B. P. The Jomon population, which had been sustained by a favorable warm climate environment, again collapsed to a mere 70,000 or 80,000 at the end of the period when the climate cooled. (3) A Yayoi food procuring system based on wet rice agriculture made a constant and ample food supply possible, the cooler climate notwithstanding. The Japanese population again grew rapidly until by the end of the period. It exceeded 1,000,000. This growth continued through historic times

under the same system; by the end of the Edo period (150 B.P.) it had reached as much as 30,000,000.

Following our assumption that population size is closely related to the techno-environment, a population can be estimated by calculating and comparing caloric outcome from main food resources in an unit area (Table 2).

Table 2 Evaluation of Food Resources

	kg/h	Energy (Kcal)	ratio
Deer (Toya Lake, Hokkaido)	54	57,780	1
Acorn (Expo Park, Osaka)	1500	4,880,000	84
Rice (Paddy Field)	1780	6,016,400	104

Current data for deer around the Toyako Lake in Hoddaido were used to estimate hunted animals in the Paleolithic period. An average of 54kg/year meat can be extracted from one hectare (10,000m^2). This means 60,000 calories from the unit area. The figure increases 80 times for acorns, the typocal Jomon food, and 100 times for rice, the typical food from the Yayoi period on. These differences of food value match the rise in the population curve.

V. Conclusion

The Paleolithic culture was a culture of big game hunters. People formed groups of 20 to 30 members (resembling the bands of Australian aborigines) as an economic unit, probably organized with strong patterns of reciprocity. Larger association through loose combinations of these groups, similar to those of the aborigines, may also have existed.

The Jomon culture which followed had already achieved the level of horticulture by exploiting abundant forest resources. They had storage capability through their invention of pottery vessels. The society which still maintained a band character became more sedentary, judging from excavated site structures which have horseshoe formations of pit dwellings with numerous storage pits, graves, and ceremonial sites. They indicate increased cooperative work. These sedentary villages may have formed local unions which became a base of local culture. Ethnographically, the Jomon culture is thought to resemble the fishing-hunting-gathering societies of the Ainu, and the Northwest Coast and California Indians (Koyama and Thomas 1981). There may have been leaders or chief Gains who could control members through accumulating and redistributing resorces and who presided over big feasts. Sites such as the stone circles of Ohyu in Akita prefecture and huge timber circles of Shinbochikamori in Ishikawa prefecture indicate such social complexities.

The Yayoi period marked the establishment of agricultural food-production and the dawn of the state. Commercial activity had begun, and even a rudimintary monetary economy seems to have appeared. Such changes were achieved through interaction with the continent, particularly by migration. Early Yayoi sites in the Kyushu and Kinki areas have large building compounds surrounded by deep moats for defense, indicating intensive local development which then spread throughout the Japanese archipelago. Social classes began to separate. The consolidation and merger of local groups had already started. These conditions eventually gave birth to the Yamato (Imperial) Court in the next period. However, in Hokkaido,

hunting-gathering-fishing continued to form the basis of food production among the Ainu people until recently.

Looking at the corelations between population figures, changes in the techno-environment, and corresponding social organization gives us a glimpse of prehistoric Japan. But once one enters the historical era it is difficult to lay out such clear correlations.

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日本先史時代の人口動態

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筆者がおこなった推算によると先史時代の日本列島の人口は旧石器、縄文、弥生という時代にそれぞれ独立した動態をしめす。それは各時代の主要食資源の生産様式あるいは食糧システムに起因すると考えられる。

まず、旧石器時代は狩猟の時代でその主たる対象は大型獣であった。したがって食エネルギーの総生産は低く、それに対応して人口は最大時（約２万年前）でも10,000に満たなかった。分布は列島上にほぼ均一であった。

旧石器時代の食糧システムは氷河末期からの気候暖化によって終焉する。海面が上昇し、日本は大陸から孤立したためヒンターランドを失った動物資源が枯渇し、それにともない人口も減少した。

第二期の縄文時代は約12,000年前の土器の出現とともにはじまる。土器のもつ煮沸機能によって、アク抜きや硬い繊維質の軟化が可能になり、植物食の利用が盛んになった。縄文時代は堅果類を主食糧源とすることで食エネルギーが飛躍的に増大し、その結果人口量は盛期（中期）にいたって30万近くまで増えた。分布は生産力の高い落葉樹林の広がる東日本に集中している。

縄文時代の食糧システムは気候の寒冷化によって、効果的に機能しなくなった。堅果類の生産量が低下し、それまで過大に増加していた人口は崩壊する。

第三期にあたる弥生時代は大陸から水田稲作という新しい食糧システムの導入によってはじまった。これによって日本列島の人口は急激に増加し人口は弥生時代末には100万に達している。前代とは逆に温暖な西日本に人口が濃密になる。

人口と食資源の間には高い量的な相関関係がある。ここでいう食糧システムとは与えられた環境の下でいかに食資源を取り出すか、つまり環境の総生産量と、そこから食資源を取り出すための技術を意味するが、前者には気候要因、後者には技術や知識の発達、集団の規模といった変数が介在している。

旧石器時代は寒冷気候に適応した大型獣を対象とする狩猟を中心とした食糧システム、縄文時代は温暖気候下での堅果類の採集に依存するシステムであった。とくに縄文時代の食糧システムは効率が高く、多くの人口を支え、それによって高度な文化が開花したことはよく知られている。しかし狩猟採集という自然経済は激しい環境変化に対する耐性が低かった。日本列島の人口は農耕という食糧を管理生産する人工的な食糧システムの確立によってはじめて増加、安定したのである。