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AN OVERVIEW OF AROID CULTIVATION ON ATOLLS IN THE PACIFIC OCEAN

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Abstract

In Ulithi Atoll, we conducted a field survey. The information we were able to obtain may be useful for developing the discussion of aroid production on low islands to the general level. The method of cultivation on Mogmog Islet is not exceptional and is typical of pit cultivation. In this survey, we confirmed the cultivation of *Colocasia, Cyrtosperma* and *Alocasia or Xanthosoma.*

Keywords: aroid cultivation, atoll, Mogmog Islet, Ulithi Atoll

Particular Reference to Mogmog Islet in Ulithi Atoll

An overview of the islands in tropical Oceania requires no quantitative description of particular cases in order to understand the importance of aroids (taro and other botanically related food plants) to foodstuff production in the past. However, comparative studies of aroid cultivation and other related aspects demonstrate a broad diversity in differing natural and sociocultural environments. In this regard, it is convenient to classify islands into "high islands" and "low islands". The method of aroid production on atolls characterized by extremely low elevation contrasts markedly to that of the high islands.

Since Mogmog Islet in Ulithi Atoll, where we conducted a field survey, is one of the islets composing a typical atoll, the information we were able to obtain there may be useful for developing the discussion of aroid production on low islands to the general level. The most important natural factors in the atoll environment which relate to agriculture or horticulture are the limited availability of freshwater and the extremely calcareous soil. Mogmog Islet is located in the tropical oceanic region where the temperature of the sea surface is the highest in the world, and partly because of this, it very rarely undergoes severe drought. Nevertheless, because the coral reef composing the geologically upper layer of the atoll is highly porous and allows the seawater to continuously infiltrate, freshwater is not ubiquitously available. As is well known, freshwater accumulates only in a limited underground area in the shape of a lens, on account of its lower specific gravity than that of seawater. Accordingly, the aroids which cannot tolerate water with high salinity can grow only within a limited area, unless some artificial facilities are used. Furthermore, the fertility of highly calcareous soil is generally low. Such soil rapidly consumes organic matter, so continued cultivation in these areas requires continual inputs of organic matter (BARRAU 1961).

The general features of the cultivation of aroids on the Pacific atolls are described in BARRAU (1961). The method of cultivation on Mogmog Islet is not exceptional and exemplifies

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the category of pit cultivation. As a rule, a piece of land intended for aroid production is planted and cultivated without fallow. A great quantity of organic matter is added from the surrounding area, both for mulching and for maintaining soil fertility. The sporadic growth (though perhaps spontaneous) of *Vigna marina* (Leguminosae) (MANNER 1989–1990) also seems to contribute somewhat toward maintaining soil fertility. This type of cultivation is very "intensive". As shown in MANNER (1989–1990), the predominant aroid produced on Mogmog is giant swamp taro (*Cyrtosperuma chamissonis*) which "has a higher tolerance of salinity" (FALANRUW 1995). The islanders usually dig out the tubers of these plants after one year from planting.

The growth rate of the Mogmog tubers seems to be markedly higher than those on the Yap Islands, where the main crop is also the identical species of aroids (FALANRUW 1994). Although the actual measurement was for only one sample, the weight of a tuber with epidermis dug out after one full year from planting was 920 g. In reference to the estimated growth rate on the Yap Islands, under the assumption that tubers simply increase in arithmetic progression (in fact, the growth weight for the first year is considered to be less than the estimate with this assumption), their weight with their epidermis after one full year from planting is calculated to be approximately 500 g using the estimate based on the samples collected by NAKANO (2001). This difference in the initial growth rates is obviously considered to be closely correlated with the great quantity of organic matter added to the taro patch on Mogmog. On the Yap Islands, taro patches of giant swamp taro seem to receive less intensive management after they have been developed (FALANRUW 1995), though of course, some organic matter is also applied there (VARGO 1989–1990). As MANNER (1989–1990) states, usually only women are allowed into the taro patch (pit) of Mogmog Islet. Some of the old men complained that, "Nowadays, women don't work at all." The fact that we saw some patches completely covered with weeds at the central area of the taro pit possibly supports such a complaint, although we often heard the more general comment, "Everybody worked hard in olden days," which is a typical comment anywhere in the world.

The overall population density of Mogmog Islet is estimated to be 770/km^2 because the total area of Mogmog Islet is 0.22 km^2 (the estimate planimetrically measured based on the map in USHIJIMA (1982) using Planimex 25 manufactured by Nihon Regulator Co.) and its total population is estimated to be 170 based on the latest data obtained from an officer in charge of the statistics of Yap State in 2001. This population density can be regarded as high when we exclude urban areas. Throughout the late phase of the Pacific War, Ulithi Atoll was almost entirely used by the U. S. Navy as an anchorage and supply base. Military construction destroyed the taro pits on all main islets except Mogmog, and the taro pits did not recover after the war. However, Mogmog suffered less damage than the other islets (MANNER 1989–1990), and taro production on Mogmog has continued until the present time as described above. A great quantity of munitions were reportedly dumped into the taro pit on Mogmog, but the islanders made strenuous efforts to remove them after the war. Based on the map in USHIJIMA (1982), the area of the taro pit was planimetrically estimated to be approximately 1.4 ha. However, the islanders reported that they had continued to enlarge its area little by little. If so, its present area might be slightly larger than the estimated size. Calculating the mean per capita area of taro pit (acknowledging the possibility of the slight underestimate due to the foregoing circumstances) yields a result of 82 m^2/person. From this we may conclude that the taro pit cannot support the islet population if taro is the predominant staple, even with the initial robust growth of the taro tubers. According to MANNER (1989–1990), the islanders consume larger quantities of breadfruit than taro. Since 1997, Mogomog women have begun cultivating banana, cassava, and some other crops on the two adjacent uninhabited islets and this has further reduced dependency on taro. Also, the islanders consume a great quantity of imported rice and foods made from wheat flour. Although the quantitative importance of taro as staple foodstuff is limited, reportedly taro still retains cardinal importance on traditionall occasions. This seems to be a major factor motivating the continuation of taro pit cultivation.

This situation of high population density combined with very intensive agriculture or horticulture, may appear to support BOSERUP's (1965) model in which population pressure is the engine driving intensification of agricultural systems. However, a Boserupian should not draw a conclusion too hastily from this case. LEACH (1999) and nine discussants who commented on the paper, examined the applicability of Boserup's model to tropical Oceanic islands and New Zealand. It appears that the archaeological surveys which have provided the material for investigating oceanic agricultural evolution have been conducted mainly on the high islands. In truth, no surveys on atolls were mentioned in the discussion between Leach and the nine commentators. Of the ten writers, including Leach herself, a few, such as P. C. Kirch, emphasize evidence that swidden agriculture was widely practiced during early stages of colonization on islands where more intensive methods developed later. Certainly, in the cases of high islands, it is not difficult to imagine a diachronic process in line with Boserup's model: a shift from swidden to more intensive systems of agriculture, with population growth following initial colonization of the island. On the other hand, it seems reasonable to surmise that islanders may have had to adopt intensive systems of aroid cultivation very shortly after initial colonization, because of the two factors stated above, namely, the limited availability of freshwater that reduced the area utilizable for production from the outset, and, that the poor soil conditions forced them to add a great quantity of organic matter. Also, when we consider that the early settlers who colonized new island environments were already familiar with intensive cultivation techniques in their homeland, the preceding argument gains strength. In other words, disintensification appears less likely to have occurred in atoll environments. Such a view underlies BAYLISS-SMITH's (1974, p. 273) comment, based on his survey in Ontong Java Atoll, "The Boserup model may be applicable as a long-term generalization for continental areas, but in the case of island populations there are extremely acute restrictions on resource availability and innovation diffusion." In addition, it relates closely to the point emphasized in BROOKFIELD's (1972) discussion that on Mogmog at present, taro is particularly significant for its sociocultural role as well as, or rather than, its actual role as a staple foodstuff.

Examples of Aroid Cultivation on Ulithi Atoll

In 1999, the authors investigated aroid cultivation in Yap Proper. The main species cultivated in Yap Proper was the giant swamp taro, *Cyrtosperma chamissonia.*

We also surveyed aroid cultivation on Ulithi Atoll in 2001, so we will report the results in this section.

In Ulithi atoll, the giant swamp taro is cultivated by constructing ordinary taro patches on only two of the four inhabited islands (Mogmog and Falalop) due to restrictions such as limited cultivation area as compared with Yap Proper and limited water supply. In the three islands other than Falalop Islet (Mogmog, Asor, and Fassarai Islets), three to seven artificial concrete taro patches per island are constructed. Each of these patches has an 18 m-long 3 m-wide on average outer frame (on average) constructed by piling up concrete blocks to a height of 60 cm for cultivating the aroids. Because there is little soil, leaves including coconut palm, breadfruit, and banana, are thrown into the frames, and cultivation begins one year later (depending on conditions) after this organic matter becomes humus and then soil. On Mogmog Islet, the patches were initially constructed to propagate favorable strains introduced from Yap Proper or for testing the adaptability to agriculture, but they are currently used simply as cultivation fields. At present, introduction has been suspended because it is highly probable that the giant swamp taro in Yap Proper is suffering from diseases (SAKAMAKI et al. 2001). It is difficult to construct ordinary taro patches in the Asor and Fassarai Islets, so concrete taro patches were constructed instead. These concrete taro patches may be unique and an appropriate method for cultivating the giant swamp taro that prefers a swamp in islands such as these that lack water and rich soil. If we consider the size of the island and its population, the giant swamp still taro plays an indispensable role in food supply in spite of their small sizes. Furthermore, rules have been established for cultivating genuine taro patches, but fewer rules have been established for cultivation in concrete taro patches. It is also interesting that these concrete taro patches are not owned by individuals but are cultivated under joint management by the community. This form of cultivation may be related to the fact that taro, particularly *Cyrtosperma,* is a very significant crop because it has traditionally been used for special events as described above.

There are five genera of edible aroid: *Alocasia, Amorphophallus, Colocasia, Cyrtosperma,* and *Xanthosoma.* Of these, all but *Amorphophallus* are also cultivated on Ulithi Atoll (MERLIN et al. 1996). During this survey, we successfully confirmed the cultivation of *Colocasia* and *Cyrtosperma.* However, it is difficult to distinguish *Alocasia* and *Xanthosoma* only from the appearance of their blades and petiols, so we did not discriminate these two genera during this survey.

On Asor and Fassarai Islets, *Cyrtosperma* and *Colocasia* were cultivated in a single concrete taro patch together with *Alocasia* or *Xanthosoma.*

However, we observed *Alocasia* or *Xanthosoma,* which has relatively high drought resistance, being cultivated in various areas of Falalop Islet. Though these genera are also cultivated on the Mogmog, Asor, and Fassarai Islets, the volume of cultivation was considerably larger on Falalop Islet.

We consider that further studies are required to investigate whether this is due to human factors, such as the population level or taste, or natural environments such as the adaptability to the soils.

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