A CHANGE OF SUBSISTENCE STAPLE IN PREHISTORIC NEW GUINEA

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SUMMARY

Replacement of taro by sweet potato which began from 300—500 years ago is continuing. Sweet potato is less demanding both for site and for labour and is able to support population expansion more readily. Taro continues to be the preferred crop and has religious and cultural associations not shared by sweet potato. Factors relating to the change of crop are described.

RESUME

Le remplacement du tarot par la patate douce qui commenca il y a 300—500 ans est toujours en cours. La patate douce est moins exigeante quant au terrain et aux travaux qu'elle impose et peut suivre l'évolution de l'accroissement de la population.

Le taro continue d'être préféré et reste lié aux traditions religieuses et culturelles, ce qui n'est pas le cas avec la patate douce. Les facteurs liés au changement de cette plante ont été exposés.

RESUMEN

El reemplazo de la malanga** por el camote***, iniciado hace unos 300—500 años, continuea. El camote es menos exigente en cuanto al sitio en que se cultiva y en cuanto a fuerza de trabajo y es capaz de soportar la expanción de la población más fácilmente. La malanga continua siendo el cultivo preferido y tiene asociaciones religiosas y culturales no compartidas por el camote. Se describen los factores relacionados con el cambio de cultivo.

INTRODUCTION

Even a casual observer of subsistence agriculture in the highlands of New Guinea becomes aware of the importance of the sweet potato (*Ipomoea batatas* (L.) Lam.) as a food plant. The literature attests the preponderant importance of this crop. Barrau, writing of lands above 1500 m, refers to the sweet potato as ". . . the staple subsistence crop of mountain dwellers in New Guinea". Brookfield[4] also noted the highlanders' heavy dependence on the sweet potato as a characteristic distinguishing these people from other closely settled populations at similar elevations elsewhere in the tropics. Pospisil writes[17] that more than 90 percent of the area of gardens among the Kapauku of Irian Jaya was planted to sweet potatoes. Hundreds of miles to the east in Papua New Guinea among the Chimbu group that Hipsley and Kirk[9] studied in 1962 or the Fore families observed by Reid and Gajdusek[18] in 1957, sweet potatoes contributed at a minimum 70 percent of the people's total intake of calories.

Not only is the sweet potato the dominant crop over much of the central range of New Guinea, but it is grown under a variety of specialized local techniques, including the making of small mounds, the composting of large mounds, the making of grid-iron-ditched plots on dry land, the fertilization of swamp-garden plots with ditch spoil, quasi-terracing, the tillage of grassland soil, and the use of untilled forest soil under a system of long-fallow slash-and-burn cultivation.

However, even though the sweet potato is the commonest crop, the major source of calories, and is planted in regionally specialized ways, this crop has been considered only to have been introduced into montane New Guinea within the past 300—500 years[13,23]. Before the sweet potato's introduction, it is assumed that ancient Asian crops, particularly taro (*Colocasia esculenta* (L.) Schott), provided the major source of food to montane New Guineans[5,6].

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** Nota del Traductor: *Colocasia* es conocida como Malanga en diversos paises de habla hispana como Cuba y Mexico. Especies de *Xanthosoma* son a veces mencionadas como Malanga. *Colocasia* se conoce como Taro en Hawaii.

***Nota del Traductor: el camote (sweet potato) es conocido en diversos países de habla hispana como batata dulce, batata o boniato.

REGIONAL STATUS OF TARO

An ancient cultivated plant of Indian or Southeast Asian origin[7,24], taro is now widely diffused through the tropical and parts of the subtropical world[1]. In production by weight taro is exceeded only by sweet potatoes and bananas[20]. Barrau[1] states that taro is the invariable staple crop in the rainforest-covered areas of foothills and mountains below 1500 m. Although such is not in fact everywhere the case, the picture put forward by Barrau is not inaccurate as a general pattern. Taro is also commonly grown in both dry and swampy lowlands – even in places where wild sago is a more important food. Higher in the mountains where sweet potato is now the dominant crop, taro is nonetheless cultivated almost everywhere. Unlike the sweet potato, taro has ceremonial or prestigious attributes attached to it[2,11,15,25] a characteristic often taken to indicate antiquity.

Several questions arise as to the past and present place of taro among highland crops and horticultural practices. Does taro occupy a niche significantly different from the sweet potato? Why did the sweet potato come to so surpass taro in quantitative importance? Could taro once have supported populations as dense as those now found in some places in montane New Guinea? What ecological significance did the shift in staple crop have? In an attempt to answer these and other questions, I have over the past few years made field observations on taro cultivation in several parts of New Guinea and have carried out a few yield trials in gardens planted by traditional methods.

TARO CULTIVATION IN NEW GUINEA SUBSISTENCE FARMING

Based on field observations, as well as on the literature, I can make the following statements about taro as it is grown in New Guinean subsistence systems.

1. Taro is planted at all elevations where cultivation is practiced although it is less common above 2100 m than below. At the highest elevations (2600–2700 m) it is slow to mature, taking in places as much as 18 months, whereas sweet potatoes may be mature in about a year. However, unlike yams or bananas (the other important, vegetatively reproduced, starchy staples from Southeast Asia), taro will produce a crop up to the elevational limit of horticulture in New Guinea. Moreover, to judge from the recovery of taro and sweet potato following the severe frosts of 1972, taro is just about as frost-resistant as the sweet potato. In both crops the leaves die back with heavy frosts, but then both resprout from underground parts and eventually bear – although, as would be expected, taro is slower to do so than the sweet potato. It would seem, therefore, that taro-dependent horticulturalists could have supported themselves at elevations as high as any utilized by present-day sweet potato gardeners; but the yield per unit area per unit time would have been less with taro than with sweet potato.
2. More often than not, taro is absent from sites prepared with special techniques for the long-continued cultivation of sweet potatoes. That is to say that where the gardeners mound, or mound and compost, or ditch, sweet potatoes are always the dominant crop planted in the specially prepared gardens. Where taro is planted in intensively worked gardens – as in the Enga composted mounds or the swamp gardens of the Baliem Valley – it is always of infrequent occurrence compared with sweet potatoes.
3. On the other hand, in some areas the people establish gardens planted almost entirely to taro or dominantly to taro with a few associated crops other than sweet potatoes. In the choice of sites for planting taro there is considerable selectivity based on small variation in soils and topography. Taro is often planted in gullies while the adjacent rises are planted to sweet potatoes, not so much because of ideas regarding differences in moisture tolerance or requirements between the two crops as because of the belief that the gullies contain better soil. Old house sites, whose soils are rich in organic debris, are also favoured spots for small taro gardens or mixed gardens that include taro but not sweet potatoes. If taro and sweet potatoes are planted inside the same fence, taro is always planted in what is considered the best soil –on observation, dark, rich in organic matter, friable – whereas sweet potatoes are planted in any type of soil present. If a new garden site was fallowed, partly under trees and partly under grass, it is likely that the tree-fallowed soil will be planted to taro while sweet potatoes will predominate in the grass-fallowed soils. This widespread selectivity is based on the empirical knowledge that poor soils give exceedingly poor returns of taro corms but at least economic returns of sweet potato tubers. Table 1 serves to give some numerical definition to the differences in yields between the two crops in different sorts of soils. Within the small number of samples measured, sweet potatoes in 'poor' soil yielded more than taro in 'good' soil. Taro on 'good' soils yielded enough to be worth planting – especially as taro is a favoured food, in places a prestige food; but on 'poor' soils such as the long-gardened soil of Site 4, taro was considered to be a hopeless crop and was only planted because of my request.
4. Where crop rotation is practised, taro is always planted in newly cleared soil, whereas sweet potatoes occupy the later phases of rotation. Taro is scarcely ever planted twice in immediate succession, whereas sweet potatoes are often planted several times without a fallow period.

5. Observation suggests that collecting and preparing planting material takes longer with taro than with sweet potatoes. Measurement shows that planting a taro sett takes about 3 times longer than planting a single cluster of sweet potato stem cuttings, which will yield more and sooner than the taro sett. For the taro sett a sizeable hole must be dibbled; with sweet potatoes the soil is loosened by one slanting insertion of the dibble and the stem cuttings (2, 3 or 4 in number, 40 – 55 cm long) slipped in. During the cropping period taro requires more work too as the earth is piled up around the upward-growing corm.

OTHER CROPS ASSOCIATED WITH TARO CULTIVATION

Other crops (all Asian or Pacific in origin) grown in association with the taro are *Saccharum edule*, the greens *Rungia klossii* and *Oenanthe javanica*, cucumber, bananas, and sugarcane. Nearby are many *Castanopsis acuminatissima*, whose edible nuts are collected. At higher elevations are planted groves of *Pandanus julianettii*, whose seasonally maturing nuts are also an important source of food.

Several recently introduced crops further fill in blanks in a mixed garden's total period of yield. Maize provides substantial food before any of the tubers are available, onions and tomatoes provide early supplementary vegetables, and *Xanthosoma* and manioc offer a sturdy supply of carbohydrate after *Colocasia* has been harvested. At higher elevations the relatively quick maturing solanum potato is now growing in importance.

REASON FOR REPLACEMENT OF TARO BY SWEET POTATO

Several inferences can be drawn from these observations of taro and its associated crops. Although taro and sweet potatoes may both thrive growing together in an identical site (as is common in the forest-fallowed soils planted by slash-and-burn cultivation), taro, if it is to be productive, has a more limited range of tolerance than sweet potatoes with regard to soil conditions. Planted in poor soil, taro may survive as a plant but not give a worthwhile harvest, whereas sweet potatoes planted in the same soil provide an adequate return. This means that with a shift in staple from taro to sweet potatoes there could have been a spatial expansion of the area suitable for gardening, although not necessarily an altitudinal extension of gardening. This situation is well exemplified by the present-day cultivation practices at Tifalmin in Papua New Guinea, where the word for food is the same as the word for taro, and taro remains a relatively important crop. At Tifalmin the people have recently begun to occupy a grassland shelf at an elevation of 1525 m, where they now make gardens largely planted to sweet potatoes. But they also make gardens at traditional sites at 1685 m and above on forested slopes; here the dominant crop is taro planted beneath girdled trees that have been left unfelled.

The coming of the sweet potato would have allowed a temporal as well as a spatial expansion in the food production of a system previously dominated by taro. Such an expansion is immediately clear where crop rotation is practised, as by the Kapauku[17] on their valley-floor gardens or by the Karam of Papua New Guinea, whose taro gardens planted on *Casuarina*-fallowed soils are followed by one or more croppings of sweet potatoes. Under a system of single croppings of mixed gardens the temporal expansion associated with adding sweet potatoes to the crop inventory is less striking but still important. For example, in the Jimi Valley of Papua New Guinea, where taro, sweet potatoes, and a number of other crops are planted mixed together under a system of slash-and-burn cultivation, the sweet potato vines begin to bear before the taro corms are ripe and continue their staggered production for several months after the temporally concentrated taro harvest is completed. Some gardeners further expand the period of yield of sweet potatoes by putting in new cuttings at the time taro is reaching maturity. Earlier in the garden's life, too many sweet potato vines are believed to inhibit the growth of the taro. If *Colocasia* is the single staple crop, planting must be spread widely throughout the year so that corms are always ripening.

The implication of a spatial and temporal expansion of garden production such as what I have suggested is that the coming of the sweet potato could have had a mildly revolutionary effect on highland agriculture. But the pre-Ipomoean agriculture would not have been 'intermittent' or 'casual', as has been suggested by Watson[21,22]. Instead, an agriculture based on taro would have required more careful site selection and more methodically regulated periods of planting than would seem to be necessary with sweet potatoes. That an elaborated agriculture did exist long before the presumed introduction of the sweet potato is now supported by the archeological evidence of ditching in the Wahgi Valley in 350 B.C. plus or minus 120 years[8]. I would postulate that at elevations between 1400 and 2000 m, where perhaps four-fifths of the highland population now live[4] and where the wide-valley topography is often gentle enough to make ditching practicable, there could have been a relatively intensive agriculure based on taro that could have supported large and necessarily sedentary populations. With the coming of the sweet potato there could have been a dispersion of cultivation on to less favoured soils, a more careless approach to the timing of planting, and perhaps a relative lessening of labour input, as suggested by Brookfield *et al*,[5]. The intensive, swamp-ditching system

of taro cultivation[3,17] could have been abandoned. Later, because of population growth or degradation of fallow vegetation or both, in the lands newly used for sweet potato cultivation, an intensification of cultivation may have developed. The new methods would have been sufficiently different from those of the earlier intensive taro cultivation to prove inadequate to support permanent cropping of taro. This would explain why, in areas of high population density, taro became a remnant crop relegated to sites of high natural fertility.

In less densely settled highland regions, taro remains an important crop. Looking at these areas today, it is easy to postulate a pre-Ipomoean horticulture based entirely on traditional crops supplemented by collected foods — that is, gardens something like those described for Tifalmin. Such gardens would have provided a quite adequate diet, but yields in relation to labour input would probably have been lower than in gardens where sweet potato is dominant. At present, even in the montane areas where taro remains important, sweet potato is planted; and generally the local people understand that taro is the more labour-demanding crop.

In several places in montane New Guinea — as in many other parts of the Pacific — there is record of a new shift from taro toward sweet potato. For instance, Waddell[19] writes of this taking place in the densely settled Enga region. Reasons given by the Enga for the shift include disease and beetle. (*Pupuana* spp.) problems and declining soil fertility. Recognition of taro's higher labour input and an increasing use of land for cash cropping of coffee are other possible factors. Whatever the cause, it seems likely that the trend toward increasing dominance by sweet potato that began in prehistoric times will continue throughout New Guinea, perhaps to be followed in the future by a move toward still other crops found to be even more suitable or productive.

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TABLE 1

Yields of taro and sweet potato from subsistence gardens

	Crop	El.(m)	Soil	Maturation period (months)	Yield (kg/ha)
Site 1 (Jimi Valley)	taro	1200	'good',[A] fallowed 10 yrs + under forest	6	7837[B]
Site 2 (Jimi Valley)	taro	1650	'good', fallowed 10 yrs under forest	8	3944
Site 3 (Jimi Valley)	taro	1850	'poor', fallowed 1 yr	9	3104
Site 4 (Mount Hagen)	taro sweet potato	1650	'poor',cultivation for past 10-15 yrs	13 8	750[C] 9271
Site 5 (Mount Hagen)	taro sweet potato	1650	'good', fallowed 8 yrs + under *Miscanthus*	12 8	4390[C] 18447[D]

A 'Good' and 'poor' indicate soil quality according to indigenous gardeners. Soil analyses will be available at a later date.

B Return by weight of edible portion to planted material was 3.5 to 1 for Site 1; 2 to 1 for Site 2; 1.6 to 1 for Site 3.

C Weighed yield would have been 15-20% greater but for damage by the beetle *Papuana biroi* Endrodi. At Site 4 only 42% of taro setts survived as plants to maturity; at Site 5 46% survived.

D Compare with Kimber's[10] estimate of about 14000 kg/ha as the average yield of sweet potato tubers for highland