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Sago Production in a New Guinea Economy

Patricia K. Townsend[1]

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*The techniques used by the Sanio-Hiowe of Papua New Guinea to produce edible starch from the sago palm (*Metroxylon *sp.) are described. Input-output analysis demonstrates that this is a highly productive subsistence technology; nevertheless, the Sanio-Hiowe economy is characterized by an absence of intensification. This is ascribed to functional consequences of dependence on hunting and gathering in the interior. In coastal and riverine habitats, other societies using sago supplemented by fishing or horticulture can more fully exploit the potential of sago as a basis for economic intensification and a more sedentary life.*

INTRODUCTION

Starch produced from the pith of the sago palm is an abundant, easily obtained staple food in lowland New Guinea. Observations of sago production among the Sanio-Hiowe of the Upper Sepik region indicate that a quantity of sago yielding 1 million Calories can be produced in 157 man-hours, a level of production comparable to that of the horticultural systems which have been studied. Many of the sago-using societies in coastal and riverine areas have taken advantage of this and other properties of sago, such as its storage potential, to achieve a higher level of economic intensification. The Sanio-Hiowe have not similarly intensified production, but by restricting their material accumulation

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[1] Neuropsychiatric Institute, University of California, Los Angeles, California.

they maintain the mobility and leisure which are characteristic of hunters and gatherers.

These striking differences in economic intensification and in the size and sedentariness of communities among peoples whose subsistence is predominantly based on sago are closely related to the resources available to supplement sago. Even with sago as the major source of subsistence, degree of sedentariness is related to reliance on fishing or horticulture rather than hunting and gathering. Hence, in interpreting the output of economies involving sago, the caution sounded by the anthropologist Marvin Harris is especially appropriate: the qualitative as well as the quantitative aspects of production demand consideration in a discussion of either scarcity or surplus (Harris, 1959, p. 196). The "same" surplus of sago which cannot be utilized effectively in a hunting and gathering economy can be exploited more fully by a fishing or horticultural economy.

Full data on the total economy of the Sanio-Hiowe cannot be presented here. However, the data on sago production may be useful for a later comparative analysis not only of the interplay between the use of sago and the use of other resources, but also of the social and political aspects of economies in which sago or similar foodstuffs are important.

SAGO AND THE SANIO-HIOWE

Sago is an abundant and dependable wild food source throughout much of lowland Melanesia and Indonesia. It is also planted in some areas. Producing it demands little capital investment in tools and, in comparison with other types of food production, requires a relatively small input of time and energy.

Sago may be harvested year round. In many lowland areas, it is available in sufficient quantity to support large sedentary villages. The starch is compact and storable, lending itself well to accumulation for use in trade and feasting. These characteristics of sago are fully exploited by many coastal and riverine peoples of New Guinea such as the Asmat and the Iatmul. Living in large, sedentary villages, and supplementing their sago diet with fishing, and in some cases with agriculture on alluvial soils, they achieved a level of politicoeconomic complexity which supported specialized development in war, ritual, and art. The year-round availability, storage potential, and productivity of sago make it a valuable food for both feasting and famine for lowland and foothill horticulturalists such as the Kwoma, Arapesh, and Abelam.

Not all sago-using peoples take full advantage of the abundance, productivity, and storage potential of their major food source, however. In addition to the coastal and riverine pattern of adaptation, there is a distinct adaptation based on sago in the interior, away from major rivers. These semi-nomadic sago-using peoples are characterized by a simple, portable material culture, a lack of economic intensification, and small-scale sociopolitical organization. The staple sago is characteristically supplemented by hunting and gathering more

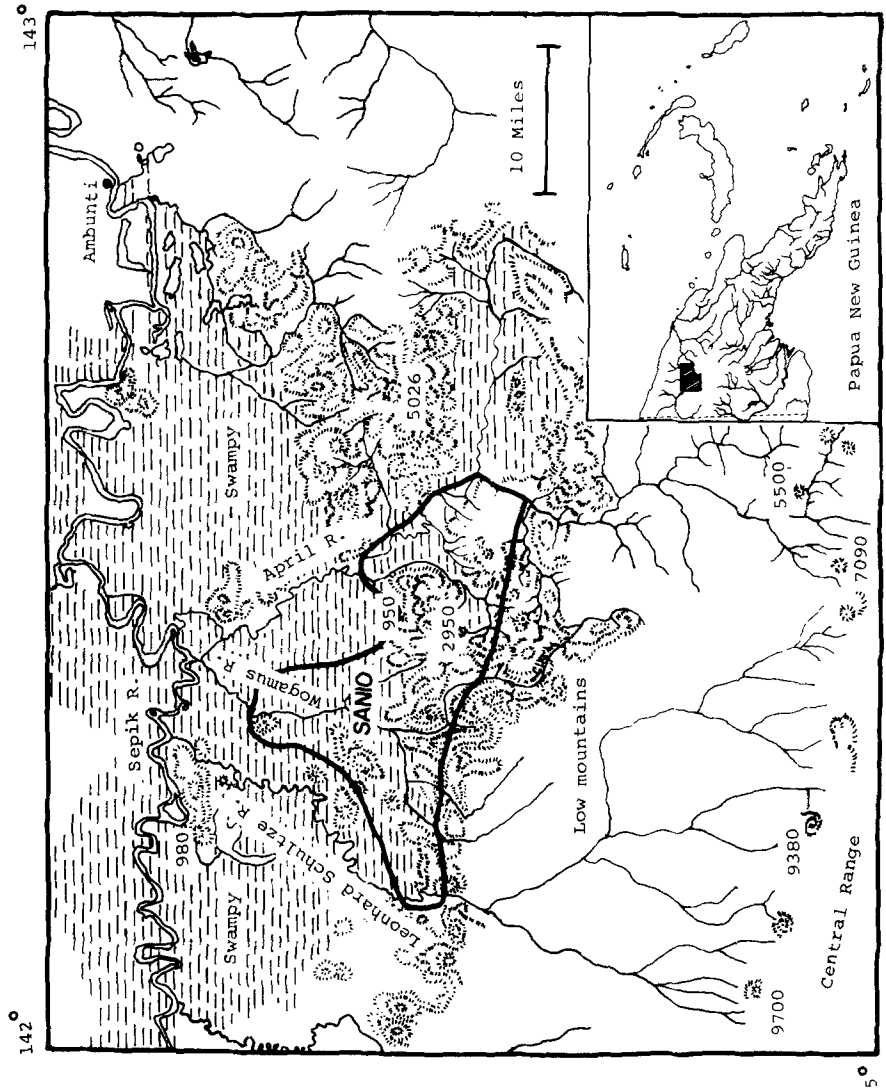

Fig. 1. Area inhabited by the Sanio-Hiowe in Papua New Guinea.

than by fishing and agriculture. Like hunting and gathering cultures, these cultures are characterized by a resource-use pattern which maintains a complex ecosystem with a diversity of species at the cost of lower productivity (Holling and Goldberg, 1971, p. 224). Among these cultures in New Guinea are the peoples of the interior of the Tor (Oosterwal, 1961), Sarmi (van der Leeden, 1956), and the southern tributaries of the Sepik (Haberland, 1966), including the Sanio-Hiowe.

The Sanio-Hiowe live in the foothills of the Central Range at the southern edge of the Sepik flood plain along the Wogamus River, a small blackwater tributary of the upper Sepik River in Papua New Guinea (Fig. 1). The 234 people living in the nine hamlets which were the focus of this study represent the western half of the Sanio language group (Dye *et al.*, 1968). This population occupies an area of approximately 40 square miles. Their population density of six persons per square mile is comparatively high for this type of adaptation. Overall population density in the Sepik Hill language family of which Sanio is a part is two persons per square mile in areas characterized by this type of adaptation.

The Sanio-Hiowe live in hamlets of six to 40 residents. These residential groups are bilateral kinship groupings of continually fluctuating size and membership. In the absence of other political institutions, tensions within the group are relieved by moving, which is easily done because of the lack of investment in gardens and other immovable property. Land and sago are nominally owned by small named patrilineages, but any nuclear family shifts at intervals of weeks or months among its several residential options — to the husband's father's or mother's land, or the wife's land, or with other kin. Multifamily houses built to last from 2 to 5 years give these communities an appearance of permanence which is not supported by the turnover of personnel within them.

THE SAGO PALM

The low hills on which the Sanio-Hiowe prefer to locate their hamlets rise from sago swamps, which are at an altitude of about 300 ft above sea level. Rainfall exceeded 200 inches a year during the period of research, falling mostly at night. Rainfall records are not complete enough to determine any clear pattern of seasonality. After a few days of heavy rain, the Wogamus River rises and floods parts of the swamp, improving conditions for weir fishing and driving game to high ground where it is more easily hunted, but having little effect on sago work. Heavy rains make the swamp trails difficult to traverse, but this does not keep the sago workers home.

The species of sago palm which are found in the Sepik River region of New Guinea have been presumed by various investigators (e.g., Edwards, 1961, pp. 10-12) to be *Metroxylon sagu* and *M. rumphii,* the former with a smooth petiole and the latter with a thorny one, but otherwise very similar. However, a number

of botanists have expressed doubts about the stability of thorny vs. smooth varieties, and it seems unlikely that these represent more than one species of *Metroxylon* (Barrau, 1959, p. 153). Native nomenclature for the sago palm is much more detailed. The Sanio-Hiowe distinguish at least ten varieties by characteristics of spines, leaves, color, and height. The one spineless variety, *nau siye,* is rare. The most common variety is *yapai,* which is said to yield the least starch and thus is seldom worked. The distribution of sago varieties is correlated, at least in part, with environmental variations. In the swamp just west of the hamlet of Yareno, *yapai* dominates the poorly drained northern part, which is flooded whenever the river overflows its banks, while one of the most desirable varieties, *nau tavario,* is abundant in better-drained areas along the south and west fringes of the swamp.

Fig. 2. Sago palms of the variety *nau tavario.*

Metroxylon dominates the swamp forest, but other palms, trees, and herbs are found among the sago palms (Fig. 2). Various authors claim that the presence of other species and great density affect the production of starch adversely, good productivity being obtained only when superfluous young trees are removed (Held, 1957, p. 348; Sprecher Von Bernegg, 1929, p. 293). In the area studied, clearing is not done systematically, but other practices tend to have a secondary effect of thinning the sago stands. These include cutting young palms for their leaves for roof thatching or for their edible heart, cutting trees to improve the trail, and cutting mature palms for grubs.[2]

The Sanio-Hiowe rely entirely on wild stands of sago, though they are aware that sago can be planted by cutting and replanting young shoots which have sprung up around the base of an old palm. Damm (1957, p. 158) suggests that sago-planting peoples are found in roughly the eastern half of New Guinea and sago-collecting peoples, relying on wild sago, only in the western half. This hypothesis, based on limited data, was refuted by Schlesier (1961), who found cases opposite to the prediction and numerous examples of the use of both wild and cultivated sago by the same group. Schlesier's alternative suggestion is that planting of sago is associated with the lack or shortage of natural stands and that wild stands are used when they are abundant. Groups which normally use wild stands may also plant some sago in order to have it conveniently located or to have more of the desired varieties.

THE TECHNOLOGY OF SAGO PRODUCTION

The sago palm flowers and bears fruit only once and then dies. In preparation for this, great quantities of starch are built up, converted to sugar, and depleted in flowering and fruiting. Thus to obtain the maximum starch from a palm, it is desirable to cut it at the end of its growth period, just before it flowers. In deciding if a palm is ready to cut, the Sanio-Hiowe consider the height of the palm relative to the normal mature height of its variety.

Either a man or a woman may fell the palm, using a steel axe or a stone pick (*ipei*), the steel axe offering little or no saving of time in this task. Cutting times for sago palms ranged from 10 to 30 min, with the best time that of a young man who switched back and forth between a steel axe and a stone sago pick.[3] After the sago palm is felled, a section of the rind of the palm is split open with a sharpened hardwood stake (*vare'e*), exposing the fibrous white pith.

[2] When a sago log is cut, the sago beetle lays its eggs in the exposed pith. A month or so later, the interior of the log is tunneled by the plump white larvae eating their way through the sago pith (Fig. 6). The pith can easily be broken apart with a digging stick and larvae readily picked out. The adult sago beetle (*une*) and larvae in two developmental stages (*asaye* and *tenivei*) are all eaten. Young men cut sago palms a month or two before an anticipated feast, notch the logs, and return later to collect the grubs.

[3] Townsend (1969) has discussed the 4.4:1 time advantage of the steel axe over the stone adze in cutting ordinary forest trees. Even after the stone adze was completely displaced by the steel axe, the stone pick remained in use for cutting sago palms because it was an efficient tool.

Sago starch is produced from the log by two or three women working side by side but without a division of labor between them. The women loosen the pith by scraping and pounding it with a *fiase,* a flaked basalt tool (Fig. 3). The sawdust-like pith is piled on a sheet of palm sheath and carried to the nearby trough for washing. Each woman builds her own trough near a stream or pool of standing water. The trough is built of sago leaf bases set up at waist height on crossed sticks tied with vines. One section forms a washing trough which slopes downward into another section serving as a settling trough. The two sections are separated by a strainer (*taro*) of fibrous matting taken from the leaf base of a coconut palm.

The pounded pith is placed in the trough above the strainer and water is poured on the pith. The soaked pith is kneaded and pressed against the strainer

Fig. 3. Pounding sago.

Fig. 4. Kneading moistened sago pith in the washing trough.

(Fig. 4). The water, milky with suspended starch, flows through the strainer and into the settling trough. After the fibers are depleted of most of their starch, they are tossed on the ground. At the end of the day the moist starch is lifted out of the trough in blocks, wrapped in leaves, and tied with vines.[4]

Small packets of starch are taken home for immediate use, and large packages of 30-40 lb are stored by one of two methods. *Poyva nau,* "sun sago," is sago stored by hanging it from a stump or tree to dry in the sun. This method

[4] Sago-working techniques are similar throughout New Guinea with slight variations in equipment. The Warao of the Orinoco Delta in Venezuela exploit the *moriche* palm (*Mauritia flexuosa*) for its starch as their staple food, using techniques which are strikingly similar to these (Suarez, 1968).

allows sago to be kept for several weeks. *Sa'i nau,* "water sago," can be kept for several months by burying the leaf-wrapped package under mud and water in the swamp.

Unlike many other sago-eating peoples, the Sanio-Hiowe have very few ways of cooking sago. Most sago is simply wrapped in leaves and baked on the coals. Sago is most often made into a paste or pudding (*'ene*) when the meal includes meat. Sago starch is mixed with a small amount of cold water in a *wahu,* a vessel made of folded palm spathe. (No pottery vessels are made or obtained in trade, nor were metal pots yet available at the time this study was made.) Water is heated by the stone-boiling method and stirred into the starch mixture (Fig. 5). The final ratio of water to sago by weight is about 3:1, making

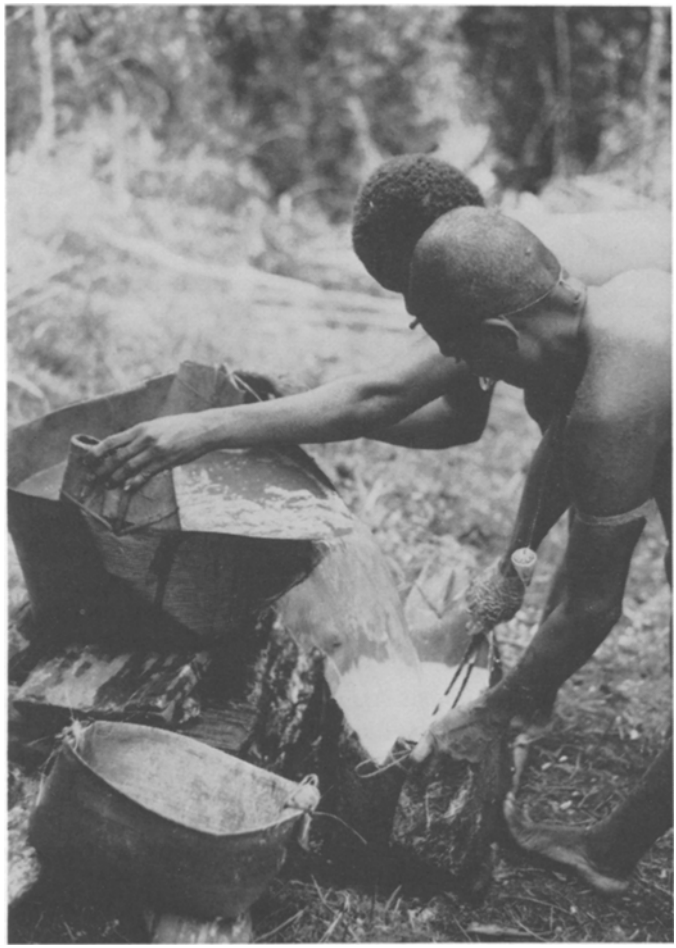

Fig. 5. Two women pouring hot water to make sago pudding in Yareno hamlet.

a stiff gray or white pudding. The juices of a few otherwise inedible fruits may be added; these include species of *Ficus*, *Citrus*, and *Garcinia*. Either the natural enzyme action of the fruit or the small amount of acid may initiate the process of starch breakdown, thus making the pudding more digestible (Lloyd, 1964, p. 87). This effect may be important here because the cooking achieved by the stone-boiling method is not very thorough. The Sanio themselves regard the pudding as indigestible to many people.

PRODUCTIVITY OF SAGO WORK

Two types of data about sago production were collected. First, women were timed at various activities throughout several work days. Second, a record was made for seven sago palms of the volume of pith worked and the weight of starch produced, as well as the number of woman-days of labor. A study of the yield of seven palms requiring 54½ days of work indicates that in an average work day, a woman produces 24.6 lb of sago (Table I). Subtracting 1 hr for walking to and from the swamp and 2 hr for breaks and extraneous activities from the observed average 8-hr day, a woman produces 4.9 lb of sago in 1 hr of work. If walking is included, production drops to 4.1 lb of sago per hour.

Some comparable data on production in other sago areas are available. Lea (1964, p. 122) reports 5 lb of sago per man-hour in the Abelam village of Yenigo north of the Sepik River. Abelam sago technology and division of labor are similar to those in the Sanio-Hiowe area, except that sago palms are planted and tended, and sago is produced mostly to tide people over the lean period between yam seasons. The output per man-hour indicates that the two groups produce sago with equal efficiency. However, Abelam yields per cubic foot (ft^3) of pith processed are much higher.[5] Lea (1964) reports data from two palms, one containing 35.3 ft^3 and one 31 ft^3 of pith, which yielded 483 lb of starch, or 15.6 lb/ft^3. In the present study, yields averaged 6.3 lb/ft^3, less than half the Abelam yields. In other words, the Sanio-Hiowe women process more than twice as much pith to get the same amount of starch as the Abelam. The Abelam may have better-yielding varieties of sago because they plant it and practice selection of varieties. Edwards (1961, pp. 11-13) indicates that there is considerable variation in starch yields from different strains.[6] However, if the Abelam simply had better-yielding varieties of sago the time saved in felling and opening palms and

[5] Volume of pith worked was calculated from measurements of outside circumference of palm before it was worked and length of portion worked. A 1-inch thickness of unworked rind was subtracted from the radius to give the volume of pith. Although this is a reasonable estimate, it is a possible source of error and variation among logs.

[6] The laboratory analysis of two specimens from near Marienburg on the Lower Sepik yielded 11.3 and 10.2 lb/ft^3 at 12% moisture (Edwards, 1961, p. 12). Even after Edwards' figures are corrected for lower moisture, they do not equal the high Abelam yields. Lea's (1964) data and mine are based on the weight of moist sago, which I assume to be about 27% water.

Table I. Starch Production from Seven Sago Palms near Yareno

Variety	Outside diameter (inches)	Length worked (ft)	Volume of pith (ft^3)[a]	Starch (lb)	Starch (lb/ ft^3 pith)	Woman-days labor	lb/day
1. *Tare*	20.5	20.5	36.2	189	5.2	6.0	31.5
2. *Tare*	18.0	23.0	30.6	173	5.7	5.5	31.5
3. *Tare*	18.5	14.9[b]	22.1	165	7.5	6.0	27.5
4. *Tavario*	19.0	23.6[c]	37.1	228	6.5	10.0	22.8
5. *Tavario*	19.5	29.5[d]	49.2	453	9.2	21.0	21.6
6. *Wepi*	17.5	15.0	19.7	68	3.5	3.0	22.7
7. *Wepi*	15.0	10.3	9.4	62	6.6	3.0	21.0

[a]Unworked rind assumed to be 1 inch thick.
[b]After the study ended, an additional 2 ft 9 inches was worked which was not weighed.
[c]After the study an additional 15 ft was worked.
[d]The bottom 9 ft of the log was not worked.

handling the pith should be reflected in a better output per man-hour. Instead, the Abelam seem to be offsetting some of this advantage by expending extra effort in a more thorough extraction of starch. Although techniques are basically similar in the two areas, Abelam women, who live in an area of reported population pressure, may be pounding the pith more finely and kneading it longer in the trough than the more wasteful Sanio-Hiowe women, who have abundant wild-growing sago in their area of much lower population density.

Data on sago production from other areas are somewhat more sketchy. Whiting and Reed (1939, p. 179) observed that a Kwoma man and woman working together could produce 50 lb of sago in a "long morning's work." If a long morning is about 5 hr, the Kwoma produce at 5 lb per hour, about the same rate as the Abelam and Sanio. Schlesier (1965, pp. 6-13) describes the working of a palm on Normanby Island which seems to have yielded only about 1½ lb per man-hour. However, some of the workers appear to have been mostly standing and watching, and the workers were disappointed in the yield from the palm, so this figure should not be taken as representative. At the opposite extreme, Edwards (1961, pp. 20-21) reports that Emory observed yields of 8.9 and 10.6 lb per man-hour in the lower Sepik region. The techniques used there are similar but the division of labor is different: men cut and section the log and pound the pith; women wash out the starch. Wallace (1869, p. 385), probably the first to write about the productivity of sago work, observed a sago palm in eastern Ceram that yielded 900 lb of fresh sago, which he claimed would have been 600 lb baked, enough to feed one man for a year. This tree took two men 5 days to work. Wallace's figures indicate that Ceram had palms which were larger or higher-yielding than New Guinea palms and that the Indonesian men were producing three times as much sago per day as New Guinea women.

The variability in productivity both between areas and within the study area seems to stem not from differences in extractive technology so much as from differences in starch yield among sago varieties, differences in maturity

between individual palms of the same variety, and differences in the skill, strength, and thoroughness of the particular workers observed. Lack of consistency is methodology and sampling among observers is undoubtedly also significant. Despite the speculative nature of comparison between areas, it can be concluded that the Sanio-Hiowe average of 4-5 lb of starch per man-hour is a low to intermediate value for sago production. We can now ask how the productivity of this sago economy compares with other subsistence economies.

Since a pound of sago is not identical in caloric value to a pound of other staple foods, in order to compare sago production readily with other subsistence economies, some more general measure of productivity is needed. One such measure is the number of man-hours needed to produce 1 million Calories (Carneiro, 1957, p. 169). Data from several different economies are presented in Table II. Among those compared, sago production is most comparable to swidden cultivation in output. It can be seen that the more intensive agricultural systems require higher labor inputs than swiddening for the same caloric return, as argued by Boserup (1965). In some instances, the gathering of uncultivated vegetable foods exceeds certain agricultural systems in productivity per unit of labor.

Another way to compare the effectiveness of subsistence economies is to compute the ratio of energy derived to energy expended in the food quest (Rappaport, 1968; Harris, 1971, pp. 202-218). This method has the advantage of allowing for the fact that one man-hour of work is not metabolically the same as every other man-hour of work, taking into account the pace and difficulty of the task and the sex and body size of the worker. However, in the absence of precise measurements of energy expended for the particular population and tasks involved, the expression of input in terms of Calories (kcal) instead of man-hours may introduce significant inaccuracies. Although calorimetric measurements of Sanio-Hiowe sago workers have not been made, the fact that they are female and small — weighing an average of 85 lb — suggests that their hours spent in sago work are less costly metabolically than many of the other subsistence activities recorded in Table II.

SANIO-HIOWE SUBSISTENCE

Sago starch contains little food value other than carbohydrates. Peters (1957) gives the following composition for 100 g of raw sago: 285 kcal; 0.2 g protein; 71 g carbohydrate; 27 g water; 0.3 g fiber; 30 mg calcium; 0.7 mg iron; negligible fat, carotene, thiamin, and ascorbic acid. Though it is an effective source of calories, sago must be supplemented by foods which fill other nutritional needs. To a varying extent, this is true of all staple foods; however, none is as poor as sago in this respect.

In order to determine the place of sago in relation to other foods in the Sanio-Hiowe diet, a detailed record was made of food produced and consumed

Table II. Man-Hours Required to Produce 1 Million Calories in Various Economies

Area	Subsistence type	Man-hours/ million kcal	Reference
Lower Sepik, New Guinea	Sago, walking excluded	80	Edwards (1961)
Abelam, New Guinea	Sago, walking excluded	154	Lea (1964)
Sanio-Hiowe, New Guinea	Sago, walking excluded	157	
	Sago, walking included	188	
Hanunoo, Philippines	Dry rice and miscellaneous swidden crops	111	Conklin (1957)[a]
Neo-Brazilians	Manioc cultivation	126	Wagley (1953)[b]
Kuikuru, Brazil	Manioc swidden, walking excluded	146	Carneiro (1957)
	Manioc swidden, walking to field included	202	
Amahuaca, Peru	Horticulture before steel axe (estimated)	603	Carneiro (1968)
	Horticulture (maize and manioc) after introduction of steel axe	258	
	Hunting (estimated)	795	
China	Wet rice agriculture	186	Buck (1930)[b]
Maya, Mexico	Maize cultivation	214	Morley (1946)[b]
Genieri Village, Gambia	Swamp rice cultivation	430	Haswell (1953)
	Millet (savannah agriculture)	600	
Bushmen	Gathering vegetable foods	400	Lee (1968)[c]
	Hunting	1000	
Hemple Bay, Groote Eylandt, Australia	Fishing, gathering water lily rhizomes	1316	McCarthy and McArthur (1960)
Fish Creek, Arnhem Land, Australia	Hunting, fishing, gathering wild yams	1460	McCarthy and McArthur (1960)

[a] Computed using additional data provided by Rappaport (1968, p. 262) regarding caloric equivalents.
[b] Computed by Carneiro (1957, p. 171) from data in these references.
[c] Lee's own computations (1968, p. 40) differ from these by a factor of 10, but using his own data (1968, pp. 38-39) I arrive at these totals.

by the residents of the hamlet of Yareno, an average of 32 persons, during a 9-day period in May and a 10-day period in July 1967. The detailed results of this study are presented in Townsend, *et al.* (1973), and include a discussion of the diet by a nutritionist. Summarizing these findings, the various groups of foods contributed calories in the following proportions:

sago starch	85%
other vegetable foods	5%
animal foods	10%

Of the other vegetable foods, the most important are bananas, taro, breadfruit seeds, wild greens (especially the fern *Cyclosorus*), sago cabbage, and recently introduced papaya and pumpkin. Very small quantities of a great diversity of wild and domesticated fruits, nuts, tubers, and fungi complete the vegetable component. The sexual division of labor which is so rigid in assigning the sago work to women and the hunting and fishing to men is very flexible in the cultivation or gathering of vegetable foods. Both men and women plant these in small quantities in house clearings and gather wild vegetable foods in the forest.

The protein component of the Sanio-Hiowe diet comes almost entirely from animal sources. The largest source is the meat of domesticated and feral pigs. Pig husbandry is not highly developed in this area. Though a few small pigs are captured from the wild, most domesticated pigs come from the mating of domesticated sows with wild boars, since all domesticated boars are castrated at a few months of age. Immediately after farrowing, the shoats are taken from the sow. Usually only one or two from a litter survive. The shoat is cared for by a woman who carries it in her arms or net bag on the trail, keeps it on a leash in the house, and hand feeds it premasticated sago pudding. As the pig gets larger, it gets most of its food by foraging in the swamp forest, and remains only tenuously domesticated. Pigs, feral or wild, seldom attain a live weight of 100 lb. The quantity of pork obtained throughout the year from domesticated pigs is approximately equal to that from wild pigs, the only difference being that consumption of domesticated pork is focused on ritual occasions, particularly curing ceremonies.

The successful hunting with bow and arrows of a wild pig, lizard, snake, cassowary, or smaller bird is an infrequent and unpredictable event. In contrast, fishing more regularly provides a small amount of protein nearly every day, though it is quantitatively less important than hunting. Weir baskets, fish poison, spears, and imported fish hooks are used by men. Women catch fish by hand from small streams they have partially dammed.

Following pig husbandry, hunting, and fishing in importance is the collecting of sago grubs. Men fell sago palms for the express purpose of later collecting the grubs (Fig. 6), but women also obtain them from the unworked portions of sago palms they have cut a month or more earlier. It seems especially significant that the grubs serve as a rather efficient way of concentrating the food energy in low-yield sago pith. The unworked portions of the sago log from which women

Fig. 6. Young man splitting open sago log for grubs. Tunneling of pith by larvae is apparent in open section.

get larvae are the stump and the section just below the crown. These parts of the log are relatively low in starch (Schlesier, 1965, pp. 8-11). For grubs the men cut *yapai* sago, also called *asaye nau,* "grub sago." This variety is said to be low in starch yield. The use of the beetle larvae thus exploits this sago as a food source while sparing the women the work of processing large amounts of low-yield sago pith. More importantly, carbohydrates are converted to protein and fat.

Pig husbandry, hunting, fishing, and gathering give much lower caloric returns on time and energy expended than sago production. However, they are carried out so casually, often incidentally to some other activity such as house-building or travel, and with such irregular success, that it would be difficult to obtain meaningful quantitative data on energy return for most of them. At any rate, their significance as energy sources is minor compared to the significance of the essential protein and other nutrients they supply, so that one must view the productivity of sago work as subsidizing these essential supplementary activities.

THE ORGANIZATION OF SAGO WORK

Given the Sanio-Hiowe division of labor by age and sex, it is possible to estimate how much, on the average, women need to work sago in order to feed the community. In a total population of 234, there are 82 adolescent and adult females who are potential sago workers. Of the 82, six are girls just learning to

work sago, one is a cripple, 11 are widows who did not work sago during the period of study, and three others who worked during part of the period of study were under mourning taboos during another part. Eliminating all of these, there were 61 effective sago workers in a population of 234. An average worker was thus supporting 3.8 people including herself. In an average day she could produce 24.6 lb of sago. Studies of the diet show that the daily per capita consumption averages 1.47 lb (Townsend, *et al.*, 1973). Since a woman can produce sufficient sago in 1 day to provide for 16.7 people, she would need to work sago on the average of only 1 day in 4 or 5. This estimate is consistent with women's observed work except that instead of working 1 day and then resting, they work for several days in a row, finishing off one or more palms and building up their stores before resting.

Other tasks assigned to women in the Sanio division of labor are caring for children or pigs, making string bags and string ornaments, and gathering firewood. Longer breaks from work are taken for travel, or illness, or mourning for a deceased husband or child. Though there are no taboos on sago work for pregnant or nursing women, a woman with a sick or irritable infant avoids work if possible. Infected sores and respiratory ailments are common, and a woman with such an illness readily stays home from work. Another major loss of work comes from healthy women who stay home to care for sick husbands.

Sanio-Hiowe sago production requires little capital (the palm itself and stone tools), no division of labor beyond that of age and sex, and no coordinated activity. It is possible for a society to organize sago production in more complicated ways, though no great productive advantage seems to be derived from doing so. For example, in areas where men work sago, some of them specialize as pounders and others as washers for the whole operation; in Wogeo, a few men are noted as outstanding sago washers and are hired to do this (Hogbin, 1939, p. 307). On Normanby Island, the owner of a palm coordinates the work of several of his kinsmen and is responsible for observing food and sex taboos and practicing magic to insure the success of the work (Schlesier, 1965, pp. 11, 15). In Tikopia, a group of brothers and brothers-in-law work a palm jointly. The distribution of the starch is based on ownership and social position, not simply on labor contributed. Chiefs perform first-fruits rituals to appease the deity associated with the sago palm (Firth, 1950). In Sarawak, where sago is a cash crop and the division of labor is a simple one along sex lines, the nuclear family is the economic unit. Requirements of capital, though greater than in New Guinea, are still not high: a boat, imported ironwood vessels, and a shelter for washing sago. The Sarawak sago producers are linked in creditor-debtor relationships with Chinese traders (Morris, 1953).

Although sago production prescribes a no more complicated economic organization than that of the simplest collecting economy, the supplementary food and nonfood requirements of the sago producers may thus involve them in other more elaborate kinds of political and economic organization which may, in turn, affect the organization of sago work. This brief review shows that sago economies, like agricultural ones, can operate at many different levels of output. Sago is the basis of simple hunting and gathering economies; it enters the recip-

rocal exchange of tribal-level economies; and as a cash crop it is produced for export in peasant economies in Indonesia and Sarawak.

Even among the Sanio-Hiowe with their simply organized economy, sago work is highly productive. The high energy return of sago work allows the women, working only 1 day in 4 or 5, to provide 85% of the caloric intake of their community. How is this surplus of time or of sago used? First, it subsidizes food-getting activities such as gathering wild greens or hunting, which offer unfavorable energy returns but provide nutrients which are needed because of the poor food value of sago. Second, men are freed not only for hunting and fishing but also for house-building and craft activities, the most elaborate of which is the carving of arrow foreshafts and war shields. However, the mobility which is a requisite of their social organization discourages input of labor into immovable capital goods and decorative or status items. The high productivity of sago work and the storage potential of sago, in conjunction with the fact that the nuclear family is not the exclusive unit of consumption, free women from work when they are sick or burdened with small children or sick husbands and make it possible to prohibit sago work during mourning. These facts suggest that the surplus potential of sago is largely unutilized except as leisure.

Because sago is not seasonal and because it stores well, it serves horticultural peoples as both a food for hungry seasons and a feast food. Its storage potential and compactness also made it an important item in coastal New Guinea trade networks (Harding, 1967; Fortune, 1932; Malinowski, 1922; Seligman, 1910). However, sago was not very important in traditional trade in the Sanio-Hiowe area. In 1967, there was some enthusiasm for selling sago to the people of the village of Kubkain on the Sepik River, but 200-300 lb which was taken down by canoe by six men brought them only a few pieces of cloth and a bushknife, a disappointing return for a 5-day journey, to say nothing of the sago work.

The women build up stocks of sago for occasional feasts, but in the absence of any central authority to stimulate and direct production their accumulation remains small. Keeping packets of sago stored in the swamp rather than in or near the house seems to free women from the pressure to share it with individual relatives for the time being. The stocks are quickly depleted in feasting when a domesticated pig is killed for use in a curing ritual or when game is brought in and shared throughout the hamlet. At a marriage payment, the groom's family provides meat and sago pudding for the bride's relatives after an all-night dance. However, there is none of the conspicuous consumption here that characterizes feasts in much of New Guinea. Thus a potential surplus production of sago is not expended in trade or large-scale communal activities any more than in craft production or other specialization.

CONCLUSIONS

As has been noted, striking differences in economic intensification and in the size and sedentariness of communities among peoples whose subsistence is

predominantly based on sago are closely related to the resources that may be available to supplement sago. Further, where sago is the major source of subsistence, degree of sedentariness is related to reliance on fishing or horticulture rather than to reliance on hunting and gathering. A similar formulation has been made for Amazonian societies by Carneiro (1968), who, with quantitative data from seven societies, demonstrated a direct relationship between the proportion of subsistence derived from fishing and agriculture, as opposed to hunting and gathering, and the degree of sedentariness, as measured by the size and permanence of communities. Although quantitative data adequate for testing the applicability of Carneiro's index to the New Guinea lowlands are lacking, it appears that the same relationship may hold, but with the proportion of sago probably being a neutral factor, adaptable either to dispersal or to sedentariness. Thus a quantitatively minor portion of subsistence becomes adaptively critical. This has been argued previously with respect to population regulation among the Sanio-Hiowe (Townsend, 1971).

While little is known of the natural checks on population increase, the major cultural regulators of Sanio-Hiowe population are infanticide and the postpartum prohibition on sexual relations. Both of these controls are sensitive to feedback from pressure on resources other than sago even while sago remains abundant. Because sago is not regarded as a suitable food for infants and because these practices are enforced to allow the continued breast-feeding of an older sibling, they are likely to be enforced more strictly when the foods which supplement sago are becoming scarce.

In the interior where sago-using societies lack abundant resources of fish and rich alluvial soils, a dispersed, mobile population can maintain itself in a favorable balance with hunted animals and economic plants. Dispersal and mobility are also fostered by the sociopolitical system. Interpersonal friction is avoided by frequent changes of residence. Beliefs in supernatural dangers also lead people to relocate at times of illness or death in the community.

In contrast, the coastal and riverine societies using sago need not meet the same requirements of dispersal to protect game and wild plant resources from overexploitation, since they depend on fishing and agriculture. In addition, the wider usefulness of water transport allows them to exploit a larger area from a single settlement. Political evolution generates alternatives to fissioning as a means to avoid and resolve conflicts within the large community. Political life is, in turn, a stimulus to production (Sahlins, 1972, p. 135). In these societies, open competition for status leads would-be big men to enlarge their households and step up production in order to display and distribute goods. Ritual and aesthetic activity flourishes.

The contrast between the interior and coastal/riverine adaptations is sharpened by the differential effects of competition within each of the niches. The effect of warfare in coastal regions is to further concentrate settlement, while in the interior, warfare tends to further dispersal. An experimental test of

this formulation was provided by the intervention of Europeans in both systems. Among the people of the Purari Delta, for example, the effect of pacification was to break up large villages (Maher, 1961, p. 115). In the western interior of Sarmi (van der Leeden, 1956, p. 21) and the neighboring Tor area (Oosterwal, 1961, pp. 54, 76), formerly dispersed, semi-nomadic sago peoples began to concentrate in riverside villages as a result of contact with missionaries and administration officials, and in doing so made changes in their subsistence patterns. This shift in ecological stance, which is occurring in the Sepik area also, may be a costly one, for it may also result in increased mortality from malaria and other diseases. The effect of contact thus may be to reduce two formerly distinct types of adaptation involving sago to a single generalized type.

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