THE NEW GUINEA HIGHLANDS ON THE EVE OF AGRICULTURE

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AGRICULTURE AND ALTITUDE

Whether based on plants introduced from Southeast Asia or independently domesticated in New Guinea (see Golson, pp. 48-53 above), there is no doubt that the beginnings of agriculture in the island were the result of processes taking place at low altitude. In a listing of cultigens putatively of New Guinea origin, Yen (in press: Table 2) allocates them to their specific ecological, mainly altitudinal, zones of derivation and notes the individual extensions of range they subsequently underwent in the hands of people, both within the island and out into the Pacific. The Highlands component consists of six vegetables (leaf or bud) and two nut trees (*Pandanus*). Of these only two vegetables have spread, and only within New Guinea; *Rungia klossii* into the Highlands Fringe and *Setaria palmifolia* (Highlands pitpit) there and beyond into the Low Montane.

The implications of Yen's study are confirmed and extended by as yet unpublished research by Bourke (ms.) on the altitudinal ranges of economic plants in Papua New Guinea, which includes an analysis of 160 food species. This total incorporates a number introduced during the colonial period, which, however, display the same general pattern as the traditional plants. These themselves include, besides some non-domesticates, cultigens both of New Guinea origin and of prehistoric introduction, earlier in the case of the Southeast Asian yams, *Dioscorea esculenta* and *D. alata* (Yen 1990:260, 264; cf. Yen 1982:284, 289) and later in the case of the South American sweet potato, *Ipomoea batatas* (Yen 1974:317). According to Bourke, his analysis provides a firm basis for a "frequently recognised" zonation in food procurement: the lowlands, up to 600 m (roughly corresponding to Yen's Coastal, Lowland and Low Montane); an intermediate zone, 600-1200 m (Yen's Highland Fringe); the highlands, 1200-1800 m (roughly equivalent to Yen's Highland zone); and a high-altitude zone at 1800-2700 m. Bourke points out that within the intermediate zone occur the upper altitudinal limits of a number of important lowland tree species, while the large number of species which grow up to 1750-1900 m defines the upper limit of the highlands zone. This latter group includes some of the more important agricultural plants, such as all the yams (*Dioscorea* spp.) and most of the bananas (*Musa*

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spp.). The present staple of Highlands agriculture, sweet potato, goes much higher but being a plant of relatively recent introduction it is not of relevance in the present context. Of the older plants, taro (*Colocasia esculenta*) and the now unimportant *Pueraria lobata* are found beyond Bourke's highlands limit.

Bourke's ranges, of course, register what native gardeners have been able to achieve with plants during millennia of horticultural enterprise under climates substantially similar to the present. Such climates became established in the montane areas of New Guinea about 9500 years ago, with the end of the last glaciation (Hope 1983b:40; cf. Brookfield 1989:308-309). Under the glacial regime the treeline fell below its present level of 3900-4000 m to varying extents, reaching a low point of 2000-2400 m from 20,000 to 15,000 years ago around the glacial maximum (Hope 1983b:40). Below the treeline, on limited evidence, forest zones may have been depressed by as much as 500-700 m (Hope and Hope 1976:33), though Hope (1980:230) cautions that there are unusual features about the vegetation at the time of the glacial maximum which show that it was not a matter of simple depression of vegetation zones. Bowler *et al.* (1976:362-365) give a series of qualified estimates for mean annual temperatures at different stages of the late Pleistocene based on palynological reconstruction of vegetation. Thus at Sirunki, at 2500 m in Enga Province, suggested values range from 1.5-3.5°C below present at 27,000 years ago through 7-11°C at the glacial maximum and 1-2.5°C at 9000 years ago. At the lower-altitude Draepi site at 1800 m near Mt Hagen in Western Highlands Province the estimate is 3-6°C lower than present for the period 18,000-23,000 years ago, which is said to be in fair agreement with the Sirunki evidence.

The reason for this excursion into late Pleistocene climates is because of the claim, based on evidence from the Kuk site at 1550 m in the upper Wahgi valley not far from Draepi, that gardening began in the Highlands around 9000 years ago, when temperatures were beginning to achieve their modern levels (Golson and Hughes 1980; cf. Golson 1989:678-683). The implications of the general evidence for late Pleistocene climates, however qualified in detail it must be, is that agriculture of a familiar kind was impossible at Kuk, and more widely throughout the Highlands, before 9000 years ago. That is why in discussions of Kuk it has always been said that if there was gardening there at 9000 years ago, there must have been gardening at an earlier date at lower altitudes (Golson and Hughes 1980:301; cf. Golson 1989:681). This conclusion is strengthened by the results of Yen (in press) and Bourke (ms.), both quoted above, the former indicating the in every way limited contribution the Highlands have made by way of plants to the New Guinea and wider Pacific agricultural complex, the latter providing data on altitudinal limits which suggest how restricted was the range of food plants that would have flourished in the Highlands under Pleistocene climates.

THE NATURE OF THE EVIDENCE AT KUK

The Kuk site has revealed episodes of swamp drainage for agriculture, whose structural expressions are stratified in the form of channels and ditches in sediments continually washed into the swamp as a result of erosion in the catchment due to agricultural operations, especially vegetation clearance. There are five episodes in the swamp, dating back to about 6000 years ago, which sit above a grey clay which itself seals in a channel and a somewhat unorganised set of features dating to about 9000 years ago. The channel and associated features are interpreted as evidence for an early and short-lived episode of swamp management for agriculture, while the grey clay is seen as the erosional product of continued dryland gardening deposited in the swamp when the early drainage system fell into disuse (Golson and Hughes 1980:296-299).

If the channel and features of the 9000 year old level are accepted as artificial, and a great deal of effort has gone into trying to establish this point (cf. Golson in press), the problem respecting their interpretation as evidence of agriculture is to show that they, and the grey clay which seals them in, represent a new type of activity and not the continuation or transformation of some strategy already in operation within the general Highlands region.

Elsewhere (Golson in press) I have approached this question by stressing the continuities between the 9000 year old level at Kuk and the later undeniably agricultural phases there. Now, however, though I shall summarise the arguments for continuity, I am more concerned with the discontinuities that the 9000 year old level represents with the late Pleistocene past of the Highlands, which are barely touched upon in the article referred to (Golson in press).

CONTINUITIES AT KUK

The first example concerns the association of a set of features with a channel. Yen (1990:262-263) has seen this at the 9000 year old level as having an "experimental appearance", with planting surfaces intrinsically uncontrolled but sufficient drainage provided for wet and dry plantings, which the more structured arrangements of the second management phase in the swamp, beginning about 6000 years ago, essentially "mimic". Even at this sophisticated level, however, the argument is one by analogy.

The second continuity concerns the grey clay. In a recent study drawing on much more comprehensive data than were available to Golson and Hughes (1980:296-297), Hughes *et al.* (1991:234-235) conclude that the deposition of grey clay between 9000 and 6000 years ago at Kuk represents a rise in the rate of erosion in the catchment close to the level only reached during the 30,000 years of the sequence during the period 6000 years ago towards the present when there can be no doubt that the catchment was under agricultural use. They stress that the major long-term source of eroded sediments would have been bare or sparsely vegetated plots affected by rainsplash and surface wash, as under gardening at present. If the grey clay of the Kuk swamp represents, as they claim, the removal of vegetation in the Kuk catchment 9000 to 6000 years ago, we might expect that this, and similar activities elsewhere, would be registered in the vegetation history of the region. Unfortunately a vegetation record does not exist for the upper Wahgi for this period, but when it picks up about 5000-5300 years ago, it clearly shows the inroads that had already been made into primary forest by agricultural clearance (Powell 1982:218,225).

This truncation of the upper Wahgi vegetation record is not repeated in a pollen core from a swamp at a comparable altitude in the Baliem Valley of Irian Jaya, where intensive drainage of the swampy valley floor is a central feature of contemporary agriculture. The core records (Haberle *et al.* 1991:31-37) a virtually continuous history of agricultural impact on vegetation from before 7000 years ago to the present through the increasing replacement of primary by secondary forest taxa and associated changes, with clays and silts at the base of the core providing evidence for initial clearance at an unknown earlier date in the form of inwashed sediments produced by catchment instability following forest disturbance. This Baliem evidence, which takes us some way back to the 9000 year old agricultural beginnings claimed at Kuk, is a third strand of continuity.

THE LATE PLEISTOCENE IN THE HIGHLANDS

A number of montane sites have been investigated whose utilisation falls in or extends back into the late Pleistocene. They include Yuku, a small rockshelter at 1280 m at the base of the Hagen Range (S. Bulmer 1975:29-33); possibly Batari, a small cave in Eastern Highlands Province at 1300 m (about which, however, I shall say no more because its excavator has reservations about the late Pleistocene age of its initial occupation [White 1972:16]); NFX, an open site at 1550 m not far from Batari (Watson and Cole 1977:35-40); Wañlek, an open site in the Bismarck-Schrader Range at 1680 m (S. Bulmer 1975:40-41; 1977a:64-69); Nombe, a rockshelter in Simbu Province at 1720 m (Mountain 1983; Gillieson and Mountain 1983; Mountain 1990); and Kosipe, an open site in the Papuan Highlands at 1980 m (White *et al.* 1970). Pollen investigations have been carried out at Kosipe, both at the archaeological site and in the swamp 50 m below (Hope 1982). There are two other relevant sites of palynological investigation, though neither is associated with an archaeological site: Telefomin at 1485 m near the Indonesian border (Hope 1983a) and Supulah Hill across the border in the Baliem Valley at 1450 m (Haberle *et al.* 1991: 30-31).

When we come to consider what people were doing at these locations, we should bear in mind that though they differ in date and altitude all of them were operating under a climatic regime colder than at present. With the lower treeline that resulted, the forest-alpine grassland ecotone which today exists only as islands around the highest peaks would then have been much extended along the spine of the island (Hope and Hope 1976:32-37). Today this ecotone is favoured hunting ground for communities with access to it, so that its expanded late Pleistocene representative could have constituted an important resource zone (Hope and Hope 1976:40-41, 42, 46). While plant resources are unimportant in this setting, the high forests below contain *Pandanus* and *Elaeocarpus*, which bear edible nuts (Hope and Hope 1976:42). In principle, for topographic reasons, all the locations under review would have provided ready access to a lowered treeline, Kosipe, Nombe and Wañlek particularly so, while those on the Highlands fringe like Yuku, Wañlek and NFX would have also afforded a range extending downwards into lowland valleys (cf. Golson 1983:44).

Unfortunately, the sites themselves throw very little light on what was actually happening. Wañlek and NFX have provided no economic evidence: they are difficult sites to understand, but if there really were house structures there in the late Pleistocene (S. Bulmer 1977a:65 for Wañlek; Watson and Cole 1977:35-40, 131 fn. 10, 194 for NFX) they are obviously of high relevance to the topic of this section. Only Nombe and Yuku have produced faunal remains: for Yuku we have some summary information provided by the excavator (S. Bulmer 1975:31; 1982:185-187), while the excavator of Nombe suggests that much of the Pleistocene bone there was the result of animal predation, particularly by thylacines (*Thylacinus cynocephalus*), in the intervals between sporadic human occupation (Mountain 1990:214).

More relevant to Kuk as a valley-bottom site, however, are Kosipe, Telefomin and Supulah, particularly since Kuk itself is not strategically placed for higher-altitude exploitation, though the high-elevation Kosipe obviously is (cf. Hope and Hope 1976:43).

None of these three sites is easy to interpret. What they have in common is evidence of vegetation disturbance by burning, from 30,000 years ago onwards in the Kosipe swamp (Hope 1982:217), between roughly 25,000 and 30,000 years ago at Supulah (Haberle *et al.* 1991:31), and in three episodes at Telefomin (all accompanied by increases in grass pollen) from 18,000 to 15,500 years ago, from 11,500 to 8,200 and from 3,000 to the present (Hope 1983a:30). In all cases the burning is interpreted as due to people. There can be no doubt about this at Kosipe where we have contemporary archaeological evidence adjacent. Of Telefomin, Hope (1983a:32) remarks that the present climate is unlikely to allow lightning strikes to initiate widespread fires. For Supulah it is said (Haberle *et al.* 1991:31) that sediment analysis from Kosipe and other old sites (presumably including Telefomin) shows no record of fire in the cool, wet, montane forests prior to human activity. For all three sites pollen analysis shows rather pure stands of beech (*Nothofagus*) forest to have been once in existence, at Kosipe from 30,000 to 9000 years ago (Hope 1982:217), at Telefomin up to 12,000 years ago (Hope 1983a:32), and at Supulah throughout the sequence, roughly between 25,000 and 30,000 years ago (Haberle *et al.* 1991:31).

Palynological research overall shows beech to have been widespread in late Pleistocene montane forests between 1500 and 2100 m, indicating a "persistent cloudiness and mist" in this zone (Hope 1983b:40). The decline of beech at a number of palynological sites at the time of the temperature rise across the Pleistocene-Holocene boundary implies the "release of many of the mid-montane valleys from cloudy and misty conditions and possible periodic severe frosts" (Hope 1983b:40), heralding general changes in forest composition towards more mixed taxa, with fewer tree ferns and lianes and more palms, small trees and oaks (Hope 1983b:40-41). The absence of *Castanopsis* and *Lithocarpus* pollen from the diagrams at Supulah suggests that the accentuation of already cool conditions by cold air drainage into the Baliem Valley confined the mixed oak forest to lower altitudes (Haberle *et al.* 1991:36). This is similar to the situation at Kosipe, where oak (*Castanopsis*) pollen was rare in the samples from the swamp and absent from those from the archaeological site (Hope 1982:217).

As is well documented (Bulmer and Bulmer 1964:49; R. Bulmer 1964; Clarke 1971:53-58), the mixed oak forest is a favourable environment for plant-food procurement. Besides *Castanopsis* itself, which produces prolific quantities of small nuts, Bulmer and Bulmer (1964:49) list a number of other trees with edible nuts and seeds, including *Elaeocarpus, Sloanea, Finschia, Sterculia* and especially *Pandanus*, which is an important seasonal food resource today for high-altitude horticulturalists; vines with edible fruits; many trees, shrubs and ferns with edible foliage; many kinds of edible fungi; and wild edible yam-like tubers, apparently of the genus *Dioscorea*. Of this corpus of edible plants only *Pandanus* is at home in the beech forest which the pollen diagrams show to have been prevalent in the late Pleistocene montane environment (Bulmer and Bulmer 1964:49).

The excavator of the Kosipe archaeological site suggested *Pandanus* harvesting as the reason for its existence (White *et al.* 1970:168-169) and Susan Bulmer (1977a:69) has proposed the same purpose as the main explanation for human presence in the mountains in general during the colder climates of the late Pleistocene.

Perhaps the late Pleistocene burning in the swamp at Kosipe and Telefomin and on the hill at Supulah, extending into the early Holocene in the case of the first two, was associated with the exploitation, indeed perhaps the management (see Mountain this volume) of *Pandanus* trees and groves. If this were so, however, there is no indication of it in the pollen record. Hope (1982:217) says of Kosipe that *Pandanus* is not definitely recorded at either the swamp or the archaeological site, and the same is true of the Supulah pollen record (Haberle *et al.* 1991:31, table 2) and at Telefomin (Hope 1983a:31).

Amongst the stone tools excavated at Kosipe is the so-called waisted blade, a distinctive artifact class, exhibiting a variety of shapes, sizes and weights (cf. White *et al.* 1970: figs 3-4; S. Bulmer 1977b:45-52; Groube 1986), that proved serviceable over a wide range of altitude and environment and a great length of time. It is well represented at Kosipe itself, 1980 m altitude, throughout the life of the archaeological site from about 25,000 years ago into the early Holocene (White *et al.* 1970:163-168); present as a single specimen at Nombe, at 1720 m, in a late Pleistocene formation which also contained an edge-ground axe (Mountain 1983:93-94), better termed perhaps, following Dickson (1981) for Australian specimens, a hatchet head; again well represented at Yuku, at 1280 m, from the late Pleistocene into the early Holocene (S. Bulmer 1975:30-31); and abundant on the coastal terraces of the Huon Peninsula, where there is a date for *in situ* specimens older than 40,000 years (Groube *et al.* 1986). A common factor in these vastly different occurrences is the presence of forests. Since, moreover, waisted blades seem to have occurred side by side with edge-ground tools they presumably had functions other than these, with which their typically blunt working edges contrast. Groube (1989:296) looks upon them as tools of "primary forest clearance", citing a series of possible functions such as thinning, trimming and ring-barking, which would advantage desirable food plants in rainforest habitats (Groube 1989:296, 298). Clarke (1971:83) remarks that the chopping and gathering associated with collecting the products of high-altitude *Pandanus*

- leaves as well as nuts (Clarke 1971: Appendix B) - may encourage the maintenance and perhaps the expansion of *Pandanus*-dominated stands of forests. Perhaps it was so in the distant past.

Susan Bulmer (1975:31) records *Pandanus* as occurring throughout the history of occupation at Yuku, the only site for which plant remains have been recovered from the late Pleistocene, but she does not say what types of pandan are involved. In the lowest levels, roughly 9500 to 6000 years ago, of Manim rockshelter at 1770 m off the main Wahgi Valley, abundant carbonised drupe fragments provide evidence of heavy and sustained exploitation of *Pandanus* (Christensen 1975:31). The species is the non-seasonal bush pandan, *Pandanus antaresensis* (D. Donoghue pers. comm.), a type now neither common nor much used in the main Highlands, for which Bourke (ms.) gives a present mean usual altitudinal range of 1359-2350 m. Important today are the two seasonal nut pandans, both much easier to process than the tough-shelled *antaresensis* (cf. Hyndman 1984:296-297): the essentially wild *P. brosimos* (taken here to include the recently recognised *P. iwen*, cf. Stone 1984:305), for which Bourke (ms.) gives a usual range of 2400-3100 m, and the essentially cultivated *P. julianettii*, Bourke's range for which is 1800-2550 m. Donoghue (1989:103-104) has recently given us our first archaeological record of these pandans, at Christensen's (1975:29-31) Kamapuk site at 2050 m in the same side valley as the Manim shelter, off the upper Wahgi, but the date is later than 2500 years ago.

The period of *Pandanus antaresensis* exploitation at Manim is contemporary with the deposition of grey clay at Kuk, a few kilometres away in the centre of the main Wahgi Valley, including the first phase of swamp management there. Though there can be little doubt that *P. antaresensis* was present and utilised at the Kuk site, we can be equally sure, from what we know of its use, and that of other mountain pandans, for example amongst the Wopkaimin of the upper Fly (Hyndman 1984:294-297), that workings in the swamp would not be necessary for their propagation nor accelerated erosion as represented by the grey clay at Kuk a product of their exploitation. Moreover, pandans of some sort would have been available at Kuk for exploitation well before the 9000 year date at which swamp management and grey clay deposition begin. Indeed, under the cooler, mistier conditions of the late Pleistocene, *Pandanus* was perhaps one of the attractions at Kuk. The late Pleistocene levels below the grey clay there contain peaks of carbonised particles (J.M. Powell pers. comm.), reminiscent of the anthropogenic firing at Kosipe, and among the few humanly transported objects there is the butt end of a waisted axe.

CONCLUSIONS

A new chapter in Highlands prehistory begins with the rise in temperature across the Pleistocene-Holocene boundary, freeing mid-montane valleys like the Wahgi of their cloud and mist and their susceptibility to frost and allowing their colonisation by the resource-rich mixed oak forest. It is around this time that we see the first human use of a number of rockshelters; Kafiavana at 1350 m in Eastern Highlands Province (White 1972:83-125), Kiowa at 1530 m in Simbu Province close to Nombe (S. Bulmer 1975:35-36) and the Manim site at 1770 m off the Wahgi (Christensen 1975:29-31), of which we have already spoken. At Nombe, a site of older utilisation at 1720 m, the end of the Pleistocene saw a dramatic increase in human activity at the site, documented, as Mountain (1990:208) describes it, in the greater density of bone, artifacts and ochre lumps in the matrix and in the increased occurrence of carbon specks within the sediments.

Not only, however, did the ameliorating post-glacial climate enrich the Highlands as a habitat for humans, it made possible, so the evidence of Kuk seems to indicate, the establishment, in an environment highly advantaged in other ways, of plant husbandry previously developed under more benign conditions at lower elevations. What the plants were that were initially involved we do not yet know, but Yen's conclusions about cultigens of putatively New Guinea origin (Yen in press: Table 2) suggest that they could have included bananas and sugar cane, probably yams and possibly taro, basic elements of the Pacific agricultural complex.

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