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TRADITIONAL ENVIRONMENTAL MANAGEMENT IN NEW CALEDONIA:
A REVIEW OF EXISTING KNOWLEDGE

South Pacific Commission
Noumea, New Caledonia
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SOUTH PACIFIC REGIONAL ENVIRONMENT PROGRAMME

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P R E F A C E

Twelve years ago, the United Nations Conference on the Human Environment (Stockholm, 5-16 June, 1972) adopted the Action Plan for the Human Environment, including the General Principles for Assessment and Control of Marine Pollution. In the light of the results of the Stockholm Conference, the United Nations General Assembly decided to establish the United Nations Environment Programme (UNEP) to "serve as a focal point for environmental action and co-ordination within the United Nations system" (General Assembly resolution XXVII of 15 December 1972). The organizations of the United Nations system were invited "to adopt the measures that may be required to undertake concerted and co-ordinated programmes with regard to international environmental problems", and the "intergovernmental and non-governmental organisations that have an interest in the field of the environment" were also invited "to lend their full support and collaboration to the United Nations with a view to achieving the largest possible degree of co-operation and co-ordination". Subsequently, the Governing Council of UNEP chose "Oceans" as one of the priority areas in which it would focus efforts to fulfil its catalytic and co-ordinating role.

The Regional Seas Programme was initiated by UNEP in 1974. Since then the Governing Council of UNEP has repeatedly endorsed a regional approach to the control of marine pollution and the management of marine and coastal resources and has requested the development of regional action plans.

The Regional Seas Programme at present includes eleven regions (1) and has over 120 coastal States participating in it. It is conceived as an action-oriented programme having concern not only for the consequences but also for the causes of environmental degradation and encompassing a comprehensive approach to combating environmental problems through the management of marine and coastal areas. Each regional action plan is formulated according to the needs of the region as perceived by the Governments concerned. It is designed to link assessment of the quality of the marine environment and the causes of its deterioration with activities for the management and development of the marine and coastal environment. The action plans promote the parallel development of regional legal agreements and of action-oriented programme activities (2).

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- (1) Mediterranean, Kuwait Action Plan Region, West and Central Africa, Wider Caribbean, East Asian Seas, South-East Pacific, South Pacific, Red Sea and Gulf of Aden, East Africa, South-West Atlantic and South Asian Seas.
 - (2) UNEP : Achievements and planned development of UNEP's Regional Seas Programme and comparable programmes sponsored by other bodies. UNEP Regional Seas Reports and Studies No. 1, UNEP, 1982.

The idea for a regional South Pacific Environment management programme came from the South Pacific Commission (SPC) in 1974. Consultations between SPC and UNEP led, in 1975, to the suggestion of organizing a South Pacific Conference on the Human Environment. The South Pacific Bureau for Economic Co-operation (SPEC) and the Economic and Social Commission for Asia and the Pacific (ESCAP) soon joined SPC's initiative and UNEP supported the development of what became known as the South Pacific Regional Environment Programme (SPREP) as part of its Regional Seas Programme.

A Co-ordinating Group, consisting of representatives from SPC, SPEC, ESCAP and UNEP was established in 1980 to co-ordinate the preparations for the Conference.

The Conference on the Human Environment in the South Pacific was convened in Rarotonga (8-11 March, 1982). It adopted : the South Pacific Declaration on Natural Resources and Environment of the South Pacific Region ; and agreed on the administrative and financial arrangements needed to support the implementation of the Action Plan and on the workplan for the next phase of SPREP (3).

This report has been produced in accordance with the Action Plan by Dr. Arthur Dahl, Ecological Consultant to whom the sponsors express their gratitude.

(3) SPC / SPEC / ESCAP / UNEP : Action Plan for Managing the Natural Resources and Environment of the South Pacific Region. UNEP Regional Seas Reports and Studies No. 29, UNEP, 1983.

TRADITIONAL ENVIRONMENTAL MANAGEMENT IN NEW CALEDONIA: A REVIEW OF EXISTING KNOWLEDGE

Arthur Lyon Dahl

SUMMARY

The scattered references to traditional environmental knowledge in the published literature on New Caledonia make it possible to identify the kinds of knowledge and skills use in pre-European times in the development and management of natural resources. However, little of the actual content has been recorded. Much of this knowledge has already been lost, and the old people who hold most of what remains are not transmitting it to a younger generation which is no longer interested. This is unfortunate as much of this knowledge would be useful to define new directions for development, to resolve modern management problems, and to increase self-reliance.

Traditional agriculture in New Caledonia has been reasonably well studied. There were highly sophisticated and environmentally sound techniques for the cultivation of the principal crops, yams and taro. Yams are a dry land crop requiring deep soil, often carefully prepared, and controls to prevent erosion and flooding. Taro involved the creation of artificial wetlands and terraces fed by irrigation systems of great complexity using sophisticated water management. Many varieties of both crops were maintained, providing a genetic richness which is largely lost today. There were also many secondary food and fibre crops. The main constraints were the difficulty of maintaining a year round food supply, and the lack of methods for improving soil fertility, requiring extensive areas in fallow. An essential element, the agricultural calendar, has not been well documented. These agricultural systems collapsed under the impacts of European settlement.

Fishing was important in coastal areas, but there is only a listing of principal techniques. A fishing calendar by association with natural phenomena, and other management techniques existed but have not been recorded. Hunting was limited by lack of prey.

Medicine was elaborately developed, but only some lists of medicinal plants remain. There are some notes on traditional technologies for cloth, rope, pottery, tools and jade, but the practical skills are largely lost. The design of traditional houses was excellent for the materials available, and some examples have recently been well documented. Less has been noted on woods and their uses. There was a good understanding of natural history, including names and classifications for plants and animals, times of flowering or breeding, migrations, etc. Astronomy and meteorology were reasonably developed, and celestial navigation was used, but again little has been recorded.

Man was seen as a part of nature, not separate from it. There was considerable specialization in the holders of traditional knowledge by family and sex. What was seen as magic often used scientific approaches, such as a ritual garden functioning in fact as a plot for agricultural experiments and observations. Every effort should be made to preserve what traditional environmental knowledge remains, to retransmit it to young people, and to put it back to use where appropriate to modern problems.



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While much has been written in general terms about indigenous peoples' knowledge of and care for their environmental resources, only a few detailed case studies in widely scattered areas of the Pacific can be found in the literature. Outstanding among these are the work of Johannes (1978, 1981) on fishing in Palau, of Barrau (1956a) on agriculture in New Caledonia, and of Spriggs (1981) on taro irrigation in Vanuatu. References to environmental knowledge elsewhere in the literature are widely scattered, and often anecdotal. At times, their environmental context and importance have not even been understood.

A review of existing knowledge of traditional approaches to environmental conservation and management in New Caledonia is an essential prerequisite to any attempt to restore confidence in this important aspect of traditional culture and to apply that knowledge in a modern context. This review covers information of environmental interest in as wide a range of published sources as time and availability have allowed. Discussions with both kanaks (the melanesians of New Caledonia) and ethnologists provided additional indications and examples of the extent of traditional knowledge. Some of the most pertinent studies are still in progress, and the results are not yet fully available (I. Leblic and M.-H. Teulieres, personal communication).

This review has been made from the perspective of an ecologist rather than an ethnologist, and it makes no pretension to ethnological rigor. Many of the sources cited are known to be unreliable or biased in their interpretations, but such weaknesses may be less apt to affect environmental information than other dimensions of traditional culture. However, in one instance in this study where it was possible to check with knowledgeable local informants, erroneous information published by a well-known ethnologist was apparently given to him as a joke.

Present state of knowledge

It is clear that only a tiny fraction of this aspect of kanak culture has been recorded in the literature. Much has already been lost, and the old men and women who still possess such knowledge reasonably intact are not passing it on to the next generation; it will die with them. There is clearly some hesitancy to pass on this precious heritage either outside the family line, or to those who do not appreciate it. Persons of middle age often recall the existence of such knowledge from their childhood, but for them it has fallen into disuse, and their personal experience in its application is generally limited. The young in general see no pertinence in such traditions to the modern way of life they aspire to, and are thus disinterested.

There are many reasons why this traditional heritage is being lost. For generations, the "superstitions of primitive peoples" have been discredited by missionaries, administrators, educators and European colonists. Father Lambert, for instance, declined to record all the "superstitious ceremonies related to fishing.... It is sufficient to say: pity our poor natives, may we appreciate and encourage the apostolic work, which alone is capable of dispelling such darkness" (1900, p. 214). Children are no longer educated in

the family or the tribe, but in schools where western-style education gives little time to traditional cultures. Traditional patterns of social organization for collective action have been disrupted, making it impossible to continue group occupations such as collective fishing or the irrigated cultivation of taro. New occupations in towns, mines or commercial agriculture have attracted the most able, and reduced the extent of traditional subsistence activities. Traditional knowledge no longer passes automatically from father to son or mother to daughter. Even where subsistence activities have continued, new technologies have replaced old, and the old knowledge has seemed superfluous even where it would still be useful. The technological fix is an easy temptation for all societies.

Clearly there is no point in going back to a traditional technology such as hand-woven sennit nets when new nylon nets are readily available and more efficient. However, much of the knowledge of the fisheries resources is even more necessary today if catches are to be maintained and overfishing, made easier by new technologies, is to be avoided. The same is true in many other areas of resource use. Many imported development approaches have proven destructive of the resource base, and local traditional techniques which have been adapted to local conditions and refined over centuries may provide a better guide to sustainable development (Barrau, 1978). The originally productive land and native irrigation systems were degraded by European cattle raising in the first 50 years of colonization, leading to erosion and the replacement of useful species by introduced weeds (Barrau, 1953a, 1954).

As will be apparent from this review, some areas of traditional knowledge have been reasonably well recorded, while others have entirely escaped the review of western scholars. The number of studies in depth based on extensive field work is very limited; many papers simply repeat the observations of earlier workers with slight additions or reinterpretations. Often the existence of some type of knowledge or practice has been noted, but the actual content or necessary detail has not; a reference to the flowering of a tree is of little use without knowing what tree is referred to. Even more unfortunately, the literature consists entirely of reports by outside observers. No kanak has yet come forward to record his own culture free of the biases inherent in any outside perspective. Perhaps this review will stimulate others to arise and fill the lacunae identified here.

Studies of traditional life in New Caledonia fall naturally into three groupings. The first is the nineteenth and early twentieth century records of exploration, early scientific research, and missionary observation. These tend to range over many subjects, but often include scattered items of environmental interest, particularly since the decline in kanak culture was still in its early stages. Unfortunately many of these early references are not readily available in New Caledonia and could not be consulted for this review. Publications are very sparse in the second period to about 1950, with the outstanding exception of the work of Maurice Leenhardt. The postwar period has seen at least two generations of outstanding work in ethnology, geography, sociology and botany, among other fields, but much of this has come too late to capture more than fragments of traditional knowledge.

For convenience, this review will group traditional practices by the type of resource or activity concerned, as this best follows the usage of most past authors.

Agriculture

Since agriculture was the basis of kanak society in New Caledonia, it is only natural that it is the most widely documented aspect of traditional resource use. Early travellers such as Garnier (1875) and Lemire (1884) were particularly impressed by the irrigated taro terraces. Lemire also noted the scarcity and hunger created by the problem of bridging the gap between harvests. Glaumont (1897) singled out the important features of yam mounds as structures to trap rainfall in the dry season while protecting against erosion and flooding in the wet season. He also described the extent and ingenuity of the systems of taro irrigation. Lambert (1900) devoted two chapters to agriculture, with much useful information in spite of his bias as a missionary trying to destroy the superstitions of the natives. Among other things, he noted the pleasure many villagers found in brushfires set while clearing gardens, a problem of poor resource management that continues today. Jeanneney's (1891) advice on agriculture includes much useful information, but he does not indicate its origin, although some must certainly be traditional.

The essential features of kanak agriculture are now reasonably well understood. The two principal crops in pre-European times were yams (Dioscorea spp.) and taro (Colocasia and related genera), both the subject of intensive and highly specialized cultivation techniques which have been described many times. For New Caledonia, the study by Barrau (1956a) is perhaps the most complete.

Yams are a dry land crop with great cultural significance. They are grown in mounds specially prepared to provide ideal conditions for tuber development. On slopes, these mounds are crescent shaped with the points down hill. Stone or clod retaining walls were often used to retain their form, and the channels near the points were generally lined with stones to prevent erosion (Leenhardt, 1930, p. 112; Barrau, 1956a, p. 66). On valley bottoms and along streams, the mounds were circular or more often linear, 3-4 metres wide, more than 1 metre high, and sometimes extending for several hundred metres (Doumenge, 1974a, p. 34). Lands subject to heavy flooding were avoided (Saussol, 1979, p. 32). The channels dug out to make the mounds provided drainage and helped to protect against flood damage during the wet season (Barrau, 1956a, p. 54). The slopes of the mounds were often planted with sugar cane and other crops to retain the soil; windbreaks and mulching were also used (Barrau, 1956a, p. 69). The vines were trained up straight poles, which could be removed in the event of a cyclone; basket-like trellises were used in the Loyalty Islands. Special techniques such as planting the yams over hollow cavities allowed the production of tubers up to 2 metres long (Leenhardt, 1930, p. 183; Guiart, 1963, p. 336). Different soil conditions in the Loyalty Islands require different agricultural techniques (Guiart, 1963, p. 547-548).

Taro requires saturated or continually humid conditions for growth, which with the seasonal and irregular rainfall patterns of New Caledonia makes irrigation essential (Curry, 1960). Legend records that the technique of irrigated taro cultivation was brought long ago by foreigners who made many mistakes at first (Leenhardt, 1930, p. 112; Barrau, 1956a, p. 50), but the numerous traces of terraces show the extent to which the art was developed and perfected locally. Water was captured high up on permanent streams and

conveyed through canals, often over several kilometres, to slopes where terraces could be constructed. Aqueducts were used to cross depressions, hollowed trees were used to bridge gullies, and special overflows protected against damage in heavy rains (Leenhardt, 1930, p. 110; Doumenge, 1974a, p. 64; Spriggs, 1981, appendix 13). Terraces generally 2 to 6 metres wide were carved out of slopes up to 80% (Barrau, 1956a, p. 77), with an outer wall sometimes reinforced with stones or logs. Stone-lined spillways and sluice-gates directed the water from one terrace to another, and permitted precise control of water flow (Leenhardt, 1930, p. 110), but the systems required constant surveillance and maintenance. The hydraulic works were protected by a code of prohibitions and taboos (Leenhardt, 1930, p. 111; Barrau, 1956a, p. 54; 1965, p. 119). Earthworms were a significant cause of leaks. Plantings along the banks had both magical and practical significance in stabilization and erosion control (Leenhardt, 1930, p. 111). Some heads of valleys became great amphitheatres of taro terraces. Taro terraces were also developed along streams, and in low swampy areas where the taro was planted in raised beds (Barrau, 1956a, p. 78-79). Similar types of irrigated taro cultivation are still practiced in some parts of Vanuatu (Barrau, 1956c), where they have recently been thoroughly documented (Spriggs, 1981).

Both yams and taros are maintained as vegetatively reproduced clones (Doumenge, 1975, p. 80). Many varieties were imported at different times (Dubois, 1951a, p. 254; Barrau, 1956a, p. 50; 1967b), and others were probably generated spontaneously in gardens long left in fallow (Haudricourt, 1964). The result was a large number of varieties adapted to different culture conditions and harvest times, which were grown in different gardens and even different parts of a terrace or mound (Barrau, 1956a). One village was reported to maintain 25 varieties of taro (Barrau, 1962). There was an obvious awareness of the importance of these varieties, and new forms were sought out and tried (Haudricourt, 1964). While various lists or descriptions of these varieties have been made (Straatmans, 1950; Barrau, 1956a; Haudricourt, 1964; Bourret, 1973), the precise conditions for which they were adapted have seldom been noted, nor has there been a comparable effort to preserve the varieties themselves, and with the decline in subsistence agriculture and the collapse of irrigated taro cultivation, a large part of this valuable genetic resource base has probably been lost (Barrau, 1956a, p. 75).

Many secondary crops, such as sugar cane, bananas, and other fruits, greens and nuts, were grown in and around these staples, or gathered in abandoned gardens or in the wild. For instance, the root of *magnagna* (*Pueraria thunbergiana*) provided both food and fibre (Garnier, 1875, p. 45; Barrau, 1956b; Haudricourt, 1964). In one tribe, its use as food was restricted to times of drought (Guiart, 1963, p. 138). Other edible plants were used only in times of scarcity; these may have been more important in early pre-cultivation times (Dubois, 1951a, p. 254; Barrau, 1956a, p. 53, 57; 1960, p. 68). Others were important sources of fibres and other materials. These useful plants have been reasonably well documented elsewhere, so no attempt will be made to discuss them all here (Vieillard, 1862; Vieillard and Deplanche, 1863; Lanessan, 1886; Virot, 1951; Barrau, 1953b, 1956a, 1958, 1962; Dubois, 1971; Doumenge, 1975, p. 81). Unfortunately, some listings of useful plants do not indicate whether the use is traditional or a European introduction (Jeanneney, 1891; Barrau, 1950; Bourret, 1981).

There were two principal constraints on traditional agriculture in New Caledonia. The first was the difficulty of maintaining an adequate food supply

all year round. References to periods of scarcity and the use of less palatable foods from the forest are common. The yam is a seasonal crop, and while it can be stored for about 6 to 10 months under cool dry conditions (Guiart, 1963, p. 655), there is often a gap before the next harvest, especially if much of the supply is consumed at an important event. Taro keeps only a few days after harvesting, but with irrigation it can be planted all year round and held in the ground for a long period after maturity. This was a principal justification for the effort of maintaining irrigated taro. The potential for growing both of these staples also varied from one area to another, and in some places it was necessary to rely on lesser crops (Guiart, 1963, p. 655). The accumulation of agricultural surpluses was therefore impossible (Guiart, 1963, p. 655; Doumenge, 1982), and a system of exchanges for immediate consumption remained the basis of the economic system (Guiart, 1963, p. 656). The food supply was also vulnerable to disasters such as cyclones, and plantings were fragmented for better security (Doumenge, 1982). The success or failure of a crop depended on factors beyond human control, and much traditional magic was an attempt to influence these factors. With the introduction of new crops and imported foodstuffs, this is now less of a problem.

The second constraint was the lack of methods for maintaining or improving soil fertility (Doumenge, 1982). In spite of the great investment in constructing terraces or mounds, only a single harvest was generally possible before yields declined. A fallow period of 3 to 10 years was often necessary before the land could be used again (Barrau, 1956a, p. 79; Doumenge, 1975, p. 82). This meant that very large areas had to be developed, with a large percentage in fallow at any one time (Doumenge, 1982). Europeans unaccustomed to such a system often interpreted fallow land as abandoned land, leading to assumptions that the population did not need so much land, and even to projections of a much larger kanak population in the past (Roux, 1983). The creation of the reserves and the reduction in agricultural land available to the kanak population made such long fallows impossible, leading to declines in soil fertility and productivity (Barrau, 1956a, p. 123). The destruction of forests and frequent burning have only accelerated the problem (Barrau, 1958, p. 78). The adoption of intensified cultivation with new crops, and European techniques of cultivation with their consequent accelerated erosion can only make matters worse (Barrau, 1956a, p. 127). Inexpensive soil supplements or means of maintaining soil fertility are needed to resolve this problem in modern subsistence agriculture (Barrau, 1958, p. 85).

The agricultural calendar is one of the most critical aspects of any agricultural system, yet little information on this has been preserved. Leenhardt (1930, p. 114-133) gives a general description of the yam calendar from clearing the land in July through planting in September and October, to the start of the new yam harvest in March. Lambert (1900, p. 57) noted that the time for yam planting was marked by the rise of a particular constellation. However, the details in terms of adaptation to particular local areas, weather patterns, crop varieties, and other factors are lacking. Even Leenhardt's excellent study of Melanesian concepts of time (1947, chapter 6) provides little further information. The potential for variation is shown in a comparable yam calendar for Pentecost Island, Vanuatu, where yams are planted in November-December and the new yam harvest begins in May (Muller, 1975). Even Spriggs' (1981) excellent study of taro cultivation is silent on questions of timing. Such timing was one of the most important aspects of Melanesian life, to the point that plants such as yams that

permitted men to situate himself in time were given magic or ritual qualities (Barrau, 1967a). Counting or measuring time does not seem to have been part of Melanesian culture, so there was more reliance on celestial events and on a calendar by association with events in nature such as the flowering or fruiting of trees (Lambert, 1900, p. 58; Leenhardt, 1947, p. 79; Barrau, 1958, p. 33). However, other than two examples given by Leenhardt, there seem to be no published records of what these associations actually are, although this type of information is readily volunteered even today.

Another area where the published record is silent is on the traditional control of plant pests and diseases. Even though the number of such problems has obviously increased with European introductions, there must have been traditional control methods that have apparently escaped observers' attention.

Traditional agriculture in New Caledonia has declined steadily since the arrival of the Europeans, and today only the simpler types of subsistence cultivation remain. Garnier (1875, p. 45) describes taro terraces on Mont-Dore already abandoned in 1864. The European introduction of cattle that trampled hillside structures and raided gardens was disastrous for the irrigation systems on which taro depended (Leenhardt, 1930; Barrau, 1956a). It is possible that introduced deer (Barrau and Devambe, 1957) may have had a similar but less noticeable effect. With the displacement of many clans from their ancestral lands, and the colonization of the best agricultural land by Europeans who did not understand or appreciate traditional agriculture, the continuity of agricultural development was broken. The population decline, the breakdown of traditional social structures, the competition for land and labour from cash crops such as coffee and other employment, the introduction of crops easier to cultivate such as manioc, and the availability of imported foods have all contributed to the collapse of traditional agricultural systems (Barrau, 1956a, 1958; Curry, 1960; Doumenge, 1974b). In the Canala area, the number of populated centres has declined from 150 to 30 and the formerly cultivated land had been reduced by half by about 1970 (Doumenge, 1974a). The nickel "boom" at that time brought traditional agriculture to its lowest point ever, but there has been some return to the land since the end of the boom (Bourret, 1978). Even where yam cultivation continues, the less demanding varieties are now preferred. Little remains today of the elaborate and sophisticated agricultural systems of the past.

Fishing

In comparison with agriculture, traditional fishing has been greatly neglected in New Caledonia. Only one significant paper is devoted in part to fishing methods in the territory, including a few references to traditional methods (Legand, 1950), and there is nothing comparable to the excellent studies done elsewhere in the region (for example Nordhoff, 1930; Johannes, 1978, 1981; Gillett, 1984) although research on the subject is now in progress (I. Leblie and M.-H. Tuilleries, personal communication). From the scattered references, the following picture of traditional fishing knowledge can be constructed.

Fishing was a significant activity for coastal people who claimed property rights over fishing areas (Lemire, 1884, p. 103; Guiart, 1963, p. 364), and who often traded fish for other staples grown in the interior (Barrau, 1956a, p. 58; Guiart, 1963, p. 654). Early observers often commented on the

abundance of marine resources such as Tridacna clams (Lemire, 1884; Legand, 1950) and turtles (Legand, 1950).

The basic fishing techniques seem similar to many Pacific Island areas. Women gleaned crabs, sea urchins, octopus and various shellfish (Locard, 1896) from reef and mangrove areas accessible at low tide (Lambert, 1900, p. 204). Fishing with nets, lines and spears was a men's occupation (Lambert, 1900, p. 205). Nets were made with fibres from a forest vine (Garnier, 1875, p. 56) or with coconut fibre (Legand, 1950, p. 176) and could reach 50 metres in length (Lambert, 1900, p. 205). The fish encircled with such a net were grabbed, clubbed or speared (Lambert, 1900, p. 206; Legand, 1950, p. 176). Special large nets were made for catching turtles (Lambert, 1900, p. 207; Legand, 1950, p. 177; Guiart, 1963, p. 210). Smaller nets served to catch sardines or mullet (Lambert, 1900, p. 209). Coconut leaves were also used to encircle fish (Legand, 1950, p. 176). Fish traps were constructed, particularly in the Loyalty Islands, and were sometimes baited with papaya leaves (Legand, 1950, p. 177; Guiart, 1963, p. 654). Dugong were hunted when possible (Lemire, 1884, p. 164, 213; Legand, 1950, p. 178). Turtle eggs collected on the beach were reserved for the chief, at least in the South (Garnier, 1875, p. 59).

Poisons from various plants were also used for fishing (Legand, 1950, p. 178) in both rivers and the sea, and the plants used have been documented (Virot, 1950) and in the case of Euphorbia kanalensis were even cultivated (Barrau, 1956a, p. 116). Traditionally such techniques were used judiciously and in moderation (Barrau, 1956a, p. 116). Lambert (1900, p. 212) reports that a bundle composed of three (unidentified) plants was placed in the sea to attract sardines. A lure made of a rock or shell with coconut leaf tail imitating the form of a rat and suspended from a fishing pole was used to catch octopus (Legand, 1950, p. 178). Metais (1976, p. 50) describes a unique technique for collecting shells for shell money on the fibre skirts of old women, but when this technique was described to some of the few old people who still make shell money it brought only laughter; the ethnologist's informant apparently told it as a joke.

There appears to have been an extensive lore linking the flowering or fruiting of various trees with the best times for catching different species of fish. Lambert (1900, p. 212) refers to a women's song listing the trees that flower on the arrival of the fish. Leenhardt (1947, p. 79) notes that erythrine flowers are the signal for the shark hunt. My informants have confirmed the widespread occurrence of this type of information. Unfortunately, the details as to which flower is associated with which fish in which area have never been recorded.

Most island peoples observed a complex set of rules governing fisheries which ensured sound management of the resource. This would seem to have been the case in New Caledonia, as Guiart (1963, p. 603) describes a ban on fishing on Ouvea for the first six months of the year. However, no further details are given and no other references to such practices have been found in the literature. Islanders similarly had detailed knowledge of the behavior, migration and reproduction of different species of fish, and of the best locations and times to catch them (Johannes, 1978), but none of this has been recorded for New Caledonia.

Subsistence fishing has suffered the same decline as agriculture, and those techniques requiring collective effort are rarely if ever practiced

(Metais, 1976). The changes brought by European fishing technology and improved boats have probably been even greater than in agriculture. Even with the great areas of reef and lagoon available in New Caledonia, overfishing has become an increasing problem. A return to more traditional fisheries management techniques might be a solution, but so little has been recorded and so much time has passed that it may now be too late to try to salvage or reconstruct them.

Hunting

The lack of adequate sources of animal protein on the land was a major problem, especially for tribes without access to or an orientation towards the sea. The forest only provided flying foxes (fruit bats) and pigeons (notous) as game worth hunting (Guiart, 1963, p. 654). The land snail (Barrau, 1956a, p. 117) and certain grubs were also eaten. None of the lore associated with traditional hunting seems to have been recorded.

As in other societies where animal protein was limited, the desire for flesh was frequently expressed (Lambert, 1900, p. 204) and cannibalism was practiced (Lemire, 1884, p. 97). Kanak legends frequently describe wars motivated by a desire for meat, and in certain areas it was a role of certain families to supply one of their members for the chief's meat. The European introduction of large mammals has made other sources of protein widely available. Deer in particular have helped to fill the meat requirement of tribes in the mountainous interior (Barrau and Devambe, 1957).

Medicine

The one aspect of traditional medicine that has attracted scholarly attention is the use of medicinal plants. Apart from the general lists of useful plants described above, which often include medicinal uses, there have been a number of studies specifically on medicinal plants (Lenormand, 1948; Guillaumin, 1951; Barrau, 1957; Rageau, 1973; Bourret, 1981) although some of these do not distinguish between pre-European and more modern uses of these plants.

Traditional medicine is known to include both rational and psycho-therapeutic techniques, together with a folk classification and nomenclature of ills and diseases, and involves both simple family remedies and specialist healers for different types of treatments (Barrau, 1966). Traditional surgeons, for instance, were able to replace parts of the skull with coconut shell (Metais, 1976, p. 70). It is the specialist knowledge that is particularly difficult to obtain and that is rapidly being lost (Barrau, 1966; Metais, 1967). By the mid-1960s the surgeons had disappeared in New Caledonia, and only one traditional midwife remained (Metais, 1967). The documentation on this aspect of traditional knowledge is almost non-existent.

Technology

Traditional technology concerned the knowledge and skills necessary to use the materials available in the environment to meet various human needs. A few of these techniques, such as the fabrication of bark cloth and various

types of string and rope, have been noted (Lambert, 1900, p. 162-168) as have the techniques for pottery (Leenhardt, 1930, p. 31-33), working jade (Garnier, 1875, p. 83-85) and the fabrication of different implements (Lambert, 1900, p. 169-173; Leenhardt, 1930, p. 26-31). However, the skills that can only come from practical experience have largely been lost.

While kanak huts sometimes achieved the spectacular proportions of up to 9 metres diameter by 12 metres high (Leenhardt, 1930, p. 4), they were originally condemned by the administration as unsanitary (Guiart, 1956, p. 38) and every effort was made to replace them by European-style constructions. However, the closed hut was much better adapted to the hot days, cold nights and mosquitoes of most rural areas, than the corrugated iron shacks that were built to replace them, and today many families keep both. With time, other qualities of the kanak hut came to be appreciated, such as its flexible construction that made it very resistant to cyclones (Guiart, 1956, p. 19; 1963, p. 550; Doumenge, 1982). Only now, however, have the techniques of hut construction been documented in detail (Boulay, 1984a, 1984b).

Less has been noted on traditional knowledge of trees and their woods. The kanaques were able to cut large trees in the forest, move them to a building site and erect them as centre posts, or hollow them out for canoes or aqueducts (Leenhardt, 1930, p. 4). There was obviously a very complete knowledge of the qualities and resistances of each wood and their appropriateness for different tasks. Yet the Europeans on their arrival had to learn these things all over again (Sebert, 1874).

Better documented is the place of Melanesian communities in the landscape, the space occupied by different clans and the layout of the village, for which a number of examples have been described (Leenhardt, 1930; Avias, 1953; Doumenge, 1982; Bensa, 1982) but this is only marginally pertinent to the management of environmental resources and will not be treated further here.

General

The scope of traditional knowledge of nature and the environment was very large. There were names for and a classification of every significant species of plant and animal (Lambert, 1900, p. 59). Periodic events like the movements of celestial bodies, the flowering and fruiting of trees, and the migrations of birds and fish were observed and incorporated into their system of knowledge. Celestial navigation was practiced, and the weather could be predicted, with only rare exceptions (Lambert, 1900, p. 58, 188). Apart from some names, none of the details have been recorded.

While the process of the observation of natural phenomena in kanak society was similar to that of modern science, the intellectual context within which the observations were interpreted was very different. The kanak did not identify himself as separate from the world around him; on the contrary, he was part of the world and perceived himself by analogy with objects in nature such as the yam, whose cycle symbolized the cycle of life (Leenhardt, 1944; 1947, p. 60-64). The ancestors were born from trees, and the body was identified with the vegetable kingdom (Leenhardt, 1947, p. 16-19). The different plants had symbolic meanings that were used as a kind of language (Leenhardt, 1930, p. 116; Barrau, 1970). The land was the spiritual as well as

material source of life (Saussol, 1979, p. 34). It is no wonder that the habitat was worshipped (Leenhardt, 1947, p. 57-59) and that there was no distinction between magic or myth and the natural world.

Knowledge was not held equally by everyone; there was a tendency towards specialization in the community (Leenhardt, 1947, p. 79). Each family had its own knowledge and magic passed from generation to generation, and its assigned hereditary role in the community. The family of chiefs symbolized the clan and provided political leadership, announcing decisions taken in consultation with appropriate specialists. Others provided priests, war chiefs, orators and other figures in the community. Many of these specialists had a role in managing environmental resources. The family of the first occupants provided the master of the land who distributed the land and maintained the cadastral system. There was often a master of yams or dry (male) crops, and a master of wet or female crops (taro, bananas, sugar cane) who were the agricultural technicians and decided the timing of gardening operations (Glaumont, 1897, p. 28; Leenhardt, 1930, p. 109; Barrau, 1956a, p. 53; 1965, p. 126; Guiart, 1963, p. 137). Secondary crops such as banana and magnagna could also have their master (Guiart, 1963, p. 138). The doctors and healers had their special knowledge of sicknesses, medicines and other treatments (Leenhardt, 1947, p. 123; Metais, 1976, p.69). Fishing knowledge and magic was held by the families responsible for supplying fish to the chief (Leenhardt, 1947, p. 123; Guiart, 1963, p. 202, 216). A clan might be foresters or carpenters, with a knowledge of the forest trees, the qualities of each wood, the techniques for cutting and hauling a tree to the building site, and the construction of huts or the making of canoes (Leenhardt, 1947, p. 123; Metais, 1976, p. 69). Families might own magic to control the sun, the rain, cyclones, or the land breeze to chase away bad weather (Leenhardt, 1930, p. 120-125; Tavernier, 1955; Guiart, 1963, p. 40, 137-138). These different specializations were not mutually exclusive, and the number varied with the area and the size of the community. The rolls could also be combined; a sculptor might also be a surgeon, since both required similar cutting skills (Leenhardt, 1947, p. 142). The names of families often refer to an agricultural function or to family magic (Doumenge, 1974a, p. 43).

There was also some separation of specializations between men and women (Metais, 1976, p. 66). Taro was a female crop, and women were better informants than men on the different varieties of taro (Barrau, 1956a, p. 76). Pottery, tatooing, midwifery and some types of healing were also women's roles (Metais, 1976, p. 66).

These specialists have largely disappeared and much of their knowledge has been lost. From the fragmentary information that remains, it is possible to give some indications of how they must have worked. The head of a family on Lifou had a magic allowing him to climb up on a promontory and to ask the relations of his god in another locality to send fish to his brothers-in-law; although the rite is no longer followed, when the wind blows from the other locality it still washes fish up on the sand, just as it did the day after the rite (Guiart, 1963, p. 378). The magic was thus related to a natural phenomenon, and the skill of the magician may have lain in knowing when to perform the rite.

The master of a crop frequently had a small sacred garden in which he first practiced the different acts in the cultivation of the crop (Leenhardt, 1930, p. 115-117). Barrau (1965, p. 126-127) suggests that these ritual gardens

served as microexperimental gardens and meteorological stations permitting the master to adapt his decisions to the variable climate.

A knowledge or skill was intimately related to the myth or magic with which it was inherited. Leenhardt (1947, p. 142-143) describes a skilled sculptor and surgeon whose confidence rested in the gift from his deified ancestors; when he became a Christian, this confidence was destroyed and his skill was lost.

A resource might be managed through a taboo or prohibition. A taboo might be placed on a garden to protect the crop before the harvest, or an area of tall grass might be protected presumably because it was needed to repair the thatch on the huts in the village (Lemire, 1884, p. 117, 119).

Conclusions

The above fragmentary description of traditional environmental management in New Caledonia shows what a rich heritage there must have been and how little has been preserved or recorded. On some subjects there is a good written description, but without the skills that can only come from practical experience. For other topics, there are only generalities without the detail necessary to be useful. In some areas there is only a hint of the former existence of practices or knowledge that might have been very useful as a guide to solutions to modern resource management problems.

What we do not know is how much of this information may still exist, perhaps unconsciously, in the daily practices of rural workers or the memories of old people. While no one living today can remember back to pre-colonial times (Doumenge, 1974a, p. 40), there may still be some who were young when such skills were still valued in the family. This knowledge can only be saved if young people, preferably within the family, appreciate it and are willing to make the effort to learn it. Problems of confidence and language make it much more difficult for outsiders to collect and record this information. If this review encourages the renewed transmission of traditional knowledge or inspires useful research, it will have served its purpose.

While this study has necessarily concentrated on New Caledonia, the example given has much wider pertinence to the whole of the Pacific islands. Details may differ, but the general principles of environmental knowledge and resource management are similar throughout much of the region, and their pertinence to modern problems of development is just as great. Other areas may be fortunate in having seen less of their traditional experience eroded by introduced practices and changing education. The example of New Caledonia can serve as a warning for them to record this knowledge and reinforce its transmission before it is too late.

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