
TRADITIONAL ECOLOGICAL KNOWLEDGE:
A COLLECTION OF ESSAYS

Edited by Robert E. Johannes

IUCN, The World Conservation Union

November 1989

TRADITIONAL ENVIRONMENTAL KNOWLEDGE AND RESOURCE MANAGEMENT IN NEW CALEDONIA

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Based on work, prepared for the South Pacific Regional Environment Programme (SPREP), and revised from A.L. Dahl, "Traditional environmental management in New Caledonia: a review of existing knowledge", SPREP Topic Review 18, South Pacific Commission, Noumea, New Caledonia, 1985. Permission to reuse this material is gratefully acknowledged.

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 dispersed and often anecdotal. At times, their environmental context and importance have not even been understood.

This review examines the scope of traditional Kanak knowledge of the environment and of their approaches to environmental conservation and management in New Caledonia, insofar as these can be determined from published sources. Discussions with both Kanaks (the Melanesians of New Caledonia) and ethnologists provided additional indications and examples of the extent of traditional knowledge. The perspective used is that of an ecologist rather than an ethnologist, and thus without any pretension to ethnological rigour. All the published sources cited are by Europeans (with the inevitable disadvantage of viewing a culture through foreign eyes), and some 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. While the detailed information in many published sources still requires confirmation by the Kanaks themselves, the general conclusions seem to be valid.

Present state of knowledge

It is clear that only a tiny fraction of the environmental knowledge in Kanak culture has ever been recorded. Much has already been lost, and the old men and women who still possess such knowledge reasonably intact have not passed it on to the next generation; it is dying 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 have seen no pertinence in such traditions to a modern way of life, and have thus remained disinterested, although this may change with the current revival of interest and pride in Kanak culture.

There are many reasons why so much of this traditional heritage has been lost. For generations, the "superstitions of primitive peoples" have been discredited by missionaries, administrators, educators and European colonists. Father Lambert (1900), 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". Children are no longer educated in the family or the tribe, but in schools where Western-style education has given 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 solution 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 in New Caledonia 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 interest 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 of necessary detail has not; a reference to the flowering of a tree is of little use without knowing which tree is being 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 fill the lacunae identified here.

Studies of traditional life in New Caledonia fall naturally into three groupings. The first in 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. Publications are very sparse in the second period to about 1950, with the outstanding exception of the work by 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 mound form, and the channels near the points were generally lined with stones to prevent erosion (Leenhardt 1930, Barrau 1956a). On valley bottoms and along streams, the mounds were circular or more often linear, three to four metres wide, more than one metre high, and sometimes extending for several hundred metres (Doumenge 1974a). Lands subject to heavy flooding were avoided (Saussol 1979). The channels dug out to make the mounds provided drainage and helped to protect against flood damage during the wet season (Barrau 1956a). 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). 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 two metres long (Leenhardt 1930, Guiart 1963). The different soil conditions in the Loyalty Islands dictated different agricultural techniques (Guiart 1963).

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, Barrau 1956a), 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. Aquaducts were used to cross depressions, hollowed trees were used to bridge gullies, and special overflows protected against damage in heavy rains (Leenhardt, 1930, Doumenge 1974a, Spriggs 1981). Terraces generally two to six metres wide were carved out of slopes up to 80 per cent (Barrau 1956a), 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), but the systems required constant surveillance and maintenance. The hydraulic works were protected by a code of prohibitions and taboos (Leenhardt 1930, Barrau 1956a, 1965). Earthworms were a significant cause of leaks. Plantings along the banks had both magical and practical significance in stabilization and erosion control (Leenhardt 1930). Some heads of valleys became great amphitheatres of taro terraces. These terraces were also developed along streams, and in low swampy areas where the taro was planted in raised beds (Barrau 1956a). Similar types of irrigated taro cultivation are still practised 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). Many varieties were imported at different times (Dubois 1951, Barrau 1956a, 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).

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, Barrau 1956b, Haudricourt 1964). In one tribe, its use as food was restricted to times of drought (Guiart 1963). Other edible plants were used only in times of scarcity; these may have been more important in early pre-cultivation times (Dubois 1951, Barrau 1956a, 1960). Other plants 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). 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 for the forest are common. The yam is a seasonal crop, and while it can be stored for about six to ten months under cool dry conditions (Guiart 1963), 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). The accumulation of agricultural surpluses was therefore impossible (Guiart 1963, Doumenge 1982), and a system of exchanges for immediate consumption remained the basis of the economic system (Guiart 1963). 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, uncertainty about a reliable food supply 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 three to ten years was often necessary before the land could be used again (Barrau 1956a; Doumenge 1975). This meant that extensive areas of land 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 consequent reduction in agricultural land available to the Kanak population made such long fallows impossible, resulting in declines in soil fertility and productivity (Barrau 1956a). Destruction of forests and frequent burning have only accelerated the problem (Barrau 1958). 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). Inexpensive soil supplements or means of maintaining soil fertility are needed to resolve this problem in modern subsistence agriculture (Barrau 1958).

The agricultural calendar is one of the most critical aspects of any agricultural system, yet little information on this has been preserved. Leenhardt (1930) 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) 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 (1947, see 1979) valuable study of Melanesian concepts of time 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) valuable 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 man 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, Leenhardt 1947 see 1979, Barrau 1958). 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) 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

Compared with agriculture, the documentation of 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. Leblic and M.-H. Tuilieres, 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, Guiart 1963), and who often traded fish for other staples grown in the interior (Barrau 1956a, Guiart 1963). 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). Fishing with nets, lines and spears was a men's occupation (Lambert 1900). Nets were made with fibres from a forest vine (Garnier 1875) or with coconut fibre (Legand 1950) and could reach 50 metres in length (Lambert 1900). The fish encircled with such a net were grabbed, clubbed or speared (Lambert 1900, Legand 1950). Special large nets were made for catching turtles (Lambert 1900, Legand 1950, Guiart 1963). Smaller nets served to catch sardines or mullet (Lambert 1900). Coconut leaves were also used to encircle fish (Legand 1950). Fish traps were constructed, particularly in the Loyalty Islands, and were sometimes baited with papaya leaves (Legand 1950, Guiart 1963). Dugong were hunted when possible (Lemire 1884, Legand 1950). Turtle eggs collected on the beach were reserved for the chief, at least in the south (Garnier 1875).

Poisons from various plants were also used for fishing (Legand 1950) in both rivers and the sea, and the plants used have been documented (Virot 1950) – in the case of *Euphorbia kanalensis* they were even cultivated (Barrau 1956a). Traditionally such techniques were used judiciously and in moderation (Barrau 1956a). Lambert (1900) 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). Metais (1976) 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) refers to a women's song listing the trees that flower on the arrival of the fish. Leenhardt (1947 see 1979) 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) describes a ban on fishing on Ouvéa 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. Similarly, Pacific Islanders had detailed knowledge of the behaviour, 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 practised (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). The land snail (Barrau 1956a) 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) and cannibalism was practised (Lemire 1884). Kanak legends often 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 1956a, Barrau 1956b, Barrau 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). 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 involved 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) as have the techniques for pottery (Leenhardt 1930), working jade (Garnier 1875) and the fabrication of different implements (Lambert 1900, Leenhardt 1930). However, the skills that can only come from practical experience with these techniques have largely been lost.

While Kanak huts sometimes achieved the spectacular proportions of up to nine metres diameter by twelve metres high (Leenhardt 1930), they were originally condemned by the administration as unsanitary (Guiart 1956) 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, 1963, 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 Kanaks 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). 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 and Riviere 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 Kanak 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). 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 practised, and the weather could be predicted, with only rare errors (Lambert 1900). 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 see 1979). The ancestors were born from trees, and the body was identified with the vegetable kingdom (Leenhardt 1947 see 1979). The different plants had symbolic meanings that were used as a kind of language (Leenhardt 1930, Barrau 1970). The land was the spiritual as well as material source of life (Saussol 1979). It is no wonder that the habitat was

worshipped (Leenhardt 1947 see 1979) 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 specialisation in the community (Leenhardt 1947 see 1979). 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, Leenhardt 1930, Barrau 1956a, 1965, Guiart 1963). Secondary crops such as banana and magnagna could also have their master (Guiart 1963). The doctors and healers had their special knowledge of sicknesses, medicines and other treatments (Leenhardt 1947, Metais 1976). Fishing knowledge and magic was held by the families responsible for supplying fish to the chief (Leenhardt 1947 see 1979, Guiart 1963). 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 see 1979, Metais 1976). Families might own magic to control the sun, the rain, cyclones, or the land breeze to chase away bad weather (Leenhardt 1930, Tavernier 1955, Guiart 1963). These different specializations were not mutually exclusive, and the number varied with the area and the size of the community. The roles could also be combined; a sculptor might also be a surgeon, since both required similar cutting skills (Leenhardt 1947 see 1979). The names of families often refer to an agricultural function or to family magic (Doumenge 1974a).

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

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). 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 practised the different acts in the cultivation of the crops (Leenhardt 1930). Barrau (1965) 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 see 1979) 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).

Conclusions

The above fragmentary description of traditional environmental knowledge and 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, although what is described is not derived 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 practice or knowledge that might have been very useful as a guide to solving 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), there may still be some who were young when such skills were 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 such 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 the Kanak people of New Caledonia, the example given has much wider importance 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.