

Original Article

Nutrition studies (1948) of nomadic Aborigines in Arnhem Land, northern Australia

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 American–Australian Scientific Expedition to Arnhem Land

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During 1948, scientists (an anthropologist, a nutritionist and a plant ecologist) of the American–Australian Scientific Expedition to Arnhem Land observed the daily activities of families of nomadic Aborigines in the monsoonal climate of Groote Eylandt, Bickerton Island, Port Bradshaw, Yirrkala and Oenpelli, Northern Territory. The close relationship between the hunter–gatherers and the marine and terrestrial landscape is described at Hemple Bay in Port Langdon, north-eastern Groote Eylandt. Food-gathering from both land and sea was followed hourly to assess the nutritional value of ‘bush tucker’ in comparison with that of natives eating freshly picked fruit and vegetables grown in the garden of the Umbakumba Settlement. The ecological distributions of food plants used by the Aborigines, together with their seasonality, determined the migratory pattern of the hunter–gatherers throughout the year. With only a few exceptions, the diets which were seen at the four camps in Arnhem Land were well-balanced and provided amounts of most nutrients comparable with the recommended international dietary allowances. Seasonal and regional variations in food supply were a constant problem to these nomadic people.

Key words: Australian Aborigines, ethnobotany, hunter–gatherer, nomad, nutrition, time-and-motion studies.

Introduction

The American–Australian Scientific Expedition to Arnhem Land (1948)

After World War II, the Australian Government created the Department of Information to promote cultural and scientific relations with our wartime colleague, the United States. In 1946, Charles P Mountford was given leave from the PMG (of the Post Master General) Department to undertake a lecture tour of the United States; in particular, he screened his film *Brown Men and Red Sands*, recorded on his pre-War expeditions to Ayers Rock (Uluru) and the Olgas (Kata Tjuta) where he studied the art and culture of the desert Aborigines.

In Washington, DC, the National Geographic Society and the Smithsonian Institution encouraged Mountford to organize an expedition to study the Mimi and X-ray rock art of Arnhem Land, Northern Territory (Fig. 1). From March to November 1948, 11 scientists (five from the USA and six from Australia), plus five support staff, studied Aboriginal art and culture, ecology, health and nutrition on Groote Eylandt, Bickerton Island, Yirrkala, Port Bradshaw, Milingimbi and Oenpelli in the Arnhem Land Aboriginal Reserve. Two articles on the Arnhem Land Expedition appeared in the *National Geographic Magazine* (September and December 1949);^{1,2} a number of the aboriginal paintings were reproduced in the *UNESCO World Art Series* (1954);³ four volumes on *Records of the American–Australian Scientific Expedition to Arnhem Land* were eventually published by Melbourne University Press (Mountford 1956;⁴ Specht and Mountford 1958;⁵ Mountford 1960;⁶ Specht 1962⁷).

The nutrition of Aborigines living in the settlements scattered across Arnhem Land was compared with that of the small nomadic groups still living in the pre-European lifestyle of hunter–gatherers. The results of these scientific studies were reported in the second volume dealing with *Anthropology and Nutrition* (Mountford 1960)⁶ and the ethnobotany of the hunter–gatherers in the third volume on *Botany and Plant Ecology* (Specht and Mountford 1958).⁵ By 1948, only a few Aborigines preferred a nomadic lifestyle and these groups visited the settlements every few months to supplement their harsh diet of native foods and to acquire various European tools and utensils. European blankets were readily accepted to warm them during the cool winter nights. Canvas had replaced the woven pandanus used formerly for the Macassan-type sails of their dug-out canoes. Steel axes, knives, steel for shovel-nosed spears and harpoons, wire for fish-hooks and fish-spears, etc. had replaced stone and wooden implements which, over the previous millenia, had been made so laboriously. Steel cans to hold water for cooking had replaced bailer shells. The brass bowls of the

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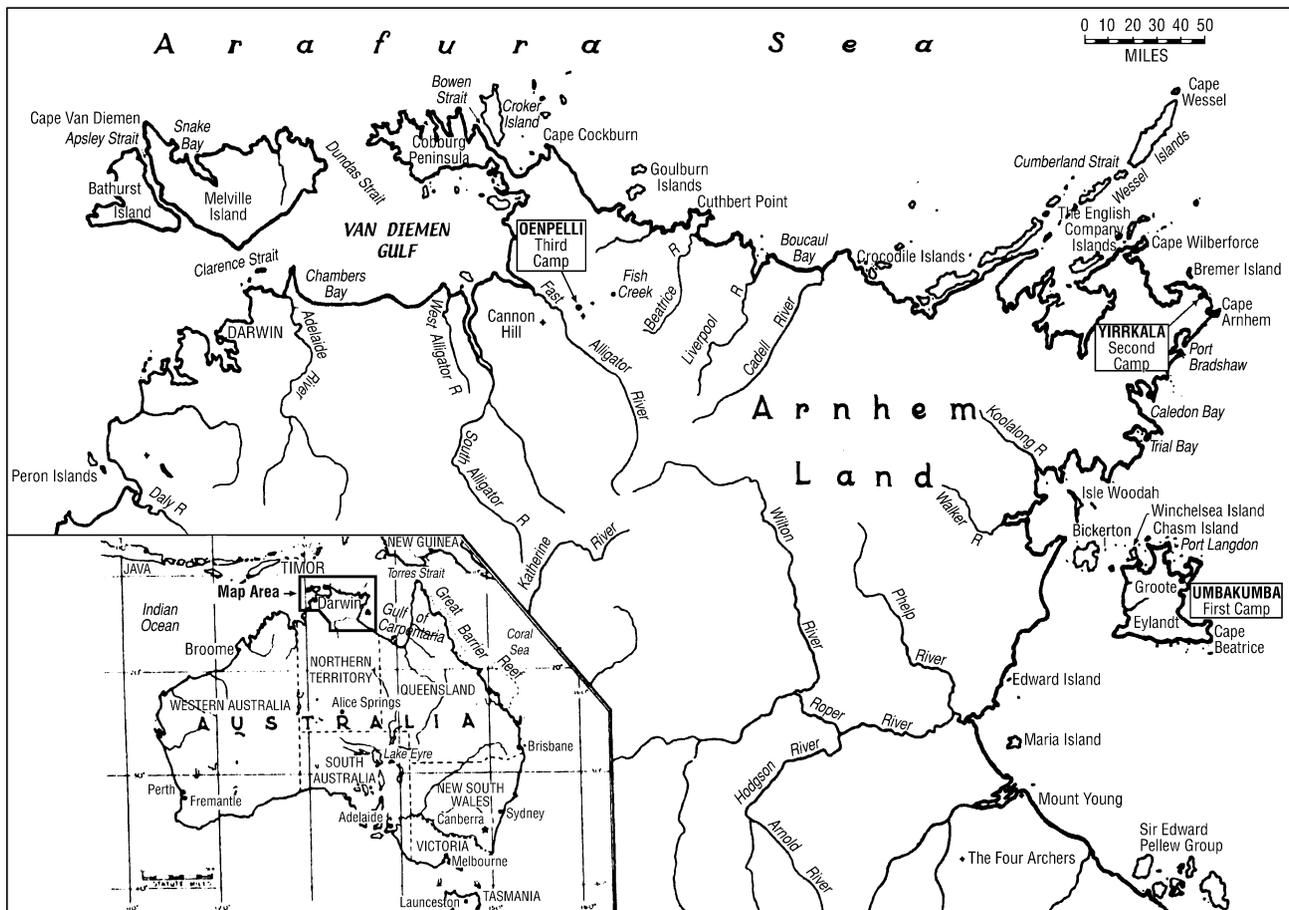


Figure 1. Map of Arnhem Land, Northern Territory of Australia, showing the location of Groote Eylandt, Bickerton Island, Port Bradshaw and Fish Creek near Oenpelli. (Figure courtesy of the State Library of South Australia.)

Macassan-style smoking pipes were made from spent cartridges.

Aboriginal ecology, health and nutrition

Two members, Margaret McArthur (nutritionist) and Ray Specht (plant ecologist), of the Arnhem Land Expedition spent 2 weeks (24 April to 9 May 1948) at Hemple Bay, Groote Eylandt ($13^{\circ}45'S$, $136^{\circ}40'E$, Fig. 2). A third place was taken by Kelvin Hodges (biochemist) during the first week and Fred McCarthy (anthropologist) replaced Kelvin during the second week. The camp was sited on the top of a dune in a very exposed position; overlooking the Bay a small tent was erected for Margaret, while the men camped beneath a tarpaulin, under which sand blew continually into our gear and food supplies. Later, on Bickerton Island ($13^{\circ}45'S$, $136^{\circ}10'E$, 5–24 June 1948), Margaret McArthur and Ray Specht had a perpetual war with native dogs, which sneaked into the tent to steal food, no matter how well the tent was battened down. We called them 'archaeologist dogs' for they were good at digging holes!

A detailed study of the geology, soils and plant ecology of each locality was made by the botanist (Specht 1958a).⁸ Detailed information on every plant species used by the Aborigines, either as food or to make implements, was collated, together with details of their preparation (Specht 1958b).⁹ As a number of the Aborigines living on Groote Eylandt and Bickerton Island were bilingual, both the Groote Eylandt (Enindilyakwa) and the Caledon Bay (Gomaidje,

Yolgnu) names of economic plants were recorded, using the international phonetic alphabet.

A time-and-motion study (lasting 4 days) was made of the food-gathering techniques and nutrition of four families who were living off 'bush tucker' at Hemple Bay (McArthur 1960b;¹⁰ McCarthy and McArthur 1960;¹¹ Specht and Specht 1999).¹² Uncooked plant products were prepared by Kelvin Hodges for analysis in the laboratory of the Institute of Anatomy, Canberra (Fysh *et al.* 1960).¹³ The nutritive value of the 'bush tucker' diet was compared with that of natives eating freshly picked vegetables and fruit, grown at the Umbakumba Settlement where animal products (for example fish, turtle) were essentially the same as in the 'bush'; the levels of serum protein, haemoglobin and plasma ascorbic acid in blood samples were compared between the two nutritional groups (Hodges 1960).¹⁴

Observations

The daily life of hunter-gatherers at Hemple Bay (McArthur,¹⁰ McCarthy^{11,15} and Specht^{9,16})

Four Aboriginal families were camped on the beach, each with its own shelter, about 50 m apart. The shelters were made of sheets of stringybark in 1–2 m lengths, set on their edges in a semicircle about 45–60 cm high. Two had, in addition, a pile of kurrajong branches, up to 1.5 m high on the windward side. Firewood was carried in by the women for the fire which was made in various spots within the shelters.

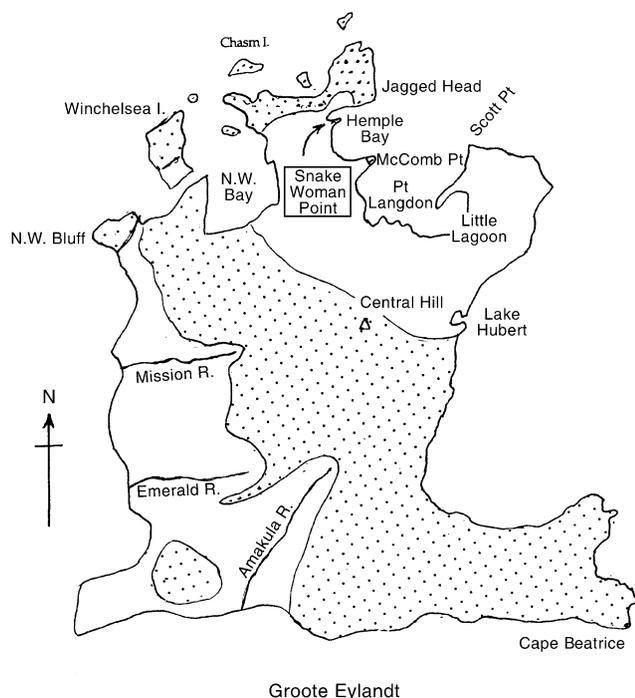


Figure 2. Map of Groote Eylandt, Northern Territory, showing the distribution of quartzitic rocks (□) and the location of Hemple Bay (13°45'S, 136°42'E).

The majority of the area was a savannah forest of stringybark (*Eucalyptus tetradonta*), growing on an undulating ridge of truncated lateritic soils (Specht 1958a);⁸ occasional outcrops of quartzite occurred at, for example, Jagged Head, McComb Point and the 'Snake Woman Point'. A coastal sanddune (with a hard calcrete core), which was carpeted with grasses and an occasional bush and/or *Pandanus* tree, ran alongside most of the north-south beach. Behind this coastal dune, narrow belts of monsoon rainforest and paperbark swamp occurred. A lagoon contained blue waterlilies and green sedges, rich in food resources. The swamps fed into a couple of freshwater streams which were lined with mangroves near their mouths. The beaches were sandy, lined with *Casuarina equisetifolia*, and merged into a reef of lateritic slabs or of quartzite.

The beach was selected as the campsite to avoid flies and mosquitoes. The camp was used mainly for the evening and morning meals and for sleeping. In the evening, the Aborigines stoked up the fire, rolled up in their European blankets and huddled around the fire, which was fuelled from time to time during the night whenever it died down. They were usually asleep by 8 p.m. and awake at dawn (6.15–6.30 a.m.) when there was movement getting wood for the fires to cook breakfast from food gathered on the previous day. This, of course, depended on the results of the day before; occasionally they went without breakfast.

By about 8 a.m. the natives moved off to collect food — the women into the bush, the swamps or to the mangroves and reefs; the men dragged out their canoes (two 5 m boats, dug out of a *Melaleuca leucadendra* paperbark, 'ai-i-luk-wa') to go fishing or set out hunting in the bush. As fish (e.g. *Scarus ghobban*, parrot fish and *Choerodon venustus*, Venus tusk fish) and turtle (*Chelonia* sp., 'i-men-da') were very plentiful at Hemple Bay, fishing was the more popular occu-

pation with the men. For fishing, the men firstly gathered crabs from holes along the sandy beach, then paddled out to water 4–6 m deep above the reefs where they cast in their lines — with no sinker and with barbless hooks of wire, baited by burying the hook through half a crab. The crab, a few centimetres in diameter, was broken lengthwise into two and the hook pushed through one leg from inside the cephalothorax; this piece was then broken off on the hook and the process repeated until the four legs and body were all on the hook. After getting the crab-bait on the hook, it was practically impossible to get it off, except by biting the crab into bits; hence the same crab-bait could be used to catch several fish. As soon as the fish (anything up to 10 kg) was hooked, they pulled in the line as fast as it could be, grabbed the fish out of the water and, if it was large, put their fingers under each gill and yanked the gills apart until the spine was broken. If the fish was small, they bit the spine behind the head with their teeth. Without a barb on their hooks, fish were not played on the line and quite often they lost the fish and frequently had their hooks straightened out or bitten off. If their line was snagged or broken, they dived down to retrieve the situation. As they did not use a sinker, they coiled up their lines and threw them out into the current. This was not very good, for half of the throws became entangled, but sinkers tended to snag on the reef.

For turtling, they kept their eyes open for typical signs such as different water colouration, bubbles and ripples, and paddled towards them, directed by the man in the prow with the harpoon (with steel barbed points 15 cm long), attached to a rope and held by the shaft. When they neared the turtle ('i-men-da'), the man in the prow flung his harpoon either from the boat or by hurling himself into the water with it. The shaft was withdrawn, leaving the head of the spear in the turtle's carapace (shell). The turtle was played and dragged in and more harpoon heads (up to four) plunged through its carapace until it could be brought alongside the canoe; there its head was clubbed to expose the brain. The turtle was then hauled aboard and died after a few more clubbings. Some of these turtles yielded up to 35 kg of flesh.

On Bickerton Island (June 5th to 24th 1948), two of the single boys caught a huge green turtle 100 cm × 75 cm. Altogether, the turtle weighed over 140 kg, including 80 kg of meat and 30 kg of blood. To bring it ashore, they had to upturn their canoe, tie the turtle to the seat, right the canoe plus turtle and then bail furiously. They brought the turtle in alive to keep it fresh for the next day.

McArthur (1960b, pp. 115–116)¹⁰ described the method of butchering and cooking this animal. Stones up to 10 cm in diameter were heated in a large fire. When the fire had burned down, the turtle, after its head was crushed, was put on the fire, right side up, and left for 20 minutes. It was then taken off the fire, slit around the neck and the head twisted off and put aside. The alimentary canal was pulled out, and the liver was separated from the intestines and later roasted on the coals for 10 minutes. The intestine was split along its entire length, washed in the sea and cooked on the coals for 15 minutes. After removal of the gut, the body cavity was filled with hot stones and the neck opening plugged with paperbark. It was left in this condition for half an hour. The two front flippers were then cut off and roasted on the coals for half an hour. The plastron was removed in sections; the skin was cut first, and while one man pulled the shell, another cut away the muscles. The two shoulder-blades, with muscles attached, were cut out

next and then the back flippers were torn from the body. The remaining meat was cut from the carapace. All the omental and mesenteric fat was carefully kept. Part of the blood was heated in a tin to be drunk.

A hollow was made in the hot sand and the two large pieces of the plastron were placed on coals in the depression. All the meat, including the back flippers, was laid on the plastron and the carapace was placed over the top. The spaces between the shell where the neck and flippers formerly protruded were stuffed with paperbark. An oven was made by scooping sand over the top, leaving only a small area of the shell exposed. It was left to cook for over an hour and when taken out was still half raw as judged by European standards.

Following this preliminary treatment and dissection, the meat was distributed around the camp and each group further cooked its own share. The men, who usually sat together on such occasions, made an oven similar to that described above. The women and children cooked their share in hot sand and ashes.

The butchering and subsequent distribution of the meat were the prerogative of the man or men who caught the turtle. The normal procedure was for the men to keep the front flippers and share the rest with the women and children. The omental and mesenteric fat were perhaps the greatest delicacies, but the heart, liver and intestines were also highly regarded. The distribution of the offal depended on the man in charge, but usually all sections of the camp received a part.

The day after this huge turtle had been eaten, a party of natives arrived in a canoe from the mainland, bringing dugong (*Dugong dugon*) and all had a wonderful feed. Later, several natives complained of a stomach-ache! Food exchange, being studied by the nutritionist, became impossible after the arrival of these visitors (RL Specht, unpubl. data, June 1948).

After catching, if they were lucky, 20 kg of fish or a turtle or two, the men returned to the shore to rest and smoke under the shade of a *Casuarina equisetifolia* tree. Depending on the catch, the men spent only the morning, sometimes the whole day, out fishing. If the results were good, then the men were all 'knocked up' and spent the next day resting and smoking their Macassan pipes.

The families were very altruistic, sharing most of their food, tobacco, implements and canoes. If they caught a lot of food, it was all eaten within 24 h — none was saved, as there was no refrigeration. If they had gorged one day, they rested during the next. They did not do any more food-gathering than was needed!

Off-days were used to repair canoes and other implements. When the canoes leaked badly they found a tree called 'mu-mu-pur-a' (*Terminalia carpentariae*) growing on the coastal dunes, scraped off the outer bark and gathered the inner bark in a bark dish; the red inner bark was mixed with water and plastered into the cracks where it dried rapidly within a few hours, sealing cracks. To make rope, they stripped the inner bark of a small kurrajong (*Brachychiton paradoxum*, called 'mi-a-rou-a') which also grew on the sanddunes and in the stringybark forest; the strands of inner bark were dried and rolled tightly between the palms into a cord, the thickness of which depended on the number of strands used (for example for fishing lines two or three strands, turtle and anchor lines seven to ten). When the cord was finished, two were twisted tightly together into a rope which compared favourably with European ropes. If neces-

sary, they repaired the sails which included a Macassan-type sail, of their canoes. With these sails, the canoes would really shoot across the water. The canoes were very stable, well-balanced and had a shallow draft.

Sometimes the men decided to wander down the coast with their woomeras and fish spears, two or four pronged, to spear fish. They were amazingly accurate, frequently spearing quite large fish in water less than 60 cm deep. At other times, they collected oysters (*Saccostrea cucullata*) and clams ('in-na-wum-bug-ga', *Tridacna* sp.) from reefs.

In comparison with seafoods, land animals such as bandicoots (*Isoodon macrourus*), porcupine (echidna, *Tachyglossus aculeatus*) and goanna (*Varanus* sp.) were rare. It was said that they were plentiful, but after walking many kilometres they were lucky to catch one. The men hunted with barbed and shovel-nosed spears; they would peer into all fallen and hollow logs, then push their spears up the logs to see whether there were any small animals inside. If there were, the logs would be cut open with their tomahawks (of European origin) to extract the animals. Sometimes the animals would dart out, but usually the natives would overtake them. They also would dig out a few holes in search of animals. Rarely would they expend the time needed to hunt a wallaby (*Macropus agilis*). An eagle eye was kept out for the stingless bee that made 'sugar bag' (yielding honeycomb about the size of the index finger). They traced the bee to the tree, where they cut out the 'sugar bag'. Eggs of birds (for example tern, *Sterna bergii*) and turtles (*Chelonia* sp.) supplemented rations occasionally, but they apparently never caught small birds and rarely snakes.

On Groote Eylandt, nomadic Aborigines thrust firesticks into tufts of grass, setting the savanna understorey of the eucalypt open-forest/woodland on fire. The fires, which burnt the spear grass and other prickly plants, made movement easier and also safer as enemies could no longer hide in the dense grass! The smoke from the fires could be seen for a considerable distance, enabling other Aborigines to locate the travellers (Levitt 1981).¹⁷

Johnson (1961, p. 447)¹⁸ noted that

'The practice of burning off the ground vegetation that is indulged in every year by aborigines throughout Arnhem Land destroys the habitat of some kinds of ground-dwelling small mammals. The bandicoots seem better able than other kinds to survive this burning, perhaps because they customarily take shelter in hollow logs that are only slightly scorched by the brief fires. There is no doubt, however, that the bandicoot population is greatly reduced as a result of the burning. In the small patches of forest understorey that escape the fires, nests and runways of bandicoots can nearly always be found.'

The women, meanwhile, searched for yams, tubers, roots, berries, etc. through the monsoonal rainforest, freshwater swamp and stringybark forest. Most of their food came from the swamp — for example waterlily bulbs ('ung-buta', *Nymphaea gigantea*), a round yam ('mun-gu-ra', *Dioscorea bulbifera*), a parsnip yam ('mun-dai-ge-ri-er-a', *Dioscorea transversa*) and native grapes ('a-kwi-ren-a', *Ampelocissus acetosa*). Grapes and fruit were usually eaten raw, whereas the tubers and yams were cooked either in sand or ashes or between hot stones, within or alongside the fire, the method depending on the time needed for cooking. Most foods could be eaten after cooking, but 'mun-gu-ra' was first put between

hot stones, covered with paperbark and sand and cooked for a long time. The yams were taken out of the fire, the skin peeled off, and then the yam cut into 'chips' using a little land snail shell, called '*im-mun-de-rim-a*' (*Xanthomelon janellei*), with a hole made in its side. Before eating, the chips had to be soaked in running water in a stream for an afternoon or overnight, as a poisonous element in the round yam had to be removed by running water. The natives were much alarmed when the stream stopped running and they were no longer able to eat any more '*mun-gu-ra*'. Actually, the yam was very tasteless, but filling.

Fish, turtle and clam were either grilled in hot ashes or boiled in water. The women spent most of the day gathering plant foods into their bark baskets, sometimes collecting clams ('*in-na-wum-bug-ga*') and mangrove and rock oysters. But it was a very easy life — three-quarters of an hour gathering food, then 1–2 h resting, and eating snacks all day long before returning to organize the evening meal.

'No attempt was made to dispose of waste by any other method than the simple one of flinging it aside. There is little waste from the vegetable foods, but fish bones, animal bones, scraps of meat and gristle, and the entrails of all game are merely thrown away. Anything which is edible to dogs or birds is soon removed, and the rest remains. Since most of the cooking is not done on the family fires, these are kept relatively clean; but the site used for cooking game soon becomes dirty. If the smell becomes too offensive, those sleeping nearby shift their quarters, but an offensive odour was not a dominant feature of any of the camps.' (McArthur 1960b, p. 123,¹⁰ discussing food consumption and dietary levels of Arnhem Land Aborigines living on naturally occurring foods.)

Both sexes of all ages urinated in the bushes around the edge of the campsite, while faeces were buried at least 100 m beyond the campsite (Dr ID Keen, Milingimbi Aborigines and Fred Gray, Caledon Bay Aborigines, pers. comm. 1987). A campsite which had been occupied for some time reeked of stale urine. With distance from the campsite, the native vegetation on nutrient-poor soils became less affected by additions of these waste products (Specht and Specht 1999, pp. 290–301¹²).

The children, all under 6 years (the older children were kept at school at the Umbakumba Settlement), spend most of the day playing, howling, making a nuisance of themselves, eating and sleeping. There was practically no discipline, the children doing practically whatever they liked. Although their mothers may have asked them to do something; usually the kids obstinately refused, but were never chastised. Of course, the treatment varied between parents, but discipline was generally lacking. The children were nurtured by their mothers until 2 years old, at least. One mother was very determined to wean her 2-year-old child; he would scream and run to her, but she would brush him aside onto the ground several times, making him scream all the louder before she would suckle him. The others went on with their tasks as if nothing was happening and never attempted to interfere. In general, the parents were very fond of their children and played with them for hours and allowed them to crawl all over them. Several games were played by children such as 'mummies and daddies' (or 'native camps') with shells wrapped in rag; or 'chimneys' (burn out a hollow log); or splashing in the sea. Some of course fought and hit each other at the first opportunity, as in all communities, but most

played games amicably. As these young children spent each day with their mothers and aunts in food-gathering and preparation, they were exposed to the techniques of survival as hunter-gatherers.

As girls became older, they were expected to participate daily in all food-gathering activities. Nevertheless, there was always plenty of time to run and chase each other, to swim amongst the waterlilies, to gather seashells off the reefs; at night, to listen to legends, to dance and to sing. Some girls made 'string figure' designs depicting animals, plants, natural phenomena, cultural activities; one of the young women at Yirrkala recalled over 200 'string figures' which she had learnt as a child (McCarthy 1960).¹⁹

As young boys continued their association with the women of the tribe until adolescence, their daily activities were similar to that of their sisters. The art of spear throwing, however, had to be practised to perfection. At an early age, boys became adept at hitting flies and other insects using short sticks, 1 m long with the end encased in paperbark; later they had to make their own spears to impale fish in shallow water — adjusting their aim to cope with the refraction of light by the water. Occasionally, an elder would bring a baby wallaby (a joey) into the camp possibly to become a pet; the only one we observed was, unfortunately, maltreated by the boys who fought for possession and used it as target practice (RL Specht, unpubl. data, August 1948).

In regard to clothes, the men wore a pair of khaki shorts or a '*naga*' (four-cornered napkin) and so kept their clothes relatively clean as they used soap and combs! The women, however, had only one dress, so had no hope of keeping clean — getting wet in billabongs gathering '*ung-buta*' (*Nymphaea gigantea*), then lying in the dirt and having children crawl all over them. The women carried all goods balanced on their heads; it was comical to see a woman walk past with a European axe balanced on her head. The children were carried on hip or shoulder and ran around nude.

Ceremonial or 'communion' food

Many of the more important ceremonies were held during September when the fruit of the cycad palm (*Cycas arnhemica* ssp. *muninga*) ripened. As inland water supplies dried, clans concentrated along the rivers of south-western Groote Eylandt where the cycad palm abounds in the understorey of the *Eucalyptus tetradonta* savannah-forest. Not only were cycad nuts plentiful, but turtles came ashore to lay their eggs between September and December, ensuring a continual supply of food to be collected by the women while the men planned their ceremonies (Specht 1958b, p. 482;⁹ Levitt 1981, pp. 48–51¹⁷). Mainland Aborigines participated in these Groote Eylandt ceremonies, apparently whenever a bumper crop of cycad fruits was predicted (WE Harney, pers. comm. 1948).

Considerable time was spent in the preparation of this high-energy food. The seed coats were removed from the kernels, which were soaked in running water for 3–5 days to leach out the toxins contained in the cycad fruit. The kernels were then either cooked between hot stones before eating, or ground into a flour for baking (Specht 1958b;⁹ Specht and Specht 1999¹²). Various modifications of the technique for leaching the toxins (azoxyglycosides, especially cycasin) from the seed depended on the age of the cycad nut (Levitt 1981¹⁷ and other authors).

Seasonal and environmental distribution of food plants

(Specht 1958b⁹)

Information which was gathered at the four main camps on the American–Australian Scientific Expedition into the Arnhem Land Aboriginal Reserve in 1948, enabled the ecological distribution and seasonality of food plants to be collated (Table 1 after Specht 1958b⁹).

Every major ecosystem in northern Arnhem Land provided plant and/or animal products for food or implements. As all ecosystems were essential to the yearlong survival of the hunter–gatherers, they had to develop an intimate knowledge of the flora and fauna; for example, the names of each species, the distribution and seasonality of each, the method of use needed to be known.

In monsoonal northern Australia, species bearing edible fruits were most common in the pockets of semi-evergreen rainforests, but a number of species may also be found in the understorey of the eucalypt open-forests and in coastal dune vegetation. Small amounts of fruit ripen throughout the year and supplement the rich carbohydrate and fibre diet provided by tubers and roots. In north-eastern Queensland (Hynes and Chase 1982;²⁰ Cosgrove 1996²¹), the culture of certain fruit-bearing rainforest trees around their campsites appeared to be practised by the natives, but there was no evidence of this on Groote Eylandt.

Edible roots and tubers were most common in the wetland vegetation, at the edges of monsoonal rainforest stands, with a few scattered through the eucalypt forests and on the coastal dunes. They formed a valuable source of food in the first few months of the dry season, but became rank, but still edible, as the dry season progressed. After harvesting, fragments of larger tubers were usually left in the ground to regenerate in the next year.

In season, the open-structured communities (eucalypt open-forests and coastal dunes) yielded *Banksia* nectar (February and March), honey (April to August), *Terminalia* nuts (May), *Brachychiton* seed (October and November), and *Cycas* fruits (September). Small animals, such as bandicoots (*Isodon macrourus*), goannas (*Varanus* spp.), blue-tongued lizards (*Tiliqua* spp.), possums (*Trichosurus vulpecula*), or larger animals, such as the wallaby (*Macropus agilis*) and the wallaroo (*Macropus antilopinus*), were always available to be hunted if other food was scarce; the judicious use of fire

to expose the tracks of animals and to attract them to the tender regrowth would facilitate their capture (Johnson 1961, p. 447).¹⁸

Only the saline mangrove stands were lacking in plant foods, but this ecosystem provided a continuous supply of mangrove crabs, oysters, mussels and other shellfish (Specht and Specht 1999).¹²

The phytoplankton in the marine environment formed the basis of the foodchain for fish and turtles. Parrot fish (*Scarus ghobban*) and Venus tusk fish (*Choerodon venustus*) were plentiful, except at the end of the dry season (October to December); then turtles (*Chelonia* spp.) became more plentiful during their egg-laying season. Cooktown salmon (*Eleutheronema tetradactylon*) and red-spot emperor (*Lethrinus xanthochilus*) appeared during April and May, while stingray (*Taeniura lymna*) came inshore during September. Dugong (*Dugong dugon*) supplemented the diet in season.

The food quest and the time factor

(McCarthy and McArthur 1960)¹¹

Time-and-motion studies of the hours spent by men and women in collecting and preparing food were made by Margaret McArthur and Fred McCarthy, over 7 days at coastal Hemple Bay, Groote Eylandt and over 14 days at inland Fish Creek, near Oenpelli.

At both localities, the men spent over 6 hours fishing and occasionally hunting game (Table 2). At the beginning of the dry season, the women spent the same amount of time as the men gathering plant foods at Hemple Bay. As plant foods were limited at the end of the dry season, they spent only 4 h away from the Fish Creek camp-site. Both men and women spent about 1 h (1.17 ± 0.19 h [mean \pm SD]; observations = 20 person-days) preparing and cooking the results of their collecting forays.

The men spent over an hour a day repairing weapons, fishing lines, boats, etc. or making Macassan smoking pipes (1.35 h \pm 0.80 h [mean \pm SD]; observations = 17 person-days). Depending on the success of their morning's fishing or hunting, the men would rest or sleep under the shade of a tree throughout the afternoon and sometimes for the whole of the next day.

Caring for young children was the continual role of the women. Daytime rests were taken intermittently whenever

Table 1. Seasonal and environmental distribution of food plants in Arnhem Land, Northern Territory (Specht 1958b)⁹

Plant formation	Number of food species*			Wet season		Dry season	
	Total	Fruit	Tubers	Nov– Dec	Jan– Mar	Apr– Aug	Sept– Oct
Monsoon rainforest	23	22	1	8	8	8	10
Eucalypt open-forest	9	4	3	4	4	3	5
Sandstone hills	3	2	0	0	0	2	1
Wetlands	24	7	18	4	4	18	18
Estuarine plains	3	2	0	0	0	2	1
Mangrove vegetation	0	0	0	0	0	0	0
Coastal dunes	20	16	2	13	10	6	7
Strand vegetation	3	0	1	1	1	1	1

* The total number of food species included the developing leaf fronds of some palm species which were occasionally eaten. Drier, inland localities in northern Australia provide far fewer food-plants, especially towards the end of the monsoonal dry season, thus altering the balance between animal and plant products in the diet.

More detailed data are included in Levitt (1981)¹⁷ and Waddy (1984)²² for Groote Eylandt; S. Davis and Lawuk Ganambar in Carr and Carr (1981),²³ also Wightman and Smith (1989)²⁴ for Milingimbi; Smyth and von Sturmer (1981)²⁵ for Oenpelli; Yunupingu *et al.* (1995)²⁶ for Yirrkala; Roth (1897)²⁷ for north-west Queensland

Table 2. Time spent daily collecting plant and animal foods at coastal Hemple Bay, Groote Eylandt, and at inland Fish Creek, near Oenpelli (after McCarthy and McArthur 1960¹¹)

Sex	Hemple Bay, Groote Eylandt (beginning of the dry season)		Fish Creek, near Oenpelli (end of the dry season)	
	Collecting (no. person- days)	Collecting (no. h)	Collecting (no. person- days)	Collecting (no. h)
Male adult	19	6.46 ± 1.12 SD	40	6.11 ± 1.58 SD
Female adult	22	6.54 ± 1.73 SD	36	4.05 ± 1.37 SD

there was a break in the daily routine of collecting plant foods, shellfish and small animals.

Food consumption of hunter-gatherers

(McArthur 1960b)¹⁰

The food consumption (Table 3) of groups of Aborigines, who had been living on naturally occurring foods for some months, was studied at four campsites in Arnhem Land, Northern Territory, the first three coastal, the fourth inland:

1. Hemple Bay (13°45'S, 136°40'E), Groote Eylandt — 24 April to 8 May 1948

Food-collecting techniques of 13 Aborigines were studied continuously for 4 days. Foods collected included: animal foods — fish and turtle. Plant foods — tubers of the waterlily (*Nymphaea gigantea*) and roots of *Ipomoea velutina*.

2. Bickerton Island (13°45'S, 136°10'E) — 5–24 June 1948

Food-collecting techniques of 15 Aborigines were studied continuously for 3 days. Foods collected included: animal foods — fish. Plant foods — mostly roots of *Ipomoea graminea* and *Vigna vexillata* and fruits of the bush grape (*Cayratia trifolia*).

3. Port Bradshaw (12°29'S, 136°45'E), NE Arnhem Land — 23–29 July 1948

Food-collecting techniques of 20 Aborigines were studied continuously for 4 days. Foods collected included: animal foods — fish and oysters. Plant foods — mostly tubers of *Dioscorea transversa* (parsnip yam), some tubers of *Curculigo ensifolia* (grass potato) and some tubers of *Amorphophallus galbra* (stinking arum).

4. Fish Creek (12°15'S, 133°15'E) near Oenpelli — 7–20 October 1948

Food-collecting techniques of 9 Aborigines were studied continuously for 11 days. Foods collected included: animal foods — freshwater fish and kangaroo. Plant foods — a few round yams (*Dioscorea bulbifera*) and some fruits of *Syzygium suborbiculare* (red apple).

In 1948, only 3 years after the end of World War II, the Europeans in charge of the Aboriginal settlements in Arnhem Land found it difficult to supply fresh food for consumption, year-round, to the native populations. Stuart M James, an agricultural diplomate from Tamworth, New South Wales, had just been appointed to develop the gardens at the Church Missionary Society (CMS) Missions on Groote Eylandt and at Oenpelli. The garden at the Umbakumba Settlement, Groote Eylandt, however, had been developed by Fred Gray to supply the Department of Civil Aviation (DCA) seaplane base on Little Lagoon with fresh vegetables and fruit. Between March 1948 and March 1949, Aborigines at Umbakumba each consumed daily 450 g of cassava (*Manihot esculenta*), 200 g of sweet potatoes (*Ipomoea batatas*), 100 g of watermelon (*Citrullus lanatus*) and 100 g of other vegetables and fruit, all grown in the Settlement garden (McArthur 1960a, p. 15).²⁸ Turtle meat, turtle eggs and fish provided animal protein.

The daily dietary value of the food consumed by each person in the four campsites in Arnhem Land, Northern Territory, was assessed (Table 4).

The food collected by the Aborigines at Hemple Bay and Fish Creek provided the recommended dietary allowance of energy and four times the recommended amount of animal protein per day. At Hemple Bay, ascorbic acid in plant foods was almost four times the recommended daily intake, whereas plant foods were almost absent from the daily diet at Fish Creek at the end of the dry season (McArthur 1960b).¹⁰ With the wide variety of tubers, roots, fruits and soft leafy shoots available in coastal Arnhem Land, the diet of the nomadic Aborigines is probably better balanced than that of many Europeans as there is no refinement of food, no storage, no overcooking, little waste and no leaching of vitamins and minerals in cooking water.

Discussion

From late April to early May, 1948, members of the American–Australian Scientific Expedition to Arnhem Land, Northern Territory, studied food-gathering strategies, health and nutrition of four Aboriginal families living off 'bush tucker' at Hemple Bay, Groote Eylandt (McArthur 1960b;¹⁰ McCarthy and McArthur 1960;¹¹ Specht 1958b;⁹ Specht and Specht 1999¹²). The food-gathering schedules of members of this small Aboriginal community were reported in detail by Margaret McArthur, nutritionist on the Expedition. The daily activities of men, women and children in the camps at Hemple Bay and on Bickerton Island were described (1948) in field notes and letters by the anthropologist, Fred

Table 3. Consumption of animal and plant foods collected by small tribal groups at four campsites in Arnhem Land, Northern Territory (McArthur 1960b)¹⁰

Campsite	Month	Number of days	Number of people		Animal (kg*)	Food gathered	
			Adults	Children		Plant (kg*)	Animal + Plant kg*/person/day
Hemple Bay	May	4	8	5	98	41	2.0 + 0.7
Bickerton Island	June	3	9	6	21	36	0.5 + 0.8
Port Bradshaw	July	4	9	11	88	42	1.1 + 0.6
Fish Creek	October	11	8	1	237	19	2.4 + 0.3

* The bones, skin, etc. of the animals, the husks of yams, the pips of fruit, etc. were included in the fresh weight of the food.

Table 4. Mean daily consumption of various nutrients per head at four campsites in Arnhem Land, Northern Territory (McArthur 1960b)¹⁰

Campsite	Month	Energy (joules)	Protein (g)		Iron* (mg)	Calcium (g)	Ascorbic acid (mg)
			Animal	Plant			
Hemple Bay	May	9040 (116%) [†]	205 (444%) [†]	27	12 (80%) [†]	> 0.7 (128%) [†]	224 (394%) [†]
Bickerton Island	June	4900 (74%)	60 (172%)	16	3 (135%)	1.1 (41%)	103 (234%)
Port Bradshaw	July	5780 (79%)	140 (300%)	10	42 (131%)	> 1.1 (490%)	110 (220%)
Fish Creek	Oct.	8920 (104%)	300 (544%)	3	35 (33%)	0.3 (335%)	28 (47%)

* Iron from animal products only.

[†] Percentages of the recommended dietary allowances (National Research Council 1948),³⁰ calculated for men, women and children of different ages, are shown in parentheses below each value

McCarthy¹⁵ and the plant ecologist, Ray Specht.¹⁶ The ethnobotany of all plants, used for food or to make implements, was documented in detail (Specht 1958b).⁹

It is not known to what extent these observations reflect conditions which prevailed before the traditional way of life of the Aborigines was disturbed by Europeans. The normal food intake of Aboriginal communities was never a constant quantity. Living as they did from the natural products of the country through which they moved, they had little control over the supply of food, which varied from season to season and from year to year. Nevertheless, the Aborigines did not wander aimlessly about the countryside looking for food. As is evident from this study, they applied knowledge and skills accumulated over countless centuries. The women knew the ecosystems in which food was to be found and the type of food they would find in each; the men knew when and where to hunt game, fish and turtle. The element of chance cannot be eliminated, but it was not by any means the predominant feature of food-gathering by these hunter-gatherers.

With only a few exceptions, the diets which were recorded at four camps in Arnhem Land — from the beginning to the end of the dry season of the monsoonal climate — were well balanced in protein, fat, carbohydrate and crude fibre, and were comparable to international dietary recommendations in energy, iron, calcium and ascorbic acid.

Ascorbic acid intake (McArthur 1960b)¹⁰ was low at the end of the dry season, as there was then a dearth of plant foods before the wet season began. By 1948, only a few Arnhem Land Aborigines still maintained a nomadic lifestyle. At the beginning of the dry season, the levels (0.53 ± 0.07 mg% [mean \pm SD]) of plasma ascorbic acid in the blood of the eight nomads who returned to the Umbakumba Settlement while the Expedition was present were not significantly different from those (0.47 ± 0.16 mg% [mean \pm SD]) of natives eating vegetables and fruit grown in the Umbakumba garden (Hodges 1960).¹⁴ At the end of the dry season at Oenpelli, the level of plasma ascorbic acid had fallen, mean \pm SD values of 0.16 ± 0.17 mg% in eight nomadic natives were significantly higher those of the Mission (0.08 ± 0.08 mg%), where fresh fruit and vegetables were in short supply.

At the beginning of the 1900s, the nutrition of nomadic Aborigines, especially at the end of the dry season, may have enabled some of the men of Caledon Bay and Groote Eylandt to live to a great age (Cole 1984,³¹ Fred Gray, personal com-

munication 1987), a rarity in Aboriginal settlements in 1948 where health appeared to have deteriorated (Billington 1960;³² Moody 1960³³).

In the coastal ecosystems of monsoonal Arnhem Land, the great variety of plant foods and the range of phytochemicals which they contained (Miller *et al.* 1993)³⁴ ensured a balanced diet for the small groups of nomadic hunter-gatherers (Wahlqvist and Specht 1998).³⁵ The nomadic diet of native plant foods when considered throughout the whole yearly climatic cycle was, and still is, difficult to match with vegetables and fruit produced in gardens established on nutrient-rich soils (McArthur 1960a, 1960b^{10,28}), a rarity among the nutrient-poor lateritic and sandstone soils which predominate in the Arnhem Land landscape (Specht 1958a).⁸

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