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Australian Aboriginal Subsistence in the Western Desert

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This paper describes Aboriginal subsistance patterns in the northern part of the Western Desert, Western Australia. It describes the seasonal round of the Aboriginal people living in this area, provides a quantified description of the plant and animal resources, and concludes by drawing attention to specific aspects of Aboriginal subsistence in this area.

KEY WORDS: Western Australia; Aboriginal Subsistence; Ethnobotany.

INTRODUCTION

This paper presents recent information regarding traditional Aboriginal subsistence in the Great Sandy Desert, north Western Australia (Fig. 1). Aboriginal people belonging to the Pintubi and Gugadja linguistic units lived a full hunter-gatherer existence in this part of Australia until the mid-1950's and early 1960's when they moved from the desert onto cattle stations, missions, and government settlements, scattered around the desert fringe.

For this research, many months over a period of 6 years were spent with Gugadja people visiting old campsites and documenting subsistence activities. This paper is intended to complement the pioneering work done by Gould (1968, 1969) and O'Connell, Latz, and Barnett (1983) in central Australia. The first section presents a generalized picture of the traditional seasonal round to provide the reader with a broad view of Aboriginal subsistence in in the region, and to act as a backdrop against which more detailed, quantitative data relating to specific subsistence activities can be presented. The paper presents this data by identifying the resources used by desert Aborigi-

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Fig. 1. Location of study area.

nal people and describing the various methods of procurement and processing. An assessment is made of the nutritional contribution and importance of various key food stuffs.

ENVIRONMENTAL SETTING

In order to give the reader an impression of the landscape in which this paper is set, it would almost be sufficient to quote the titles and page headings of the journals of explorers who traveled through the region. Carnegie's (1898) book for example, was called *Spinifex and Sand,* and Warburtons's journal (1875) provides illustrative page headings such as "The Desert," "Sand Hills and Spinifex," "More Sand Hills," "Scanty Wells," and "Carnivorous Flys." Terry (1928, 1931, 1937) called three of his books *Sand and Sun, Untold Miles,* and, perhaps nearer the reality, *Hidden Wealth and Hiding People.*

The Great Sandy Desert is a vast expanse of undulating sand on which the dominant landforms are seemingly endless longitudinal dunes. These run east–west over 1000 km across the Canning Basin (Fletcher, 1965; Brown, 1960). The desert rises only 400 m above sea level, and the highest point in the entire region is the Stansmore Range, only 510 m above sea level (Blake and Yeates, 1976).

From a botanical point of view, the landscape has been described as "desert in its more limited sense" (Gardiner, 1944, p. 56), and is generally described as mixed shrub steppe (Beard and Webb, 1974). By and large, the botanical landscape has remained much as it was prior to the arrival of Europeans. The only real changes have been a decrease in fire frequency (related to decreased Aboriginal land use in the region) and the introduction of feral cats and camels. No rabbits, foxes, donkeys, or pigs have colonized the area. The vegetation is still dominated by Acacia and spinifex *(Triodia* sp). Mulga *(Acacia aneura)* is rare, and most of the woodland is dominated by Acacia, grevillea, hakea shrubs, and mallee eucalyptus.

Animal life is relatively scarce. Small birds congregate around waterholes and occasionally bustards (*Eupodotis australis*) are found on the plains. Populations of large animals such as dingos, emus, and kangaroos are small, and the number of small marsupials has declined over the recent past, partly because of changes in fire frequency (Bolton and Latz, 1978) and the introduction of feral cats mentioned above.

The stark and desolate landscape of the study area is matched by the harshness of its climate. According to the Climatic Atlas of Australia (1975), the study area falls within a region which experiences the highest average summer (39°C) and winter (24°C) temperature range in Australia. This corresponds to an equally high evaporation rate of between 4000–4500 mm a year. The average rainfall at Balgo, a small mission 100 km north of the study area, is only 268 mm (Beard and Webb, 1974, p. 26). This rainfall is unpredictable, and over the last 40 years has varied from as little as 91 mm to over 900 mm per year (Bureau of Meteorology). Beard and Webb (1974) claim Balgo experiences a "true desert climate" and that further south, toward the study area, it is drier but still gets summer rain.

SEASONAL ROUND

Most researchers working in the Western Desert of Australia have noted the flexibility and mobility of desert life (Long, 1971; Thomson, 1975; Myers, 1976; Gould, 1969; Tonkinson, 1978). This is certainly a characteristic of life in the study region, were the availability of food and water each year has an impact on the distance people travel, the camps they travel to, and the amount of time they stay in one place. This pattern is also complicated

by other factors such as the need to obtain raw materials, fulfill social obligations, and attend ceremonies. Nevertheless, there is a system which may be described as starting with the wet season, to which the desert inhabitants generally adhere.

During the wet season (December–February), family groups spread out across the desert plains. Fresh rains usually come in huge thunderstorms at this time of year, leaving drinkable water in the ephemeral stream beds, claypans, numerous little rock pools in the hills, as well as in all the major catchments. The relative abundance of water at this time of year means that people can disperse in search of fresh food, and men travel great distances to get stone for making stone tools or to collect resilient wood for making spears. People congregate and travel great distances to attend ceremonies, but, most importantly, families travel to areas that have not been foraged over since the previous wet season.

However, the wet season is not a particularly fertile season. No new supplies of food have yet begun to grow and there are only limited supplies of edible fruits, seeds and tubers left from the previous year. Game is also spread across the landscape and rarely encountered. This time of the year is characterized by a relative scarcity of food so that people have to move constantly from camp to camp to collect enough food for their survival, and everyone is involved in the food quest.

Once the wet season rains fall, plants begin to grow. After several months the spinifex changes from a dry straw yellow color to a bright green, and seeds and fruit begin to appear. This growing season is called the "green grass time" by the Aborigines and lasts from about March until May. At this time of year, as temperatures begin to moderate, Aboriginal families move to large surface waterholes around fertile sandplains and begin to harvest *Ipomoea* tubers. Migrating birds come into the desert, but local game is still widely dispersed.

The "green grass time" merges into the "cold time." Cold easterly winds make the first few months of this season quite chilly, although frosts are rare. Temperatures drop to 6–8°C at night and rise to about 25°C during the day. The cold winds often prevent sleep, and people sit naked around fires in the late hours of the night and then rest and rise about mid-morning. Occasionally, the "cold time" is plagued by weeks of miserable winter drizzle.

However, this is a time of economic prosperity, and plant foods such as *Ipomoea* and *Vigna* tubers, *Acacia* and grass seeds and *Solanum* fruits are abundant. People live semi-permanently around soaks and large waterholes and focus their economic attention on abundant, easily-gathered tubers. Women are the principal food gatherers and the men have ample leisure to pursue ceremonial interests. Compared to the rest of the year, this is a time of affluence, characterized by feasting, leisure, ceremonies, and social interaction.

The end of the cold season is heralded by the sudden appearance of warm westerly winds and the movement of reptiles from hibernation. The Aborigines call this spring season the "goanna get up time," and it lasts from about August till October. The relatively affluent lifestyle of the previous few months fades away and family groups slowly return to the serious business of survival in a desert environment. Temperatures steadily rise to a nightly average of 22°C and a daily average of 36°C. People fall back to large rockholes in the rocky country, escarpments, and ranges. The landscape begins to dry out and the plains are burned to attract game and stimulate the growth of new grass seeds and tubers the following year. The subsistence base becomes more generalized. Lizards and kangaroos are hunted, and fruits, *Cyperus* bulbs, *Vigna* tubers, and grass seeds are gathered. Acacia and eucalyptus seeds are collected and stored for the hot season. Both men and women spend most of the day in the pursuit of food. This time of year is thus characterized by economic diversity.

As the "goanna get up time" melts into the "hot time," temperatures rise, (reaching occasional maximums of over 50°C) waterholes dry up and supplies of food dwindle. This is the harshest time of year and family groups travel to the largest rockholes in their territory. These rockholes are usually not visited until the end of the year, and if reserved until then have the capacity to carry people through harsh dry seasons. People remember such rockholes deteriorating to no more than muddy soaks, and it is likely that they occasionally run dry. Permanent springs are rare. There are, for example, only two in an area of about 18,000 sq. km surrounding the study area.

As the "hot time" progresses, the supplies of food available to the Aborigines camped at these rockholes decreases. The accessible supplies of stored Acacia and eucalyptus seeds run out, and the drought tubers (*Cassia notobalis* and *Clerodendrum floribundum*) are used up. If rain has not come by December, economic activity comes to a virtual standstill. People try to "take it easy" during the "hot time" to conserve food and water. The responsibility of providing food falls to the men, and women stay at camp and look after children and elderly people. People wear bark sandals to protect their feet from the hot sand and, when possible, cover their heads and shoulders with layers of wet mud to reduce heat stress. After a time, the only food left to collect within the foraging radius of the rockhole is the goannas which have been missed earlier in the year. The men leave camp before dawn and return at dusk, foraging as far as 15 km from the main camp in search of food. The average calorific daily intake under these conditions is only about 800 kcal per person.

The size and number of the major waterholes control foraging movement. Water shortages and heat stress prevent people from traveling to areas where food is still available and, in a sense, people become trapped on foraging "islands" around large waterholes. If rains fail to come, tension runs high

and fights are common. Sometimes, people begin to starve and are fed blood drained from the arms of healthier individuals to get them through the last harsh few weeks of the year. The Aborigines aptly call this the "hard time" or "hungry time".

The availability of water keeps a lid on population levels. While other seasons are relatively affluent, the severity of the "hard time" means that population can never rise beyond a level that can be supported by local supplies of food and water. In this sense, the "hard time" proves to be a natural limit on population; Western Desert Aboriginal society consists of small, isolated family groups with a population density of as low as one person to 150–200 sq. km.

The Aborigines survive through the hard times, waiting anxiously for the summer rains. Throughout December and January, thunderclouds gather on the horizon, slowly building in intensity. Humidity rises until, eventually, large earth-shaking rainstorms come. As soon as these rains fall, the Aborigines escape from the permanent waterholes and spread out widely over the sandplains in search of food.

FOOD RESOURCES

The general picture of the environment and Aboriginal seasonal subsistence activities described provides a backdrop for more detailed information about the distribution, use, significance, and nutritional value of the different resources in the desert environment.

PLANT

Within the study area, 126 plants were recorded which were recognized and named by the Aborigines. One hundred and two of these plants provide materials suitable for 138 different economic, social, and medicinal functions. Various parts of 70 plants produce edible seeds, tubers, fruits, nectars, excretions, and an additional seven plants contain edible insects or larvae. This list compares with a total of 38 edible plants recorded for the southern portion of the Western Desert by Gould (1969), Cleland and Tindale (1959) and Cleland and Johnston (1939), and compares to a total of 81 economically useful plants recorded in the northeast of the Western Desert by Meggitt (1957, 1962) and Cleland and Johnston (1939). O'Connell *et al.* (1983) recorded 122 economically useful plants and between 92 and 77 edible plants in different parts of Alyawara territory in Central Australia.

Cleland and Tindale (1959, p. 120) claim that there are probably more than 1200 vascular plants in Central Australia, and O'Connell *et al.* (1983,

p. 83) provide an estimate of approximately 5000 species for the Alyawara territory. Clearly, ethno-botanical investigations in arid Australia account for only a limited range of the available flora but nevertheless appear to identify the major economically useful species found in the region. The data illustrated in this paper are representative of the economically important plant foods used within the northern parts of the Western Desert.

SEEDS

Data relating to seeds in the diet of Aboriginal people have been presented in Cane (1984, in press). Rather than reproduce this data, some of the key points will be summarized. The data presented are some of the first quantified data of seed collection and processing methods by hunting and gathering peoples and raises some interesting questions about the processing methods and the significance of wild seeds in traditional diets.

Edible seeds are collected from 42 different plants by Aborigines (Table I). These include 11 species of Acacia, 18 species of grass, four species of eucalyptus, three succulents, two herbs, and four other miscellaneous shrubs

Distribution and Availability

The vast majority of seeds grow on the sandplains and nearby creeks, waterholes, and alluvial flats adjacent to rocky ground. The major species (*Panicum cymbifome, Panicum australiense* and *Fimbristylis oxystachya)* grow in large patches extending over many hectares on the sandplains. They respond well to fire and were maintained by regular burning in the past.

Acacias and eucalyptus trees also grow extensively on the sandplains and along the sides of sand dunes. The major seed-bearing Acacias (*A. coriacea, A. stipuligra,* and *holocericea)* grow on deep well-drained sand and around waterholes. Edible herbs and succulents grow on flood plains and shallow pockets of sand in the hills.

Most of the edible seeds ripen during the winter months (Fig. 2), although some of the Acacias and eucalyptus seeds also ripen during the hotter months. The Aborigines describe the seasonal availability of the key species as follows:

Summer. Hot time, gilgidi (*Acacia holocericea*), djiprin (*A. stipuligera*), mungilba (*Tecticornia verrucosa*), kanindjul (unidentified). This one for hot time. Four for hot time.

Autumn. Early bird after rain, yibiri (an unidentified grass), light one, marradjirral (*Eragrostis tenellula*), dudjurnba (*Echinochloa colunum*), balgurrba (*Brachiaria muliiformis*), around here yulumburru (*Daspalidium rar-*

Table I. Edible Seeds

Scientific name	Aboriginal name	Habitat	Relative importance
Acacia acradenia	Wilbud	Sandplains	Minor
Acacia adsurgens	Nganamarra	Sandplains	Moderate
Acacia ancistrocarpa	Wadayurru	Sandplains	Moderate
Acacia aneura	Mandja	Flood, Laterite plains	Moderate
Acacia coriacea	Gunandru	Deep sandplains	Major
Acacia holosericea	Gilgidi	Adjacent water	Major
Acacia ligulata	Wadarrga	Sandplains	Moderate
Acacia monticola	Birrbin	Sandplains	Moderate
Acacia stipuligera	Djibrin	Deep sand, dune flanks	Major
Acacia tenuissima	Minyinggurra	Sandplains	Moderate
Acacia tumida	Ngadurrdi	Sandplains	Moderate
Brachiaria miliiformis	Balgurrba	Adjacent water	Minor
Bulbostylis barbata	Lyillyil	Adjacent water	Minor
Capparis loranthifolia	Yidaringgi	Flood plains	Minor
Chenopodium inflatum	Garndubungba	Clayey sand	Minor
Chenopodium rhadinostachyum	Galbarri	Clayey sand	Major
Cyperus iria	Yanmid	Adjacent water	Moderate
Dactyloctenium radulans	Burrandjarri	Adjacent water	Moderate
Daspalidium rarium	Yulumburru	Rocky ground	Minor
Diplachine fusca	Miarr Miarr	Floodplains	Minor
Echinochloa colunum	Dudjurnba	Adjacent water	Moderate
Eragrostis eriopoda	Wangganyu	Sandplains, near water	Moderate
Eragrostis laniflora	Burrindjurru	Deep sand	Minor
Eragrostis tenellula	Marradjirralba	Various	Moderate
Eucalyptus camaldulensis	Yabulin	Creeks	Minor
Eucalyptus microtheca	Dindjil	Adjacent water	Moderate
Eucalyptus odontocarpa	Warilyu	Deep sand	Moderate
Eucalyptus pachyphylla	Djibuburru	Deep sand	Moderate
Fimbristylis oxystachya	Lugarra	Sandplains	Major
Hedyotis pterospora	Yurrundju yurrundju	Sandplains	Minor
Panicum australiense	Yidagadji	Sandplains	Major
Panicum cymbiforme	Gumbulyu	Deep sand	Major
Panicum decompositum	Willinggiri	Flood plains	Minor
Portulaca filifolia	Bulyulari	Sandy ground	Moderate
Portulaca oleracea	Wayali	Sandy ground	Moderate
Scirpus dissachanthus	Gunamarradju	Adjacent water	Moderate
Sida sp. A (unnamed)	Dadji dadju	Sand dunes	Minor
Stylobasium spathulatum	Nirdu	Sandplains	Major
Tecticornia verrucosa	Mangil	Claypans	Minor
Triodia basedowii	Nyanmi	Sandplains	Minor
Triodia longiceps	Lanu lanu	Rocky ground	Minor
Triodia pungens	Djinal	Sandplains	Minor

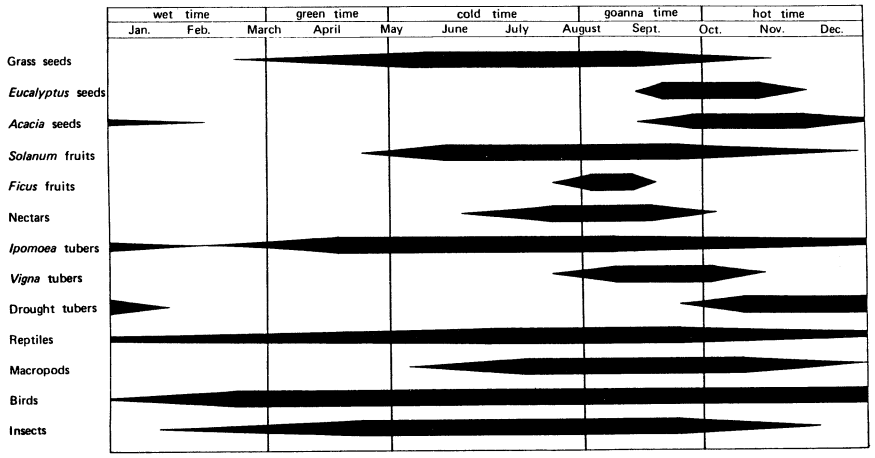

Fig. 2. Seasonal availability of major foodstuffs.

ium), brown one, then pulyulari (*Portulaca filifolia*) finished now (June). Little bit finished, burrambra, light one. You'd see him but no one been lighting, start him fire (i.e., reductions in the frequency have reduced in availability). Like a lugarra (*Fimbristylis oxystachya*), but different, light one. Woyali *Portulaca oleracea*) later, getting cooked now (June). When he dried, after rain, pull him out. He got a seeds. Djinal (*T. pungens*), nyanmi (*T. basedowii*) too. Eat straight away, little bit dry, same time. Woyali (*Portulaca oleracea*), pulyalari (*P. filifolia*) same time.

Winter. Wanggunyu (*Eragrostis eriopoda*) cold time, nice one. Gumbulyu (*Panicum cymbiforme*) coming soon. Nice food again, but he never grow at this time (May, when documented), little bit. Lugarra (*Fimbristylis oxystachya*), later on he'll be cooked. Whole lot cold time, lugarra (*F. oxystachya*), yidagadji (*Panicum australiense*), dudjurrnpa (*Echinochloa colunum*). Cold time wangganyu (*Eragrostis eriopoda*), yibiri (unidentified), lanu lanu (*Triodia loniceps*). Cheekey one (prickley) spinifex.

Spring–Summer. Gunamarradja (*Scirpus dissachanthus*) black one, long time cooked, goanna and blue tongue come out. That the time he'll be cooked. Hard one, he got to stop in water. Minyingurra, red one and yellow one (*A tenuissima* and *A. adsurgens*), ngadurrdi (*A. tumida*). Same time hot time. Mandja (*A. aneura*), gunandru (*A. coriacea*) too, hot time. Good hot time. We can eat gunandru (*A. coriacea*), gilgidi (*A. holosericea*), minyingurra (*A. tenuissiuma,* ngadurrdi (*A. tumida*), mandja (*A. aneura*). Hard work, lady one, all the ladies. Man can come and eat. Before Christmas, when rain coming, only meat, keep going, meat, meat, meat. Come back to one camp. Christmas time hard time.

It is apparent that a few species including the same Acacia and herbs ripen during the wet seasons. They are followed by the succulents (*Portulaca)* during the autumn. Most of the grasses ripen during the winter. During the spring and early summer, the bulk of the Acacia and eucalyptus seeds ripen.

Some of the Acacia seed are stored at this time for use later during the hot or hungry season (*A. holosericea, A. stipuligera, A. coriacea* and possibly *A. tumida*). Apparently, the seeds are collected for storage by stripping seed-laden branches straight from trees just prior to ripening or when they had ripened. These branches are piled into heaps on the hard, flat surface of subterranean termites' nests and beaten with sticks to dislodge the seeds. The seeds are then scraped up. The same technique is used when the Aborigines want to store the seeds. In this case, the piles of seed pods and branches are covered with spinifex which protects them from birds and reptiles until the Aborigines return to use them.

Seeds storage appears to be a very important aspect of the economic strategy in this part of arid Australia. Without it, survival during the last few months of each year would be more difficult than it already is. Even with the benefit of seed storage, supplies of vegetable food within the vicinity of the major waterholes often run out. When this occurs the Aborigines have to rely heavily on lizards or stray catches of game.

Seed storage is unrecorded in the Western Desert, but is clearly an important aspect of the economy in other arid regions of Australia (Newland 1921, p. 13; Horne and Aiston, 1924, p. 33; Tindale, 1974, p. 250, 1977, p. 346). To date, storage of *Solanum* fruits has been the only aspect of plant storage documented for the Western Desert (Carnegie, 1898, p. 230; Sweeney, 1947, p. 290; Gould, 1969, p. 261; Thomson, 1975, p. 24).

PREPARATION

The preparation of seeds is clearly a very strenuous and time-consuming operation. It involves four stages: collection, winnowing, grinding, and baking. The method of processing is similar for all seeds, whether they are from grasses, eucalyptus trees, or herbaceous shrubs. Some of the methods of processing Acacia seeds may be different, but there is little reliable data.

The collection of grass seed is relatively easy, and it is possible to collect roughly 1000 g of seed in about half an hour. Most grass seeds are stripped straight from the grass into a wooden dish by running/rubbing the heads of seeds through a loosely clenched fist. Some of the grasses (particularly *F. oxystachya* and *P. australiense*) could also be collected from the ground or from the surface of ants' nests. Ants collect these seeds to eat the nodules (eliaosome, Berg, 1975; O'Connell *et al.,* 1983) and leave the seeds scattered

around their nests. Once collected, the outer husks of most seeds have to be removed. This is done by rubbing handfuls of seeds between the heel of one hand and the palm of the other. As this is done, the seeds are dropped onto wooden dishes so the wind can blow some of the unwanted vegetable matter away (see also Tindale, 1974, p. 99, 1977, and O'Connell *et al.*, 1983 for different techniques).

When seeds have been husked, they are placed into a large softwood dish (luandja) to be separated from contaminating sticks, sand, and stones. Women are very efficient at separating seeds and can separate about 1.5 kg of rubbish from 500 g of seeds in about 40 minutes. However, this time varied according to the kind of litter mixed with the seeds. Each different material has to be winnowed out separately and this often necessitates between three and five different winnowing operations.

When the seeds begin to separate, the winnowing dish is tilted slightly and balanced between the last fingers and the ball of the thumb of the lower hand. The rocking motion is continued with the other hand, and the ball of the thumb on the lower hand is used to jar the lower end of the dish and spill the clean seeds into another dish (wirra), where they are collected for grinding. After the seeds have been cleaned, they are either ground directly or soaked for several hours beforehand. Seeds are only soaked to soften them, and this is not done if the Aborigines are hungry.

When the women are ready to start grinding they set the grinding slab into the ground and place a wooden dish under the lip of the slab. A small quantity of seeds is placed on the grinding slab and a steady trickle of water is dribbled onto them to facilitate grinding and to help the flow of seeds down the grinding groove and onto the wooden dish. Seed grinding is the most arduous part of the preparation process and takes about 50% of the total time required to make seed cakes. An average time of about 1 hour to grind approximately 200 g of seeds provides a reasonable indication of the effort required.

When the seeds are ground, the paste is either eaten raw or several small dampers are baked in a campfire. In the latter case, the raw paste is placed in a shallow depression dug into hot ashes. A small fire of spinifex or dry twigs is lit over the paste to dry the crust of the damper. The paste is then covered with hot ashes and baked for 10–20 minutes.

We prepared four dampers from different grass seeds. The details of these operations are documented in Tables II–V, and the nutritional analysis of the damper produced is documented in Table VI. Briefly, the preparation time for each meal means a handling time of about 5 hours per kg of damper and gives a return of about 350 kcal per hour.

Less is known about the processing techniques of Acacia seed. Some of the Acacias can be eaten without grinding after being roasted in the fire

Table II. Processing *Panicum australiense* and *Fimbristylis oxystachya* Seeds

Processing step	Time		Total time (min)	Weight (gm)
	Start	Finish		
Seeds ready for processing	1:50 p.m.	–	–	750
Winnow seeds five times	–	2:36	46	485[a]
Ground 1/5 of raw seeds	2:36	3:17	41	–
Cooked ground seeds	3:17	3:34	17	100
Ground remaining seeds	3:34	4:22	46	–
Cooked ground seeds	4:22	4:48	26	380
Total processing time (min) and weight of seed cakes			176	480

[a]Seventy grams of raw seed removed for nutritional analysis.

(particularly *A. coriacea;* see also O'Connell *et al.*, 1983). Returns for such seeds are very high, in the order of 4000-5000 kcal an hour (O'Connel *et al.*, 1983, p. 92).

A limited amount of information was recorded regarding the processing of Acacia seeds in this project. According to Aborigines in this area, Acacia seeds are first soaked in water and squashed. This produces a milky liquid which can be drunk. The remaining squashy mixture is spread onto the surface of flat termites' nests, and dried in the sun. When this mixture is dry, it is collected and roasted in hot sand, then winnowed to get rid of any contaminating sand. When cleaned, it is ground up and winnowed again in order to separate the edible seeds from the inedible black seed cases contained within the mixture. The clean seeds are then re-ground with water. The ground watery paste is eaten raw and never cooked.

Table III. Processing *Panicum australiense* Seeds

Processing step	Time		Total time (min)	Weight (gm)
	Start	Finish		
Collected seeds from ground	3:00 p.m.	3:15	15	2100
Winnow fine sand from seeds	7:30 a.m.	7:45	15	865
Winnow pebbles from seeds	7:45	7:57	–	630
Clean plant material from seeds	7:57	7:59	2	–
Final winnow	7:59	8:11	12	520
Soak seeds	8:11 a.m.	5:13 p.m.	–	–
Grind portion of seeds	5:13	5:50	37	–
Cook ground seeds	5:50	6:30 p.m.	40	600
Grind and cook remaining seeds	7:10 a.m.	7:40	30	240
Total processing time (min) and weight of seed cakes			150	840

Table IV. Processing *Fimbristylis oxystachya*

Processing step	Time		Total time (min)	Weight (gm)
	Start	Finish		
Collect seeds from ground	2:13 p.m.	2:28 p.m.	15	550
Start to winnow seeds	11:11 a.m.	11:20	9	–
Rest	11:20	11:36	16	–
Resume winnowing	11:36	11:53	17	340
Rest and eat lunch	11:53 a.m.	1:08 p.m.	75	–
Grind 2/3 of seeds	1:08	1:28	20	–
Cook ground seeds	1:32	1:40	8	210
Grind remaining seeds	1:40	1:55 p.m.	15	–
Cook ground seeds	1:55	2:00 p.m.	5	110
Total processing time (min) and weight of seed cakes			180	320

Aboriginal women describe this process as follows:

We can eat like milk, soak him in water. Hot time. Squash him, eat him up like shhhh (mimic slurping). Put him on ant bed now, start again, cook him. When you dry, juice, juice we can eat. Finish, leave him ant bed, flat one. Burn him now, hot sand. Start again, shake him, shake him, clean him up, finish. Alright we can start now. Rock now, grinding put him in grindstone now. We can shake him again, black one, on top one, shake him, shake him, finish now. Take him wooden dish. For man that one, for husband and wife. We can eat anything, not really damper, not really damper, gurrunba. Can't cook him. He got no fire, no law, no law. Just eating.

Table V. Processing *Panicum cymbiforme* and *Chenopodiom rhadinostachyum*

Processing step	Time		Total time (min)	Weight (gm)
	Start	Finish		
Panicum cymbiforme				
Collect seeds	10:10 a.m.	10:20 a.m.	10	280
Winnow seeds	1:53 p.m.	2:13	20	160
Soak seeds	2:15	4:37	–	–
Grind seeds	4:37	5:12	35	–
Cook seeds	5:13	5:30	17	215
Total processing time (min) and weight of seed cakes			82	215
Chenopodium rhadinostachyum				
Collect seeds from plant	2:25 p.m.	2:35 p.m.	10	560
Burn spinifex and mix ash with seeds	7:52 a.m.	8:02	10	710
Winnow seeds	8:02	8:07	5	255
Soak seeds and clean dishes	8:07	8:15	8	–
Grind seeds	8:18	9:00	42	–
Cook seeds	9:07	9:27	20	280
Total processing time (min) and weight of seed cakes			95	280

Table VI. Nutritional Analysis of Bush Foods[a]

Scientific name	Aboriginal name	Moisture (g/100 g)	Protein (g/100 g)	Fat (g/100 g)	Ash (g/100 g)	Carbo-hydrate (g/100 g)	Minerals (mg/100 g)			Ascorbic acid (mg/100 g)	Kilo Calorie (per/100 g)
							Ca	K	Na		
Seeds											
Panicum australiense and *Fimbristylis oxystachya* (Cooked damper)	Yidagadji Lugara	53.30	5.28	1.83	11.16	28.43	12.01	91.52	34.89	–	158.57
Chenopodium rhadinostachyum (Cooked damper)	Galbarri	3.67	12.32	6.29	11.30	66.42	21.23	172.02	50.37	–	373.86
(Raw seed)		51.09	14.30	1.31	11.86	21.44	127.39	282.38	39.84	–	161.69
Panicum australiense (Cooked damper)	Yidayadji	–	15.37	–	–	–	–	–	–	–	365.01
(Raw seed)		25.71	13.32	1.83	21.84	37.30	25.15	175.41	45.58	–	241.76
Fimbristylis oxystachya (Cooked damper)	Lugarra	–	13.82	4.78	9.80	–	–	50.73	22.55	–	380.99
(Raw seed)		32.60	7.10	11.96	22.57	25.77	16.90	182.70	43.96	–	244.70
Panicum cymbiforme (Cooked damper)	Gumbulyu	6.54	10.72	19.03	22.93	40.78	10.97	78.96	12.06	–	404.57
(Raw seed)		47.54	8.47	4.33	7.51	32.15	25.25	216.98	54.81	–	196.01
Styloblasium spathulatum (raw nut)	Nirdu	10.88	.31	.11	1.51	87.19	321.00	290.43	55.79	–	300.04
Tubers											
Ipomoea costata (Cooked)	Garndi	64.30	1.23	.54	.94	32.99	89.26	299.21	32.66	–	134.96
(Raw)		78.76	.81	.13	1.19	19.11	72.28	286.17	56.82	3.62	83.01
Cyper rotondus	Djunda	31.24	1.73	.43	3.06	63.54	57.22	470.12	195.18	–	277.03
Elderia sp.	Mulbu	52.22	2.53	3.80	20.43[b]	21.02	24.46	227.81	53.88	–	150.25
Fruits											
Solanum chippendalei	Wilgarrba	55.95	4.40	.55	2.33	36.77	121.73	830.65	51.56	45.25	201.64
Solanum centrale	Gawarrba	77.99	3.84	1.52	2.12	14.53	59.66	782.23	35.13	26.55	–
Ficus platypoda	Widjirgi	55.47	1.79	1.21	2.08	39.45	163.22	200.32	54.04	–	193.88
Mukia sp.	Ngalbuwandji	84.13	5.20	.19	1.60	8.88	33.52	456.55	82.20	–	70.09
Meat											
Varanus acanthurus (cooked)	Djaran	44.47	32.52	14.96	6.85	1.20	173.77	174.25	480.64	–	327.14
Varanus gouldii(cooked)	Banggabari	51.54	25.90	13.87	8.02	.67	185.08	242.11	407.93	–	245.28
Eupodatis australis (cooked)	Barrulga	60.41	29.12	6.58	2.35	1.54	33.51	247.58	355.26	–	164.03
Miscellaneous											
Sap: *Acacia acradenia*	Mawida	10.88	.31	.11	1.51	87.19	321.00	290.43	55.79	–	300.04
Wasp galls (*Eucalyptus aff. terminalis)*	Malagudu	45.01	9.66	16.12	3.61	25.60	132.07	155.40	60.96	–	–

[a]Nutritional analysis done by J. Gedeon, W.A.I.T. Dept. Home and Consumer Studies, Perth.
[b]Sample contaminated in sand.

> We two fellow; gunandru (*A. coriacea*), gilgidi (*A. holosericea*), guarrba (*A. tumida*), mirrinda (unidentified), minyingurra (*A. tenuissiuma*), ngadurrdi (*A. tumida*), mandja (*A. aneura*). That the different one, he got no law. We can't cooking damper, nothing. No. He can burn you, finish you. You'll drop. Only that first time we can cook him, that's all. Hard work that. women. Husband gone for hunting.

The Aborigines describe the raw paste as *gurrunba,* and Hansen (1977, p. 35) interprets the the term this way:

> Kurrunpa, spirit. A person's spirit, located near the stomach, leaves the body after death and returns to the birth site. The spirit is responsible for involuntary actions, vomiting, hiccoughs, etc. The spirit is personalised and said to leave one's body and go on walkabouts. One's dreams while sleeping are activities of the kurrunpa. Entrance and exit from the body is through the navel.

It is apparent from these descriptions that several species of Acacia seeds utilized in this region are toxic. There are no other references to the use of toxic seed foods in Australia. In fact, very little is known about the processing techniques for Acacia seeds at all. The only other published account is in O'Connell *et al.* (1983), but this is based on incomplete observations and does not mention anything about toxicity. Clearly, this is an area of desert subsistence that requires more research. Toxic plants are consumed elsewhere in Australia (Beaton, 1977) and the Tonga of Zambia also apparently utilize the toxic seeds of *Acacia albida* (Lee, 1979, p. 181).

Preparing seed cakes from the two herbs (*Chenopodium inflatum* and *C. rhadinostachyum*) utilized in the region is also relatively complicated. The Aborigines have to remove the aromatic flavor of the plant and the herbaceous material surrounding the seeds before they can be consumed. This is achieved by rubbing the herbaceous mixture of seeds with spinifex ash. This is rubbed together until the seeds start to separate from their herbaceous cover. They are then winnowed clean and soaked several times until the water they were washed in tastes clean.

We prepared one seed cake from *C. rhadinostachyum* (Table V). Briefly, the energy value of the damper converts to a handling rate of 5.3 hours for every kilogram of damper produced and gives a return of 300 kcal per hour.

Table VII. Roots, Tubers, and Truffles

Scientific name	Aboriginal name	Habitat	Relative importance
Cassia notabilis	Wirduga	Sandplains	Moderate
Clerodendrum floribundum	Widulyurru	Deep sand	Moderate
Cyperus rotondus	Djunda	Deep sand near water	Moderate
Elderia sp.	Mulbu	Sandplains	Minor
Ipomoea costata	Garndi	Sandplains	Major
Vigna lanceolata	Djirilbadja	Adjacent water	Major

ROOTS AND TUBERS

Six species of underground plant food are utilized in the study area. Three of these (*Ipomoea costata, Vigna lanceolata,* and *Cyperus rotondus*) are very important food items whereas another two (*Clerodendrum floribundum* and *Cassia notabilis*) are fibrous, difficult to prepare, and are generally used in times of drought. One truffle (Elderia sp.) is consumed in the region but this is a luxury item only encountered occasionally (see Tables VII and VIII).

Distribution

Ipomoea tubers are collected from the sandplains, the best tubers being located on deeper, better-drained sandplains (see Table IX). *Vigna* tubers are found in varying quantities on virtually all creek lines and sometimes on sandplains adjacent to alluvial plains and seepages from higher ground. *Cyperus rotondus* is a sedge-like grass which produces a small cluster of onion-shaped tubers close to the surface of the ground. This resource is found in places that are seasonally inundated with water.

Most of the edible roots are available for consumption all year round although their relative abundance varies throughout the year. *Cyperus rotondus* bulbs are available a few months after wet season rains and are then ready for harvesting for the rest of the year; "he is ready when you dry, this time now (June), he can stop through the hot time too."

Ipomoea tubers are also available throughout the year although their relative importance varies considerably. The Aborigines consciously stimulate the production of new tubers from surface runners by burning, "when the cold time finish" (about August). Sweeney (1947, p. 295) records that these runners are also produced after a good rain.

New tubers are harvested toward the end of the "green grass time" (May–July). When these are exhausted, the Aborigines turn to the deeper tubers on the roots of the "mother" or main plant. The older tubers are often

Table VIII. Collection Times and Calorific Returns Recorded for *Vigna lanceolata*

Collector	Weight (gm)	Total (kcal)	Time[a] (min)	*K*cal/hr
Bye Bye	120	104	15	414
Budja Budja	570	497	120	248
Bye Bye	120	104	120	52
Budja Budja	260	224	120	112
Budja Budja	260	224	30	448

[a]Does not include travel.

Table IX. Collection Times and Calorific Returns Recorded for *Ipomoea tubers*

Collector	Weight (gm)	Total (kcal)	Time[a] (min)	*K*cal/hr
Jimi, Nyami	2000	2700	65	2492
Jimi	4700	6345	60	6345
Bye Bye	2500	3375	180	1125
Budja Budja	2100	2835	180	945
Jimi	2500	3375	100	2025
Mick	890	1201	100	720
Bye Bye	7500	10125	360	1688
Nyami	4000	5400	360	960
Budja Budja	7400	9990	360	1665
Bye Bye's mother	5500	7425	360	1237
Bye Bye	6700	9045	360	1507
Nyami	3700	4995	360	832
Budja Budja	5000	6750	360	1125
Nyami	4600	6210	360	1036
Bye Nye	1500	2025	360	337
Budja Budja	7800	10530	360	1755
Bye Bye's mother	3000	4050	360	675
Jimi	800	1080	95	682
Jimi	2500	3375	38	5328
Bye Bye and Sunfly	13000	17550	240	4387
Bye Bye	1000	1350	60	1350
Nyami	2600	3510	135	1560
Bye Bye	3800	5130	135	2280
Nyami	2300	3105	100	1863
Nyami and Budja Budja	885	1195	230	312[b]

[a]Does not include travel.
[b]Tubers collected near Stansmore Range.

quite large and are usually located between 50–75 cm below the surface of the ground. They swell sufficiently to crack the ground around the middle of the cold season (June–July), and with the help of this marker are most efficiently gathered at this time of year.

As the cold season finishes *Vigna* tubers begin to swell. These can be harvested for a few months around September. *Vigna* tubers are a staple food of the "goanna get up time" (August–October), but are said to "dry up" by the extreme end of the hot season (November–December).

Both *Vigna* and *Ipomoea* tubers are very important food items in the traditional diet. If they fail to produce, the local population has to move away and forage in other areas. The women say:

> We been looking anytime. Alright we got to go another place now, nothing. Can't find him djirilbadja (*Vigna*) or garndi (*Ipomoea*). No stopping this one, this place. No stopping. Keep going, keep going. We've been having wirrgal (*Solanum centrale*) and different one djirilbadja (*Vigna*), long one, skinny one, yunala (unidentified species).

Cassia notabilis and *Clerodendrum floribundum* are both consumed during the hot time. *C. notabilis* is considered to be "a rubbish one" and apparently

produces a fibrous tuber which makes a "crack like garndi" (*Ipomoea*) during the latter part of the year.

Not much is known about *C. floribundum* except that it has an edible root resembling *Vigna* tubers and is available, if not consumed all year. O'Connell *et al.* (1983, p. 84) describe its roots as edible, but is regarded as poor food by the Alyawara because of its rough fibrous quality. Peile (1980, p. 60) also records it as a drought food.

Processing Techniques

Most of the edible roots are relatively easy to process. For example, the bulbs of *Cyprus rotondus* are simply dug by hand, roasted quickly in hot sand next to a campfire, and then rubbed between two hands to remove the outer skin. When in good supply, this is a very easy resource to gather, and, on one occasion, 12 adults collected enough bulbs to feed themselves (and had approximately 300 grams left over) in just 20 minutes. On two other occasions, the returns were substantially lower, but still yielded between 600–1000 kcal per hour (Table X).

The edible roots used during the "hard time" are more difficult to process. The techniques used to process either species was not observed, but it is said that before *C. notabilis* could be eaten, they had to "cook him, throw him in the fire, clean him, rub him, cook him again and then eat him." Peile (1980, p. 60) describes how *Clerodendrum Floribundum* was also roasted in a fire and then the "cooked endoderm is peeled off and the cooked phloem is eaten, but not the pith."

Ipomoea tubers yield the highest returns of all the edible roots collected by the Aborigines. The young shallow tubers are the easiest to collect. Often, the Aborigines could collect up to a dozen tubers from one root. The larger tubers growing on the older roots are more difficult to gather, and the Aborigines often have to dig up to 1 m below the surface to get them. The total quantities gathered on 24 different occasions show that the amounts vary from as low as 250 g an hour to over 4700 g an hour (Table IX). The

Table X. Collection Times and Calorific Returns Recorded for *Cyperus rotondus*

Collector	Weight (gm)	Total (kcal)	Time[a] (min)	*k*cal/hr
Budja Budja	950	2631	240	657
Nyami	1500	4155	240	1039

[a]Does not include travel.

average gathering rate is 1254 g an hour and, using the calorific value of cooked *Ipomoea* tubers (135 kcal per 100 g; Table VI), gives an average calorific return of 1690 kcal an hour. The best figure recorded was 6345 kcal an hour. This is virtually the same as the estimate given by O'Connell *et al.* (1983, p. 85).

Ipomoea tubers are rarely eaten until cooked. Raw tubers contain relatively high amounts of water (see Table VI) but are very hard to digest unless they are cooked. Because of this, the Aborigines cannot survive on *Ipomoea* tubers in waterless country (Sweeney, 1947, p. 268). Before tubers are eaten, they are grilled for a few minutes on top of hot coals and then baked in shallow earth ovens for about 20 minutes. When cooked, the tubers are eaten by hand without the aid of wooden or stone scoops as done in Central Australia (O'Connell, 1974).

Vigna tubers grow within 20 cm of the ground surface and are very easy to collect. The tubers are simply exposed with a digging stick and snapped off the root. Often, women collect tubers along the full length of a root in which case they dig shallow trenches several meters along the surface of the ground. When sufficient quantities of tubers have been collected, they are taken back to camp and baked by the handfuls for 5–10 minutes.

EDIBLE FRUITS

Distribution and Availability

Edible fruits are collected from 12 plants. The most important of these are the bush tomatoes (*Solanum* sp.). These are widely distributed throughout the region, occurring both on the rocky ground and on the sandplains. The bush plum (*Santalum lanceolatum*) is found consistently on deep sand and adjacent water bodies. The wild fig (*Ficus platypoda*) is confined to sheltered rocks and gorges in the hills. Two wild species of orange (*Capparis lasiantha* and *C. loranthifolia*) and a wild cucumber (*Mukia* sp.) are located on the small flood plains among the hills.

Solanum plants produce great quantities of fruit. These ripen gradually over a long period of time and can be harvested consistently between June and August. Several of these species are stored, and this extended the time these fruits are available into the hot season (December). *Ficus* fruits and wild cucumbers (*Mukia* sp.) ripen quickly and are only available for a short period at the end of the cold season. *Capparis* fruits ripen around December and provide a limited supply of food in the early part of the wet season (see Table XI).

Table XI. Fruits

Scientific name	Aboriginal name	Habitat	Relative importance
Capparis lasiantha	Ngarngguli	Flood plains	Minor
Capparis loranthifolia	Yidaringgi	Flood plain	Minor
Carissa lanceolata	Managudji	Swamp margins	Minor
Ficus platypoda	Wirrgidji	Rocky ground	Major
Mukia sp.	Ngalbuwandji	Flood plains	Minor
Santalum lanceolatum	Nuwari	Deep sand	Moderate
Solanum centrale	Garrarrba	Sandplains	Major
Solanum chippendalei	Guru	Sandplains	Major
Solanum chippendalei	Willgarrba	Rocky ground	Major
Solanum diversiflorum	Gumbubadja	Sandplains	Major
Solanum gilesii	Djarrdubidji	Sandplains	Major

Processing Techniques

With the exception of two species of bush tomato (*S. diversiflorum* and *S. chippendalei*), all the fruits can be picked and eaten directly. They are usually consumed while people are foraging. Two species of *Solanum* cannot be eaten until the astringent liquid and black seeds contained within the plant are cleaned from the inside of the fruit. This is done by biting or twisting the fruit open, shaking out the inedible black seeds, and cleaning the internal flesh by rubbing it with a thumbnail or with sand. *Solanum* are very easy to gather and are either collected in wooden dishes or skewered onto a length of *Sida virgata*. For example, on one occasion, *S. Chippendalei* was collected from an unharvested crop of shrubs at an average rate of 5325 g an hour. This gave a calorific return of 9380 kcal an hour, or enough to feed four people for a day (Table XII). This is similar to the returns recorded for *S. centrale* by O'Connell *et al.* (1983) among the Alyawara in Central Australia and Gould (1969, p. 262) in the southern portion of the Western Desert.

The Aborigines store two species of bush tomato (*S. chippendalei* and *S. diversiflorum*) which can be kept for several years if necessary (see also Thomson, 1975; Gould, 1969, 1980; Peterson, 1977). When these species are stored, they have to be carefully cleaned and cooked. This is done by turning them continuously in hot ashes so that they do not burn. When cooked, the flesh is removed from the fire and winnowed free of sand and foreign matter. The cooked flesh is then mashed with water and rolled into a ball, covered with grass, and wound up with twine. Sometimes, the Aborigines mix cooked *Ipomoea* tubers with the fruit. These balls of food are kept for consumption during the hot time, given to young men when they go into ritual isolation, or are traded with visiting people for meat.

Table XII. Collection Times and Calorific Returns Recorded for *Solanum chippendalei*

Collector	Weight (gm)	Total (kcal)	Time[a] (min)	*K*cal/hr
Peter	450	907	30	1815
Nyami	2200	4436	30	8872
Sunfly	3600	4546	30	9092
Jimi	4400	8872	20	17744

[a]Does not include travel.

NECTARS AND EDIBLE GUMS

A variety of nectares and edible gums are consumed in the study area (see Table XIII). The most important of these is the nectar of *Grevillea* aff. *eriostachya, Hakea macrocarpa, H. suberea,* and the sap of *Acacia acradenia.* These species are commonly found on the sandplains and produce edible substances between July and September. These sweet foods are a luxurious addition to the diet.

INSECTS

Six plant species are hosts for a variety of edible insects (Table XIV). The most important of these is the witchetty grub (*Cossidae* sp.; see Tindale, 1935) which can be found in great quantities in coolibah trees (*Eucalyptus microtheca*) along creeks and waterholes. Witchetty grubs can be located in these trees by a red spot on the white bark of the tree and are removed by simply opening the bark with an axe or rock and pulling the grub out with a hooked twig (yanggu) or the fingers. They are eaten raw or roasted quick-

Table XIII. Nectars

Scientific name	Aboriginal name	Habitat	Relative importance
Crotalaria cunninghamii	Ngalyibi	Sand dunes	Moderate
Eremophila latrobei	Miin miin	Sandplains	Minor
Eremophila aff. *latrobei*	Yadawarra	Sandplains	Minor
Eucalyptus pachyphylla	Djiduburru	Deep sand	Minor
Grevillea aff. *eriostachya*	Galin galin	Sandplains	Major
Hakea macrocarpa	Biruwa	Sandplains	Major
Hakea suberea	Yuradajarrdu	Sandplains	Moderate
Melaleuca lasiandra	Djandandu	Swampy ground	Moderate

Table XIV. Edible Parasites

Scientific name	Aboriginal name	Habitat	Relative importance	Parasite – location
Acacia hilliana	Bundaldji	Rocky ground	Moderate	Grub – root
Cassia venusta	Galbirr Galbirr	Rare: sandplains, adjacent hills	Minor	Grub – root
Eucalyptus aspera	Gilbilba	Sandplains	Major	Grub – trunk and branches
Eucalyptus microtheca	Dindjil	Adjacent water	Major	Grub – trunk and branches
Eucalyptus aff. *terminalis*	Gundubung	Sides of dunes	Moderate	Wasp Larvae – galls on branches
Templetonia incana	Ngadjeri	Sandplains	Minor	Grub – root

Table XV. Collection Times and Calorific Returns Recorded for Witchetty Grubs

Collector	Weight (gm)	Total (kcal)	Time[a] (min)	*K*cal/hr
Five people	385	1001	10	6006
Nyami and Budja Budja	490	1274	60	1274
Bye Bye	470	1222	60	1222

[a]Does not include travel.

ly on hot coals. Witchetty grubs gathered in this way are easy to collect. They are collected at a rate of about 30–40 grubs (400 g) an hour, giving an average calorific return of about 1000 kcal per hour (Table XV; see also O'Connell *et al.*, 1983; Tindale, 193).

Other species of grubs can be collected from the roots of *Acacia hilliana, Cassia venusta,* and *Templetonia incana. A. hilliana* is an important source for grubs and is found in abundance on the interface between rocky ground and the sandplains. Grubs from *A. hilliana* are obtained by simply uprooting small trees and retrieving the grubs from the roots. The other plants are found on the sandplain but are fairly restricted in their distribution.

Another insect food frequently sought are the wasp parasite and larvae inhabiting the coccid galls on the desert bloodwood (*Eucalyptus* aff. *terminalis*). These trees only grow on flanks of sanddunes, and the galls are collected during the cold season while still hosting the parasite (Sweeney, 1947; Peile, 1980).

WOODEN IMPLEMENTS

Two of the most important plants used to make wooden implements in the region are two species of Acacias, mulga (*Acacia anuera*) and *A. pachycarpa.* Both species grow on laterite plains and flood plains, although the distribution of mulga is quite restricted. Mulga is used to make large ceremonial boards, parrying shields, spear throwers, women's clubs, boomerangs, and punishment spears. *A. pachycarpa* is primarily used to make boomerangs.

Seven plants growing on the sandplains are used to make wooden implements. Two species of Acacia (*A. coriacea* and *A. pruinocarpa*) are quite commonly used to make boomerangs. The straight saplings of *A. adsurgens* are used to make digging sticks, clubs, and, occasionally, hunting spears, although the best woods for spear making are *Acacia cowleana* and *A dictyophleba. A. cowleana* is not as resilient as *A. dictyophleba* and is only used when the latter is not available. *A. dictyophleba* is highly prized but is quite rare, growing in dense, isolated stands in remote sand dune country. People

travel to these areas during the wet season to obtain the wood (also see Gould, 1969).

Eucalyptus is also used to make wooden artifacts. Hardwood digging bowls are made from the bloodwood (*E. terminalis*) and coolibah (*E. microtheca*). Bark dishes are made from the smooth white bark of *E. aspera* and *E. microtheca*.

One of the most important woods in the region is the bean tree (*Erythrina vespertilio*). This is a light, tough softwood and is used to make the large winnowing dishes and men's shields. Bean trees are found in greatest abundance along the numerous small creeks running from hills.

The only species found on the hills used for making implements is *Acacia rhodophloia*. This is used to make hooked fighting boomerangs (Table XVI).

Miscellaneous

Apart from obtaining food and wooden implements from plants found in the study area, the Aborigines use various plants for other purposes. These include ceremonial decorations, twines, baskets, water filters, children's spears, head pads, shoes, adhesives, medicines, and ashes for mixing with tobacco. A brief description of these is provided in Tables XVII–XXI.

ANIMALS

Within the literature, there is only a limited amount of information available on the animal foods eaten by Aboriginal people in the Western Desert (Gould, 1969, 1980; Tonkinson, 1978; Meggitt, 1962; Lawrence, 1969; Long, 1971).

Throughout this project, it has been difficult to assess the wildlife resources likely to have existed in pre-contact times because the marsupial fauna is largely nocturnal and has changed somewhat during the last 50 years (Frith, 1978). The most important influences on the local fauna appear to be the introduction of cats and the decrease in fire frequency. Bolton and Latz (1978) suggest that the decreased fire frequency in the desert since the Aborigines left the region has destroyed the habitats and populations of some of the small marsupials. Feral cats also appear to be responsible for the decrease in the population of small marsupials, and are recorded as preying on small birds and reptiles as well (Frith, 1978, p. 91). Carnegie (1898, p. 214) recorded that feral cats were in the desert before the turn of the century and they are part of the subsistence base of people in the region today. Rabbits, cattle, and camels are rare and seem to have had little influence on the local environment.

Table XVI. Major Plants Used for Wooden Implements

Scientific name	Aboriginal name	Habitat	Relative importance	Use
Acacia adsurgens	Ngardja	Sandplains	Minor	Spears, fighting sticks, digging sticks
Acacia aneura	Mandja	Laterite plains	Major	Spear throwers, fighting sticks, shields, punishment spears, ceremonial boards
Acacia coriacea	Gundandru	Sandplains	Major	Boomerangs and punishment spears
Acacia cowleana	Garna garna	Sandplains	Moderate	Hunting spears
Acacia dictyophleba	Gulada	Sandplains	Major	Hunting spears
Acacia pachycarpa	Badieri	Flood plains	Major	Boomerangs
Acacia pruinocarpa	Mandila	Sandplains	Minor	Boomerangs
Acacia rhodophloia	Djarrgadjiri	Rocky ground	Moderate	Hooked boomerangs
Erythrina vespertilio	Gumbubanu	Creek lines	Major	Shields, dishes, fire sticks
Eucalyptus aspera	Gilgilba	Sandplains	Moderate	Hardwood and bark dishes
Eucalyptus microtheca	Dindjil	Near water	Moderate	Hardwood and bark dishes
Eucalyptus terminalis	Waldji	Sanddunes	Moderate	Hardwood dishes
Triodia pungens	Djinalba	Sandplains	Major	Resin

Table XVII. Some Plants With Medicinal Functions

Scientific name	Aboriginal name	Habitat	Relative importance	Use
Acacia ancistrocarpa	Wadayurru	Sandplains	Major	Leaves chewed and saliva rubbed in open wounds
Acacia pachycarpa	Badieri	Flood plains	Moderate	Walwadjeri and Djaru people use as medicine
Carissa lanceolata	Managudji	Near water	Moderate	Leaves used as antiseptic
Cleome viscosa	Djilbirrngarning	Sandplains	Moderate	Twine wound around aching part of body
Eucalyptus brevidolia	Manggaburru	Rocky ground	Minor	Juice from bark rubbed onto wound
Euphorbia coghlaniis	Yibi Yibi	Sandplains	Moderate	Sap rubbed into skin to stimulate lacation
Halogaris aspera	Bandingunmaunma	Flood plains	Major	Smoke inhaled for cold
Ipomoea costata	Garndi	Sandplains	Minor	Twine wound around aching part of body
Sacrostemma australe	Ngarmalu	Rocky ground	Moderate	sap rubbed into skin to stimulate lactation
Streptoglossa bubakii	Manyanii	Laterite plains	Moderate	Smoke inhaled against colds
Streptoglossa macrocephala	Ngunungunu	Laterite plains	Moderate	Smoke inhaled against colds
Tribulopis angustifolia	Yibi Yibi	Sandplains	Moderate	Sap rubbed into skin to stimulate lactation

Table XVIII. Plants Used as Tobacco or Ash Mixed With Tobacco

Scientific name	Aboriginal name	Habitat	Relative importance	Use
Acacia cuthbertsonii	Wilbiiya	Laterite plains	Minor	Dry twigs burned for ash
Acacia ligulata	Wadarrga	Sandplains	Minor	Dry twigs burned for ash
Acacia pruinocarpa	Djawil	Sandplains	Minor	Dry twigs burned for ash
Eucalyptus camaldulensis	Yabulin	Creeks	Minor	Bark burned for ash
Eucalyptus microtheca	Dindjil	Waterholes	Major	Bark burned for ash
Grevillea stenobotrya	Yanandi	Deep sand	Major	Leaves burned for ash
Nicotiania benthamiana	Ngundju	Rock shelters	Major	Tobacco: leaves dried and mixed with saliva and ash
Templetonia incarna	Ngadjeri	Sandplains	Minor	Leaves used as tobacco

Table XIX. Disposable Articles Used by Aborigines

Scientific name	Aboriginal name	Habitat	Relative importance	Economic use
Amphigogon caricinus	Bimbiri (grass)	Sandplains	Moderate	Head pad
Crotalaria cunninghamii	Nyalibi	Sanddunes	Major	Sandals and twine
Gonocarpus eremophilus	Yulgurru yulgurru	Sandplains	Minor	Tuft used as basket
Ipomoea muelleri	Wandidjarra	Near water	Minor	Twine and basket
Rhyncharrhena linearis	Gulibi	Sandplains	Moderate	Twine
Sida cardiophylla	Yurrungudu	Sandplains	Moderate	Basket
Sida virgata	Dadji dadji	Sandplains	Moderate	Skewer for *solanum* fruits
Stackhousia intermedia	Bimbirri (grass)	Sandplains	Moderate	Head pad
Tinospora similacina	Waragi	Sandplains	Moderate	Twine

Table XX. Plants Used in Decoration

Scientific name	Aboriginal name	Habitat	Relative importance	Use
Acacia ancistocarpa	Wadayurru	Sandplains	Major	Used by young men during ceremonies
Didymotheca tepperi	Nilbi nilbi	Sandplains	Major	Used by old men during ceremonies
Erythrina vespertilio	Gumbubanu	Creeks	Major	Seeds threaded on hair string, also fertility beads
Eucalyptus ondontocarpa	Warilyu	Sandplains	Moderate	Seeds capsules threaded on hair string with *Erythrina* beads
Euphorbia coghlarii	Yibi Yibi	Sandplains	Minor	White sap used as paint
Euphorbia wheeleri	Yibi Yibi	Sandplains	Minor	White sap used as paint
Macregoria racemigera	Gigl Gigl	Sandplains near water	Minor	Placed in childrens' hair
Mirbelia viminalis	Marrabii	Sand, laterite plains	Major	Lit during ceremonies
Mollugo molluginea	Madagurru	Rocky ground	Major	Flower heads colored with pigment and stuck on with blood
Styloblasium sparthulatum	Nirdu	Sandplains	Moderate	Seeds threaded on hair string

Table XXI. Plants with Miscellaneous Values

Scientific name	Aboriginal name	Habitat	Relative importance	Economic Use
Acacia acradenia	Wilbut	Sandplains	Minor	Sap eaten
Acacia cuthbertsonii	Wilbiiya	Laterite plains	Minor	Shade for kangaroos
Acacia holosericea	Gilgidi	Near water	Minor	Bark for sandals
Acacia pruinocarpa	Djawil	Gravelly sand	Minor	Sap eaten and shade
Aeschynomene indica	Manabulgu	Near water	Moderate	Childrens spears and spear throwers
Calytrix longiflora	Bugara	Sandplains	Minor	Bush tea
Cassia venusta	Galbirr galbirr	Laterite, sandy	Minor	Emus eat seed
Carissa lanceolata	Managudji	Swamp margin	Minor	Insect repellant
Chenopodium auricomum	Yiliyili	Swamp floors	Minors	Sign of water
Eremophila maculata	Darrdjanpa	Sandplains	Minor	Emu food
Eriachne mucronata	Birilba	Rocky ground	Moderate	Water filter
Eriachne flaccida	Galuburrudju	Claypans	Moderate	Water filter
Eucalyptus species		Various	Moderate	Branches and leaves used like plates
Grevillea wickhamii	Yidingga	Sandplains	Minor	Reptiles eat seed
Petalostylis cassioides	Djangulari	Sandplains	Moderate	Bush tea, water
Rhagodia spinescens?	Murrlu murrlu	Swamps	Minor	Sign of water
Sida virgata	Dadji dadji	Sandplains	Moderate	Childrens' spears
Triodia longiceps	Lanu lanu	Rocky ground	Minor	Sweet excretion from leaves

MAMMALS

Distribution

Large mammals are relatively scarce and restricted in their distribution. Red kangaroos (*Megaleia rufa*) are usually located on alluvial plains and flood plains. During the wet season, they tend to spread widely over the country but move back to the vicinity of major waterholes as surface water contracts. The Aborigines feel that this particular field area is good kangaroo country and said there were, in fact, "too many kangaroos." This seems to be a fairly relative observation because the combined population must be less than 40 individuals. The population of euros (*Macropus robustus*) in the region is equally small. These macropods live in the hills.

Wallabies, bandicoots, rats, mice, and dasyurids used to live on the sandplains, but their number seem to have decreased considerably in the recent past. The Aborigines say a number of species are "finished" in the region and only five burrows of the rabbit-eared bandicoot were recorded (*Macrotis lagatis;* Bolton and Latz, 1978; Gould, 1969). Carnegie (1898) makes frequent references to the collection of bandicoots by Aborigines before the turn of the century. The Aborigines say the population of echidnas (*Tachyglossus aculeatus*) living in the hills has also reduced, but that the dingo population is about the same.

Hunting Techniques

Large animals are hunted by men. The hunting spears used are only accurate up to a distance of about 20 m (Horne and Aiston, 1924, p. 79; Love, 1936, p. 81) and, as a result, the men stalk the animals very carefully, from downwind. Often they cover themselves with a disguise of spinifex and branches. Sometimes the men work in groups and use fire to drive the animals into the range of other hunters lying in wait. The men spear the animals at about thigh level hoping to prevent the animal from hopping away when hit.

When first killed, the animals are gutted, and taken to camp for cooking. When cooked, the hind legs are dislocated at the hip, the tail removed, and all the fur burned off. Hot coals are placed in a deep earth oven, and the animal is laid on top of these and covered with the remaining coals and hot sand. The tail is cooked separately and the stomach, intestinal fat, liver, and kidneys are grilled on top of the coals. If the people are not too hungry, the animal is left to cook for several hours. Otherwise, it is eaten partially raw. Blood which spills into the intestinal cavity is often drained and drunk as well.

Bandicoots are rather more difficult to get, and it requires a lot of digging to remove them from their deep underground nests. Carnegie (1898, p. 242) records that when caught, the fur is plucked off and grilled on the coals of a fire.

Dietary Importance

Carnegie's (1898) numerous references to Aborigines consuming bandicoots suggests that these are probably the most important marsupials in the traditional diet. The Aborigines value kangaroo meat but probably do not manage to kill them very often. Only eight were shot in the 10-month period of this study. Even with a vehicle and .22 rifle, many hunts were unsuccessful. Large marsupials are probably more important in the overall diet between August and December when populations contract around available waterholes, and the heat causes them to rest more often during the day.

REPTILES

Distribution and Availability

Lizards are apparently a major source of food for feral cats (Frith, 1978, p. 91) but despite this, Aborigines claim they are more abundant today than in the past, possibly a result of reduced predation by people. The major species hunted include the centralian blue tongue (*Tiliqua multifasciata*), the great desert skink (*Egernika kintorei*), and two monitors (*Varanus gouldii* and *V. acanthurus*), but there are many small dragon lizards (*Amphibolurus* sp.) caught and eaten by children. The Aborigines seem to regard geckos (*Diplodactylus* sp.) with distaste. Lizards are found widely on the sandplains and dunes, and the ridge-tailed monitor (*V. acanthurus*) is found in rocky crevices in the hills.

Snakes are not common in this part of the desert and the most commonly caught are pythons (*Aspidites melanocephalus* and *Aspidites ramsayi*). One species of edible toad (*Notaden nichollsi*) is collected in the region.

Lizards and snakes are available all year round but hibernate during the winter. The centralian blue tongue and ridge-tailed monitor are the first to leave their nests after winter and herald the start of the "goanna get up time" (September–October). The desert spade foot toad (*Notaden nichollsi*) is most commonly gathered when it leaves its nest to breed during the wet season. It is also collected after winter drizzle when it comes to the surface to feed.

Collection and Consumption

Both men and women gather reptiles. Once the tunnel of a lizard is found, its nest is located by beating the ground with the heel of the foot or a digging stick. The animal is then dug out and bashed on the head. Both snakes and lizards are baked in shallow earth mounds. Before lizards are cooked, the intestines are pulled out through the anus or hooked through the side of the neck with a stick. When gutted, reptiles are grilled on hot coals until almost bursting and then baked for about 20 minutes. Before the desert skink (*E. kintorei*) is cooked, it is scaled with a stick.

Lizards are relatively easy to collect, and the average collection rate (including travel time) for the 167 lizards collected in 1982 was 733 g per hour (Table XXII). This gives a return of approximately 2000 kcal an hour based on the average calorific value of cooked specimens (Table VI).

Edible toads are dug from deep (1.5 m) pits within sand dunes. Often, several nests of frogs are located in each hole, yielding up to 1000 g of toads per hour. Toads are killed by crushing the skull and are cooked on hot coals, skinned, and eaten (see also Peile, 1978, p. 12).

Dietary Importance

Lizards are the main source of protein and fat for the Aborigines living in the desert. They are critically important during the last few weeks of the hot season. If rains come unusually late, lizards are virtually the only food the Aborigines have to survive on. At these times, life is quite difficult and often people starve. The men said that, under these conditions, they leave camp before sunrise in pursuit of food and return after dark. They said they would try and collect about three goannas for their families. The average weight of the goannas collected was 456 g. This converts to a calorific value of 1304 kcal per goanna. Therefore, three of these goannas only yield 3912 kcal of energy. If the number of people in an average family is five people (see Cane, 1984), then this daily ration is only enough to provide each person with 782 kcal of energy a day!

BIRDS

Both birds and their eggs form an important part of the traditional diet. Emus (*dromaius novaehollandiae*) and bustards (*Eupodotis australis*) are the most commonly sought species, but emus are rather rare. For example, during the study period, only eight emus were seen, and none shot. Bustards

Table XXII. Collection Times and Calorific Returns Recorded for Lizards

Collector	Species[a]	Number	Weight (gm)	Total[b] (kcal)	Collection[c] time (min)	Kcal/hr
Jimi	Va,Ug, Tm,Eg	8	3330	9524	150	3819
Arthur	Va	4	800	2288	150	915
Bye Bye, Sunfly	Tm	3	1110	3175	90	2116
Bye Bye, Sunfly	Vg	3	1550	4433	60	4433
Arthur	Vg	2	425	1216	210	347
Arthur	Vg	2	620	1773	150	709
Jimi	Vg	3	1400	4004	60	4004
Arthur	Vg	1	840	2402	20	7207
Arthur	Vg	3	1110	3146	60	3146
Bill	Vg	2	870	243	60	243
Arthur	Vg	3	1600	4575	240	1144
Bill	Vg	2	500	1430	260	330
Nyami, Budja Budja	Vg	4	2100	6006	150	2402
Nyami, Budja Budja	Vg	3	1500	4290	240	1073
Nyami	Vg	1	590	1687	53	1910
Three people	Va,Vg Tm,Eg	8	5090	14557	180	4852
Arthur	Vg	2	930	2660	240	665
Jambu	Va	1	120	343	180	114
Jimi	Va	3	750	2145	15	8580
Child	Va	1	150	429	80	322
Child	Tm	1	260	744	80	558
Bruce	Va	2	560	1602	45	2135
Nyami	Vg	1	455	1287	80	965
Jimi	Vg	3	2600	7436	80	5577

Nyami and Jimi	Va	13	3890	11125	135	4945
Nyami	Vg	2	770	2202	60	2202
Nyami	Va	6	1150	3289	160	3289
Jimi and three children	Vg	13	3500	10010	105	5720
Bruce	Vg	1	470	1344	100	807
Nyami	Va	1	280	800	75	640
Jimi, Nyami	Va	6	2100	6006	30	12012
Jimi, Nyami	Vg,Tm	5	2390	6835	90	4557
Jimi	Vg	5	2880	8237	480	1030
Nyami	Vg	1	460	1316	180	439
Mick	Vg	1	570	1630	300	326
Sunfly	Vg	1	830	2374	300	475
Bye Bye	Va	1	240	686	15	2746
Budja Budja	Va	4	815	2331	120	1165
Nyami	Vg	1	405	1158	120	579
Bye Bye	Va	3	820	2345	120	1173
Bye Bye	Tm	1	320	915	60	915
Nyami, Sunfly, Bye Bye	Vg,Va	10	7500	21450	60	21450
Budja Budja	Vg,Va	3	695	1988	60	1988
Budja Budja, Nyami	Vg	3	2500	7150	60	7150
Bye Bye	Vg	2	1600	4576	60	4576
Nyami	Va	1	185	529	30	1058
Jimi	Va	2	440	1258	30	2517
Bye Bye's mother	Vg	3	1600	4576	180	1525
Arthur's wife	Vg	4	1900	5434	180	1811
Bye Bye, Sunfly, Nyami	Vg,Va,Tm	5	7600	21736	150	8694
Bye Bye	Vg	1	630	1802	120	901
Jimi	Tm	2	460	1230	30	2460

[a]Varanus gouldii = Vg, Varanus acanthurus = Va, Tiliqua multifasciata = Tm, Egernia kintorei = Eg.
[b]Calorific value used is average of kcal/100 g for *V. gouldii* and *V. acanthurus*.
[c]Collection time includes travel on foot.

Table XXIII. Economically Importance species of Birds

Scientific name	Aboriginal name	Common name	Seasonal availability	Location	Importance
Anas superciliosa	Djribulu	Black duck	February–April	Swamps	Moderate
Aquila audax	Walayurru	Wedgetail eagle	Year round	Hills	Major
Eupodatis australis	Barrulga	Bustard	Year round	Burned ground floodplains	Major
Artamus cinereus	Djargudjargu	Wood swallow	August–September	Rockholes	Minor
Cacatua galerita	Gibbery	Sulphur-crested cockatoo	Year round	Waterholes	Moderate
Corvus cecilae	Ganga	Crow	Year round	Camps	Minor
Dromaius novaehollandiae	Galaya	Emu	Year round	Laterite plains	Moderate
Eolophus roseicapilla	Gagalala	Galah	Year round	Rockholes	Moderate
Fulica atra	Guludju	Coot	February–April	Swamps	Minor
Geopelia cuneata	Gulugugu	Diamond dove	August–December	Rockholes	Moderate
Lophoictinia isura	Bilibili	Square-tailed kite	Year round	Camps	Minor
Melopsittacus undulatus	Ngadidjeri	Budgerigar	August–December	Rockholes	Moderate
Ocyphaps lophotes	Djaralabalgul	Crested pigeon	August–December	Waterholes	Moderate
Podargus strigoides	Biwi	Tawny frogmouth	Year round	Plains	Minor
Podiceps poliocephalus	Willagaradja	Hoary-headed grebe	February–April	Swamps	Minor
Poephila guttata	Djirigi	Zebra finch	August–December	Rockholes	Moderate

are common and are easily hunted. Flocks of between 20–30 birds were seen feeding on freshly burned ground and smaller flocks were seen of between three and five birds on the flood plains (Table XXIII).

DISCUSSION

The nature of the information presented in this paper raises certain questions about the traditional anthropological view of desert Aborigines' subsistence. It raises questions about the resource base, adaptive strategies, division of labor, settlement patterns, and a variety of other issues, which, in the absence of quantified data, have only been partially understood in the past. In the remainder of this paper, some of these issues are examined.

Regional Differences in Subsistence

It is apparent that there are regional differences in the nature of subsistance strategy practiced by Aboriginal people living in different parts of the Western Desert.

These differences result largely from cultural and geographic factors. For example, in comparison with their southern neighbors from the Gibson Desert (Gould, 1969), the Aborigines of the Great Sandy Desert appear to have enjoyed greater economic diversity and greater seasonality in the availability of resources. The Ngatatjara to the south do not enjoy access to important resources such as *Ipomoea* or *Vigna* tubers and are not recorded to have stored and utilized Acacia and eucalyptus seeds. Conversely, *Chenopodium* and *Eragrostis* seeds and *Ficus* fruit are major resources in the Gibson Desert, but are comparatively unimportance to the Gugadja in the Great Sandy Desert, who also do not have access to *Canthium* or quandong fruits (*Santalum acuminatum;* Gould, 1969, 1982). Similarly, the annual subsistence round practiced by the Gugadja is not stimulated or governed by the location and size of erratic rain showers, unlike that of the Ngatatjara, who seem to be forever on the lookout for rain. In the Great Sandy Desert, the Aborigines spread out during the summer in search of unused supplies of food. They congregate around large waterholes during the winter where abundant supplies of fruits, seeds, and roots allow participation in large ceremonies. Toward the end of the dry season, the Aborigines move back to major rockholes and practice a generalized hunter-gatherer subsistence strategy.

The Gugadja practice a very similar subsistence system to the Walpari and Alyawara to the east (Meggitt, 1962; O'Connell *et al.,* 1983). Their

resource base is almost identical, the processing methods are the same, and the seasonal round is similar.

Highlighting the regional diversity in the subsistence strategies practiced by desert Aborigines, however, is the difference between these groups and the Bagundji of the margin of the arid zone in eastern Australia (Allen, 1974). Here, the Aborigines congregate in large groups along river banks during the summer months. This is a time of high productivity and the Aborigines collect fish, shellfish, bullrushes, and migratory birds. By comparison, winter is a difficult time, and the Aborigines split up into small groups and focus their attention on mammals, seeds, fruits, and tubers. Both the Gugadja and Bagundji practice seed storage quite extensively.

The Nature of Subsistence

The information presented in this paper suggests that subsistence is not overly opportunistic. The seasonal availability of resources combined with the detailed environmental knowledge of Aboriginal peoples make hunting and gathering activities quite predictable and reliable. For example, the availability of vegetable tubers during the cold season is very predictable and allow relatively large groups of people to live semi-permanently around large waterholes. Further, the Aborigines take conscious steps to store Acacia, eucalyptus, *Stylobasium* seeds, and *Solanum* fruits for periods of food shortages. They also have a conscious policy of burning the land to stimulate new tubers, grass seeds, *Solanum* fruits, and to attract game. Hunting and gathering behavior is most opportunistic and generalized between the "goanna get up time" and the wet season (August–March) when the Aborigines forage widely for a variety of different resources.

Desert subsistence cannot be characterized as either "affluent" or unduly harsh (Thomson, 1964; Sahlins, 1968; Lee, 1968; Gould, 1969; O'Connell and Hawkes, 1981). Rather it varies between these two extremes. The best time is the cold season when easily-gathered resources such as tubers and fruits are abundant and women only have to spend a few hours gathering to provide sufficient food for an average family. This is a time of affluence, characterized by feasting, leisure, and social interaction. It is a time of ceremonial activity, when gatherings of up to 300 people congregate for religious purposes. The "goanna get up time" (August–October) is more arduous and, at this time of year, both men and women spend most of the day foraging. The last part of the year, from October until the first wet season rains (January) sees a decline in economic activities. People congregate around major waterholes and collect whatever food (usually goannas) is available within a foraging radius of about 15 km from the waterhole. This is a harsh time

of year, and food supplies often dwindle to the point of virtual starvation. When wet season rains fall family groups spread out across the country, gathering a variety of resource, left over from the previous year.

Sexual Division of Labor

Contrary to popular belief (Gould, 1969; Peterson, 1970; Hiatt, 1970; Maddock, 1970) women are not always the principal food gatherers in the desert. The role of the sexes in the collection of food appears to vary seasonally. Women are the principal food gatherers during the cold season (May–August), whereas both men and women make a substantial contribution to the diet during "goanna get up" (August–October). Men take over the role of food collecting during the hot season (October–December), and both men and women collect food during the wet season and "green grass time" (January–April). Men and women shared many of the subsistence activities. Neither sex is adverse to collecting wild fruits, eggs, small marsupials, tubers, or witchetty grubs, although seeds are always processed by women and men always do the hunting.

Importance of Desert Resources

The main foods utilized in the northern part of the Western Desert are seeds, wild fruits, tubers, reptiles, marsupials, birds, and grubs.

Without doubt, edible roots are the most important and easily-gathered food in the region. *Ipomoea* tubers are the most important of the five root crops and are usually the major resource used to support ceremonies whenever rainfall is heavy enough to allow sufficient people to gather. *Vigna* tubers are also very important but are generally only available for a short time between August and September. The edible bulb of *C. rotondus* can be harvested all year but is only available in relatively small amounts throughout the area.

Except for the *Solanum* fruits, the fruits eaten in the study area are treated as luxury items, additional to the daily fare, and are generally consumed as people traveled. Gould (1969, 1980) records that *Ficus* fruits are a desert staple, but their ripening period is so short that this is unlikely. The *Solanums* make a more substantial contribution to the diet and, with the exception of *S. centrale,* are consumed in great quantities when available. *S. centrale* is said to produce very bad headaches if too much is eaten.

Most foods are available in a broadly defined season, although some such as *Ipomoea* and *Cyperus* tubers, reptiles, birds, and witchetty grubs can be obtained all year. Most of the vegetable foods ripen during the cold

season (May–August), and, as the year progresses, a greater diversity of less abundant foods are available. Supplies of food begin to run out and are often in short supply during the hot season and wet season (November–February).

Vegetable foods do not always constitute between 70–80% of the traditional diet (Meggitt, 1957; Gould, 1969. This figure may be true for some of the winter months, but it varies seasonally. Animal foods become increasingly important during the spring, and eventually dominate the diet, i.e., lizards, during the early summer (December).

Importance of Seeds

It has always been assumed that seeds are an important part of the traditional diet in arid Australia (Gould, 1969, 1980; Allen, 1974; Meggitt, 1957; Tindale, 1974; O'Connell *et al.,* 1983; Lawrence, 1969). The information presented in this paper suggests that this assumption is not entirely correct.

Grass seeds are difficult to process, and unless the major species are particularly abundant and close to campsites, they usually constitute a "bread and butter" kind of backstop to the subsistence system.

The processing times recorded in this paper convert to a handling rate of between 3–6 hours for each kilogram of damper processed from various seeds. This translates to an energy return of between 246-810 kcal per hour. The average handling time is therefore 5 hours to produce 1 kg of food and a return of only 340 kcal an hour. If, for example, grasses are "staple" foods and constitute between 30–50% of the traditional diet as suggested by Gould (1969, 1980, 1982), then one woman would have to work between 10–15 hours a day simply to provide an average family of five with less than half their daily calorific intake. These figures might be slightly exaggerated given that the women are relatively unfit and out of practice, but, nevertheless, they give some idea of the effort involved in processing seeds. Therefore, unless large supplies of relatively easily processed grass seeds are available, they probably constitute only about 20% of the daily diet. The Aborigines always prefer to get large game, lizards, tubers, and various fruits rather than grass seeds. The unique value of seeds, however, is that (unlike many other food items which are only available seasonally, and can fail to ripen in abundance in any given year), they can be stored and can always be found somewhere. Seeds are most abundant and of greatest economic importance during the coldest seasons (between June–October), but become quite scarce during the hot and wet seasons (November–March). Grass seeds are notably more important during large ceremonies when other local resources are pushed to their limits.

With regard to the relative importance of individual species of seeds, it is apparent that, with the exception of the three species of spinifex, the

grass seeds are the most desirable. Among the grasses, *Panicum australiense, P. cymbiforme,* and *Fimbristylis oxystachya* appear to be the most important. Most of the other grass seeds are of moderate importance and are used in a supplementary fashion in the diet. The edible shrubs, Acacias, eucalyptus, spinifex, and the succulent *T. verrucosa* are generally at the bottom of the list, although their relative importance in the daily diet increases during the hot season (or in the case of spinifex, in the late wet season) when everything else is in short supply.

CONCLUSIONS

This paper presents data recorded during the final phases of hunter-gatherer activity in arid Australia. It is perhaps the last reliable data on hunter-gatherer subsistence economies from arid environments anywhere in the world. The paper has been written to provide a complete picture of Aboriginal economic life in the Western Desert. Several smaller, less detailed studies have been conducted in the Western Desert, but none have been able to fully explain the nature of desert subsistence. As such, some of these papers have presented limited interpretations of Aboriginal subsistence which this paper supplements and develops. This new data suggests new interpretations and rectifies some past misconceptions about desert subsistence.

Most obvious perhaps is the predictability of both seasons and the availability of resources. In earlier studies, extreme opportunism was noted by ethnographers. This impression must now be questioned as it is apparent that, while generalized/opportunistic hunting and gathering did occur in specific seasons, Aboriginal people also live in semi-permanent camps for extended periods throughout the year. These camps are located at major waterholes and people focus their economic activity on key resources. The locations of reliable food and water resources are well known. In this sense, Aboriginal life is quite secure and predictable.

Aboriginal people also have access to a much larger and more reliable resource base than previous studies have shown. Foods such as reptiles, *Ipomoea* and *Vigna* tubers, and *Solanum* fruits are staple resources. Other foods such as *Ficus* fruits and nectars are luxury items, and others (spinifex seeds and fibrous tubers) are used as drought foods.

Grass and Acacia seeds appear less significant in the diet than previously thought. Processing these foods is such a difficult and time-consuming task, it is unlikely that seeds can contribute more than 20% of the daily diet at most sites. Seeds are stored, however, to help people through lean times of the year.

The availability of resources fit within a broad seasonal rhythm. Vegetable foods dominate the diet during the cold season, contributing up to 70%

of the food consumed. The diet becomes more generalized utilizing both meat and vegetable foods during the spring, with reptiles being virtually the only food collected (contributing 80–90% of the foods eaten) during the late dry season (December). With these seasonal fluctuations, there are changes in the resource base. Thus, the old notion of extreme desert hardship and the contemporary notion of hunter-gatherer affluence are inaccurate. Rather than either of these two extremes, there is an alternating rhythm of affluence, leisure, and social initiations in the winter, and economic hardship and stress during the spring and summer.

This broader, more complicated view of subsistence in the Western Desert points to the value of long-term, quantitative research into hunter-gatherer economies, and provides a reliable source from which human adaptation in marginal environments can be understood.

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