THE KAKAPO (*Strigops habroptilus*, Gray, 1847) ITS FOOD, FEEDING AND HABITAT IN FIORDLAND AND MAUD ISLAND.

A thesis presented in partial
fulfilment of the requirements for the degree
of Master of Science in Zoology at
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ABSTRACT

An extensive Wild Life Service conservation program to save the Kakapo parrot from extinction has permitted the collection of feeding data in Fiordland and on the sancturary, Maud Island in Pelorus Sound, between November 1974 and March 1977. Four expeditions, each of 4 to 6 weeks between January 1975 and March 1977 enabled my spending over 4 months in the Fiordland Kakapo areas and a further 6 weeks was spent in the Kakapo search on Stewart Island in July and August 1977.

A total of 15 occupied Kakapo territories in Fiordland were found over the two and a half year period. Kakapo from 3 of these territories were moved to Maud Island and monthly visits between September 1975 and August 1976 enabled regular collection of droppings for faecal analysis study.

A combined appraisal of feeding sign and faecal content, using cuticle analysis techniques has enabled a more accurate understanding of the Kakapo's diet and its seasonal variations to be determined. The mobility of the Kakapo could also be roughly estimated and on Maud Island it appeared the Kakapo were learning to obtain new foods.

Investigation of faecal material has confirmed early reports that Kakapo are herbivorous. No insect or animal parts were found in fresh droppings. The variety of plants fed upon was extensive. In Fiordland 79+ species of herbs, grasses, shrubs and

trees have been identified and on Maud Island 28+ species. Roots, rhizomes, twigs, leaves, buds, flowers, flower-stems, fruits and seeds are utilized.

Feeding areas in Fiordland have all been found in the vicinity of the male Kakapo's track and bowl systems. These are generally located about tree line at approximately 1050 meters. The tree line in many areas is lower than expected, however, due to terrain and avalanche damage. Kakapo feeding areas, associated with track and bowl systems extend from 550 meters to 1200 meters above sea level.

On Maud Island feeding sign and droppings found were concentrated on or close to recently excavated roads, although it was apparent the birds were covering an extensive area from the coast to the summit (350m).

The Kakapo bill is adapted to crushing and extracting nutrients and enables a large proportion of fibre to be retained in the bill. The fibre is frequently squashed into a kidney shaped pellet which is expelled from the mouth. A preliminary investigation into nutrient values of Kakapo food plants is presented and it is suspected the birds select the most nutritious plant species and plant parts as food.

On Maud Island the vegetation available as food for Kakapo in preliminary analyses appears to be of greater nutritional value than in Fiordland.

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I am indebted to the New Zealand Wild Life Service for the opportunity to study the rare Kakapo. I wish to thank them for supplying a travel grant for the visits to Maud Island, and for employment as a paid worker on three of the four Fiordland expeditions in which I participated.

The Fiordland National Park Board provided a grant to cover travel expenses to and from the Park for one expedition. I thank them for this and for permission to collect Kakapo feeding sign in the Park.

A large number of Wild Life personnel and volunteers have participated in the Kakapo program over the last two and a half years in Fiordland, Stewart Island and Maud Island. They have searched for these birds over vast areas of some of the most rugged terrain in New Zealand often without the satisfaction of finding Kakapo sign, let alone seeing a Kakapo. It is only through the combined efforts of these search parties that Kakapo areas have been pinpointed. It has been my privilege to visit most of these areas after Kakapo sign had been

found. I am most appreciative of the efforts of these people.

I wish to thank Mr.D.V. Merton, who was in charge of the Kakapo program during this time. He not only encouraged me and arranged for me to do this study, but also by his efforts ensured the best possible results.

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For the use of their photographs I am grateful to Messrs. Kendrick, Merton, Morris and Morrison; and to the Lands and Survey Department for permission to reproduce part of the Fiordland topographical map (NZMS 1 series).

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(R.B. Morris)

THE KAKAPO

(*Strigops habroptilus*, Gray, 1847)

CHAPTER I

INTRODUCTION

Morphological characteristics, Classification, Distribution and General Habits

A. Introduction

The Kakapo,[1] Strigops habroptitus,[2] or the night Kaka (Plate 1, opposite), is a nocturnal parrot endemic to New Zealand. Throughout its recorded history it has proved an elusive subject to observe. The bird's cryptic colouration of green and yellow barred with brown, coupled with its habit to 'freeze' makes it difficult to find in vegetation. On the other hand, its distinctive scent and its loss of flight have made it vulnerable to the influx of predators which includes dogs, cats, mustelids and rodents. Competitive herbivors, deer and opossum, together with the felling of timber and vast areas of fire damage have reduced Kakapo populations to such an extent that the bird is now extremely rare. In recent years they have been found in two localities, Fiordland and Stewart Island.

The New Zealand Wild Life Service has undertaken to reduce and hopefully reverse the Kakapo's trend towards extinction. This feeding study has been closely associated with the Wild Life Service field

[1] Kakapo is used for both the singular and plural form in accordance with the Maori language (Wills, 1960).

[2] Nomenclature for New Zealand Birds follows that laid down in the Annotated checklist of the Birds of New Zealand (Kinsky, 1970).

program. The collection of foods and associated feeding information has been obtained on Wild Life Service expeditions in Fiordland and the off shore sanctuary of Maud Island, where three birds were released in 1974-75.

It is hoped that the collation of this information will help in furthering the understanding of the Kakapo's feeding requirements, a vital factor in preserving the species.

B. The Kakapo

i) Characteristics and Classification

Kakapo are one of the 332 extant species (Forshaw, 1973) of living parrots (Psittaciformes) and possess the typical external features of hooked bill and zygodactyle feet. This species has a number of anatomical features which together suggest the species is sufficiently distinctive to be placed alone in the genera Strigopi (Smith, 1975): they are the carotid artery pattern, the reduced sternum, the entire orbital ring, the cere type, feather barring and scratching pattern.

Forshaw (1973), although placing Strigops in an individual subfamily considers it is related to the Australian Ground parrot (Pezoporus wallicus) and the night parrot (Geopsittarus occidentals) despite marked osteological differences.

ii) Distribution of Kakapo

At the present time Kakapo have been located in

Northern Fiordland

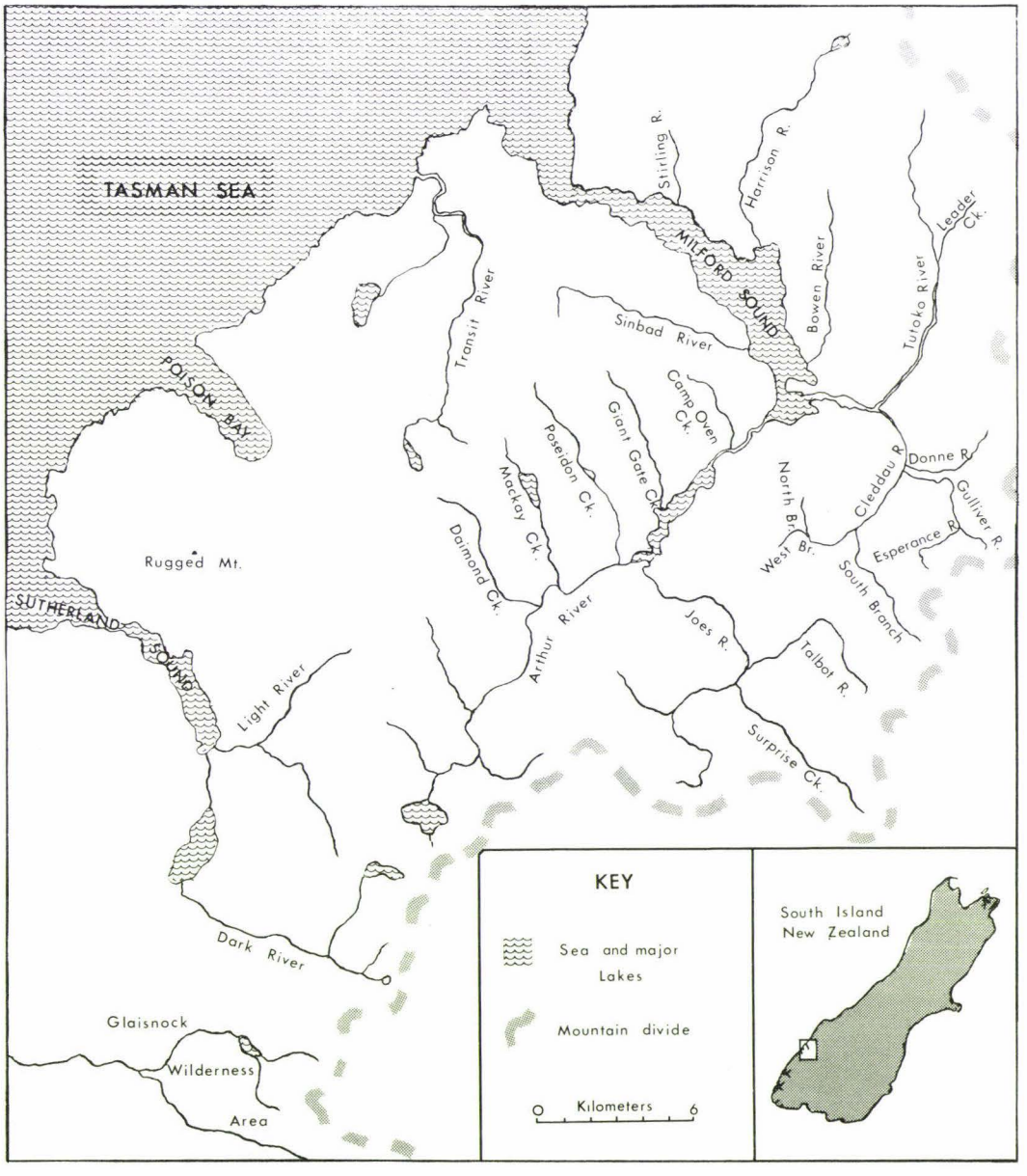


Fig. 1

three regions. The first is the Milford Sound area in the Fiordland National Park situated in the south west of the South Island (Fig.1,p.3). Between November 1974 and February 1977 fifteen birds were located within the Milford catchment area and the Transit Valley west of Milford (Plate 2,p.5).

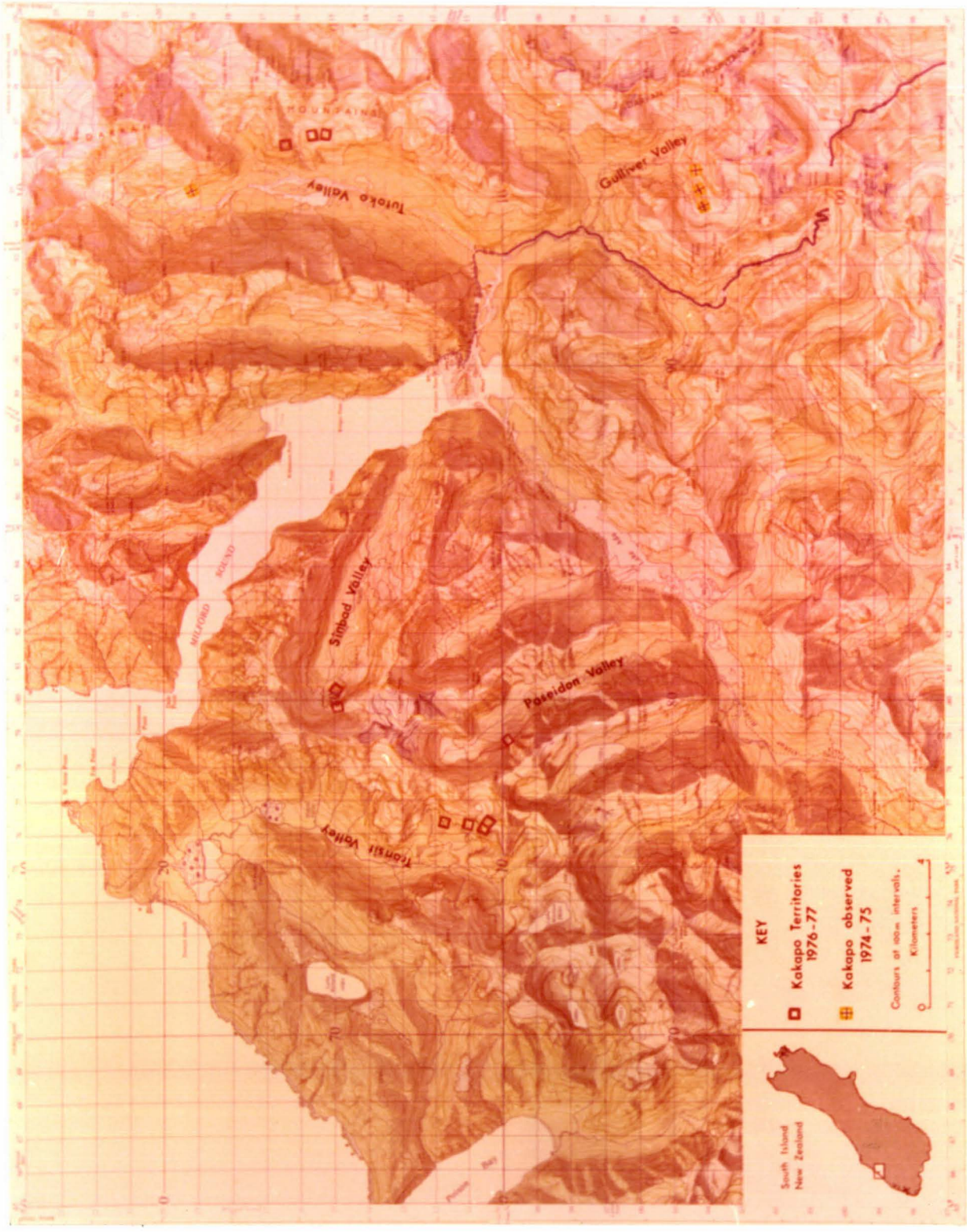
Three of these Fiordland birds were transfered to Maud Island in Pelorus Sound in the north east of the South Island (Fig.2,p.6). Maud Island is the second locality where Kakapo were observed during the study period. At least two of the three birds were present on the Island between August 1975 and December 1976.

The third locality where Kakapo are known is Stewart Island. A population of these birds was rediscovered in January 1977 by the Wild Life Service (Russ and Anderson, 1977a). At that time it was estimated that 30-40 Kakapo existed in the vicinity of Port Pegasus on the east coast and in the region to the north. A six week stay in the region in July and August 1977, and extensive searches over the country west and south, suggest that this population is probably concentrated between the Tin Range and the east coast. The region to the north has yet to be searched.

The present study does not include the Stewart Island population although some comparative facts are noted.

iii) Kakapo breeding territories

Field data obtained in Fiordland between January


Tutoko Valley
Gulliver Valley
Sinbad Valley
Poseidon Valley
Tronsil Valley
KEY
Kakapo Territories 1976-77
Kakapo observed 1974-75
Contours at 100m intervals.
Kilometers
South Island New Zealand

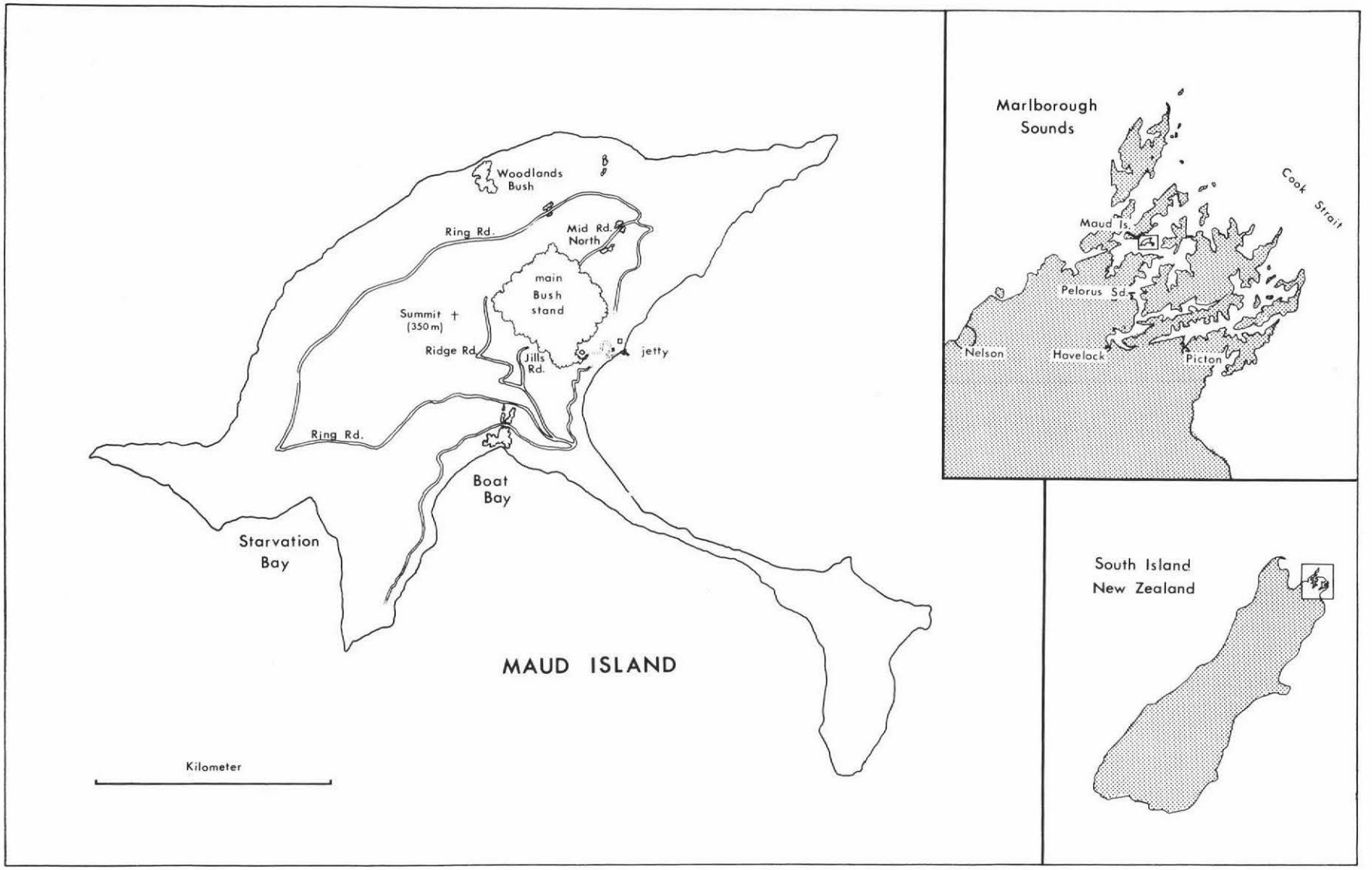

Woodlands Bush
Ring Rd.
Mid Rd. North
main Bush stand
Summit + (350m)
Ridge Rd.
Jills Rd.
jetty
Ring Rd.
Boat Bay
Starvation Bay
MAUD ISLAND
Kilometer
Marlborough Sounds
Cook Strait
Maud Is.
Pelorus Sd.
Nelson
Havelock
Picton
South Island New Zealand

Fig. 2

1975 and February 1977 was collected in the vicinity of male Kakapo breeding territories (McFadden, 1974; Gray, Merton and Morris, 1975; Merton and Morris, in prep.). These territories are comparable in specific topographical and vegetative characteristics (Chapters II, III). Areas in these territories were modified by the birds for what is suspected to be breeding purposes and are briefly outlined below. (A detailed account is in preparation by Merton et.al.).

a) Track and bowl systems. In the Milford and Transit Valley catchment areas Kakapo track and bowl systems have generally been located on prominent ridge crests, although they have been located in unobtrusive sites on avalanche debris and river banks. These 'tracks' have been cleared of vegetation. The male Kakapo clip and gnaw the vegetation with their bills. Ground plants such as Astelia spp., grasses and ferns, and low overhanging branches of various shrub species, up to 1cm in diameter and exposed roots are thus removed. Tracks up to one meter wide or more are cleared, probably over a period of many years. A track may run more or less continuously for many meters along or close to the ridge crest, curving amongst trees and rocks, and sometimes forming an interlacing network. Tracks up to 250m long have been located (Veitch, 1976a).

Kakapo may also grub away soil and gnaw roots along these tracks so making them most conspicuous amongst the surrounding ground cover of moss, fern

or litter. Tracks in low scrub or tussock about the vicinity of tree line (approximately 1000m above sea level), for example, can sometimes be seen from the air. The tracks link a series of 'bowls' or depressions in the ground, the largest of which are about 30cm deep and 100cm wide. These depressions are grubbed and scraped out by the Kakapo. It is usual for the bowls to be positioned at the base of a tree, a rock or shrub. Kakapo appear to have favourite sites, for example, under dry rock overhangs. Such bowls are usually more extensively excavated, a longer time apparently having been spent on them.

Male Kakapo have been observed 'booming' at night while standing in these bowls. Booming is a deep call, a sound not unlike blowing across the top of a bottle. Sound production appears to be aided by expanding air sack in the breast (Henry, 1903a) which alters the Kakapo's silhouette from a comparatively sleek to a rotund shape. Booming calls follow a particular sequence. A bird begins with several low grunts followed by a series of booms which rise in intensity and resonance before fading to silence. The silence lasts for several minutes before the process is repeated. In any one night the longest period of booming recorded was in territory 2 in the Sinbad Valley when one bird began booming at 1400 hours[1] on a wet misty afternoon and continued

[1] All times in New Zealand summer time

through the night until 09.00 hours the following morning, a total of 17 hours (Gray, Merton and Morris, 1975). Usually, however, a bird began about an hour after darkness had fallen and ceased before dawn (6-7 hours booming). Booming occurs nightly over a period of 4-5 months (November to March) and it appears that the birds lose weight during this time (Merton, pers.comm.).

Henry (1903a) reported that Kakapo do not boom every year. Observations in Fiordland over the last three years would tend to verify this. Booming was heard and observed in the Tutoko, Sinbad and Transit Valleys in the summers of 1974-75 and 1975-76 but not in 1976-77.

It is in the vicinity of these track and bowl systems that much of the feeding information has been obtained during these three summers.

b) Roosts. As Kakapo are nocturnal feeders it is presumed that they roost during the day. It is uncertain, however, whether they feed every night. Probably in the high rainfall area of Fiordland the birds may well roost or at least shelter during periods of heavy rain.

Most roost sites have been located on dry warm sunny slopes. Old droppings collected for food analysis studies (Chapter VIII) have been found in old roost sites under dry rock overhangs and shallow caves. In the Tutoko Valley many small quantities of droppings were collected from comparatively

exposed sites under low hanging branches, at the base of trees, expecially amongst an exposed root system, and under overhanging fern at the base of dry banks. Generally the bird had perched on a small rock or a branch just off the ground. Such roost sites would afford little protection against the torrential mountain rains. Presumably, such sites might probably be used in fine weather when the bird could bask in the sun as Henry (1903a) reported.

The small number of droppings found, coupled with the numerous roost sites (21 sites were found in one territory in one day's search; Veitch 1976b) suggest that the birds roost in the nearest suitable site once they cease feeding for the night.

Observations by Morris and Russ (1976) in the Tutoko Valley in July and Russ and Anderson (1977b) on Stewart Island in July and August support the observation that Kakapo are surprisingly mobile and wander considerable distances using many different roost sites for only brief periods. Large accumulations of droppings from some dry caves suggests that they may have been used by several generations of Kakapo.

On Stewart Island Russ and Anderson (1977a) found a collection of droppings 1m wide and 4cm deep under low scrub alongside a track and bowl system. Nothing comparable to this has been found over the last three summers in Fiordland. (Gurr, pers.comm., suggests this could be the place where the female

sits and watches the booming and display).

C. The Fiordland Kakapo Area.

The glaciated topography of the Milford catchment and surrounding fiords is a factor which has probably contributed to the survival of Kakapo in the South Island region. Access to both introduced competitors and predators has been hindered by the geographical barriers.

The valleys of the Milford catchment and surrounding region have in common a number of general features. They all have the 'U' shaped cross section typical of glaciated valleys. The valley walls are sheer and extensive areas of exposed granite and grandiorite rocks are visible. A valley floor is comprised of avalanche debris and rock falls which are piled along its sides at the bases of the over-shadowing peaks. The highest peak in the area is Mt. Tutoko (2770m) but most peaks range between 1500 and 2100 meters.

Rainfall in the region is high. At Milford Sound the average annual rainfall is 6236mm and as a result waterfalls and river levels fluctuate markedly.

The high altitude silver beech (Nothofagus menziesii) forest is the most abundant canopy species in the vicinity of Kakapo territories but on avalanche debris fans mixed Olearia, Hoheria and Senecio scrub replaces it. Above bush line

alpine scrub (Dracophyllum spp., Olearia spp., Podacarpus nivalis, and Senecio bennettii) and tussock grassland (Chionochloa crassiuscula and C. flavescens) form the predominent cover.

Bird life about the Kakapo territories is sparse. The most commonly recorded species in the high altitude forest and scrub are Redpolls (Acanthis flammea), Bellbirds (Anthornis m. melanura), Grey Warblers (Gerygone igata), Keas (Nestor notabilis), Tomtits (Petroica m. macrocephala), Rock Wrens (Xenicus gilviventris), and Silvereyes (Zosterops lateralis). Two other species of parrots regularly reported in the area besides Keas and Kakapo, are Kaka (Nestor m. meridionalis) and Parakeets (Cyanoramphus sp.).

Wild Life Service field expeditions have trapped rodents or reported rodent faeces on or close to Kakapo territories. Mustelid droppings have likewise been found throughout the Kakapo habitat. Ungulates are reported in the Milford and Transit areas but sign is at present scarse in many of these areas. In several of the higher altitude Kakapo territories deer (Cervus spp.) have not as yet penetrated and Chamois (Rupicapia rupicapia) are kept to low numbers with regular shooting by Forestry Department personnel.

Opossum (Trichosurus vulpecula) were liberated in the Milford Sound area last century and are slowly spreading throughout the Milford watershed,

especially on the warm dry faces which are favoured also by Kakapo. No opossum signs were collected in the Kakapo territories in the Transit Valley, nor in the head basins of the Sinbad and Poseidon valleys. Opossum sign, however, is widespread and abundant in the Tutoko, Gulliver and Experance territories.

D. Maud Island

Maud Island (Plate 3,p.14) of 330ha, lies at one point only one kilometer from the mainland which almost entirely encompasses the island. By sea, Maud Island is situated 15 kilometers from the township of Havelock at the head of Pelorus Sound.

The terrain of the Marlborough Sounds, although hilly and steep, is markedly different from Fiordland. It is of a lower profile and the rock type (undifferentiated Greywackes) are less stable than the Fiordland granites.

The region is extensively farmed. Most of the original forest has been burnt off and frequent burning off of scrub and bracken (Pteridium aquilinum) continues. Rainfall is considerably lower than in Milford Sound. In Nelson, the nearest city west of Maud Island an annual average of 999mm is recorded and in Blenheim to the east 664mm.

PLATE 3

(J.L. Kendrick)

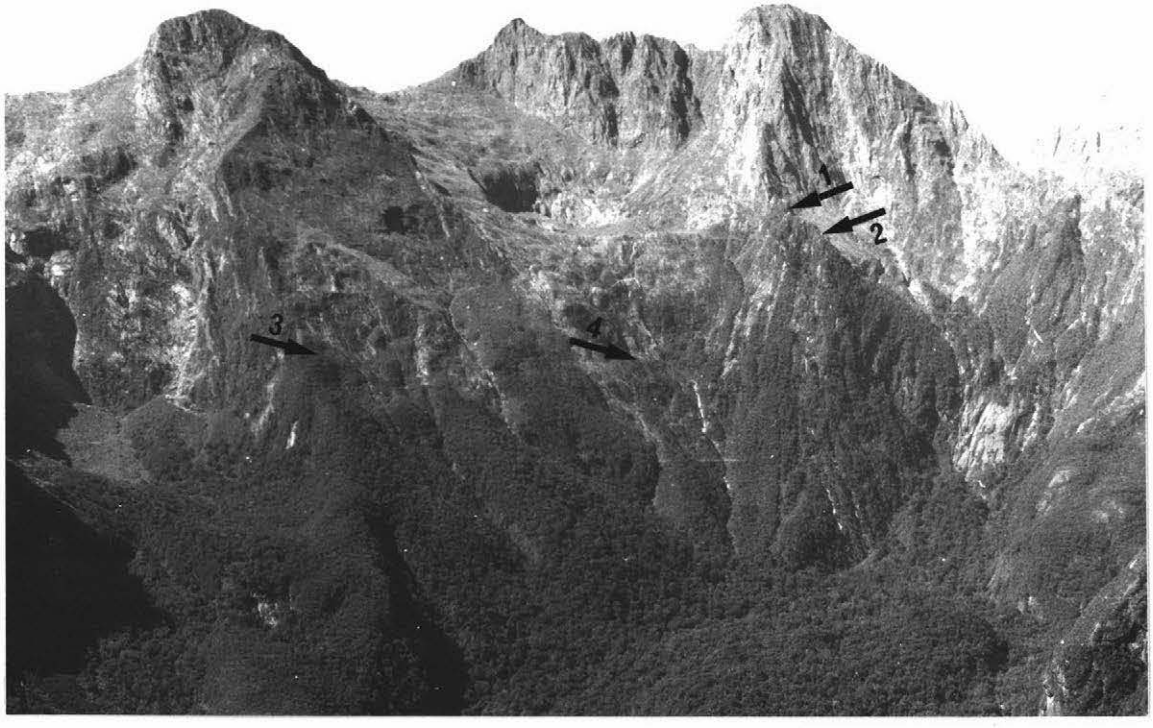
Maud Island

PLATE 4

(R.B. Morris)

Transit Valley, Fiordland

Positions of Kakapo track and bowl systems in territories 1, 2, 3 and 4 indicated


1
2
3
4

CHAPTER II

KAKAPO DISTRIBUTION AND TERRITORIES IN FIORDLAND AND MAUD ISLAND

A. Distribution

i) Historical

Confirmed reports of Kakapo sightings during the last ten years have come only from the Milford Sound region and Stewart Island. The Milford Sound Kakapo are a remnant population of this species which was wide spread in both North and South Islands (Williams, 1956). Even prior to European settlement the Kakapo population was declining in the North Island (Williams, 1956; Turbott, 1967; Atkinson, in prep.) and the last reports of their presence are from early this century. Drummond (1907) reported Kakapo in Northland and the south east coast of the North Island. Oliver (1955) noted that the last record was a sighting in the Kaimanawa Ranges in 1906. In the South Island, Haast reported in 1864 that Kakapo were confined west of the main divide except at Makarora above Lake Wanaka. Potts (1873) recorded Kakapo in Westland and O'Donoghue (1924) reported its presence in both Fiordland and Nelson. Williams (1956) suggests a number of reasons for the Kakapo decline: predators, in particular stoats; as well as competition for food, and perhaps disease. The original distribution of Kakapo on Stewart Island is unknown.

ii) Wild Life Service Search Program

Frequent expeditions by the Wild Life Service in search of Kakapo have been mounted since the late 1950s in the Milford catchment area. Over 38 expeditions are recorded in Wild Life files (46/61/1 and 25/3/4) prior to 1974, most of which were into the Tutoko and Sinbad valleys near Milford Sound.

Five Kakapo were trapped in the Tutoko Valley in 1961-62 and transported to Mt.Bruce in the Waiarapa where four died soon after but the fifth survived four and a half years. In retrospect these Kakapo expeditions added only snippets of information about Kakapo and their feeding signs. They tended rather to monitor the decline of the species in the Milford catchment area. Potts (1873) found Kakapo feeding signs on the river delta between the mouths of the Cleddau and Arthur Rivers where the airstrip now lies. In the 1950s and 1960s Wild Life Service personnel found that the Kakapo distribution had shrunk to the tributaries of these rivers, in particular the Tutoko Valley where feeding sign was found on open flats and debris fans in the upper reaches of this valley (Anderson, 1961; Morrison, pers.comm). Kakapo sign was also located on the flats and low altitude fans in the West Branch of the Cleddau, the Esperance Valley and the Sinbad Valley. In 1974 Kakapo sign had disappeared from all these low altitude sites with the exception of one bird found at the base of Mt.Tutoko (Plate 2,p.5).

At this time, November 1974, a fresh approach to the Kakapo conservation program was initiated by D.V. Merton (1975, 1976a,b) and with the aid of helicopter assistance an intensive search was undertaken in the most likely areas still harbouring Kakapo. This search has included visits into approximately two thirds of the valleys in the Milford catchment. These include the Stirling, Harrison, Bowen and Sinbad Valleys whose rivers drain directly into Milford Sound; the Cleddau with its eight main tributaries which include the Tutoko, Gulliver and Esperance Valleys; and the Arthur Valley where only four of the eleven valleys have been searched by ground parties, one of these being the Poseidon Valley (Fig.1,p.3). The search for birds has also extended south and west of the Milford catchment into the Poison Bay and Rugged Mountain area north of Sutherland Sound, the Dark and Light Rivers and the Glaisnock Wilderness area (Fig.1,p.3).

Old Kakapo droppings under dry overhangs and old track and bowl systems have been located in many of these regions such as the Harrison Valley, Surprise Creek, Poison Bay and Rugged Mountain areas but fresh sign has long since disappeared.

Although a total of fifteen Kakapo were found during the three year search program the disappearance or death of two birds (one in the Sinbad, the other in the Tutoko) and the removal of three birds from the Gulliver and Esperance Valleys to Maud Island,

resulted in the continuing presence of ten male Kakapo in four Fiordland valleys (Plate 2, p.5) at the end of March 1977.

B. Kakapo Territories

i) Location of Territories (Plate 2, p.5)

Of the fifteen occupied Kakapo territories located between November 1974 and February 1977 four birds were found in the Transit Valley (Plate 4, p.14) and the remainder in valleys of the Milford catchment. Feeding sign and droppings of one Kakapo were found in the Poseidon Valley in January 1977 (Buckingham, 1977; Gray, 1977b). Three Kakapo were seen in the Sinbad Valley between January and March 1975 (Gray, Merton and Morris, 1975; Russ, 1975) and subsequent observation of two of these birds continued to February 1977 (Roxburgh, 1975; Gray, 1977c; Morris, pers.comm.). In the Tutoko Valley four birds were located, one on the valley floor (McFadden, 1975; Gray, Merton and Morris, 1975), the remaining three on a spur and nearby bench, the latter a more gently sloping area on the mountain side 900-1100m above sea level. The three remaining Kakapo, all of which were removed to Maud Island, were located in the Esperance and Gulliver Valleys which like the Tutoko are tributaries of the Cleddau River.

With the exception of two birds, one on the floor of the Esperance Valley (Atkinson and Merton, 1974) and the second in the Tutoko (McFadden, 1975) no

Kakapo have been located on the valley floors in recent years. The remaining birds in the Transit (Anderson, 1975; Veitch, 1976a), Poseidon (Gray, 1977b), Sinbad (Gray, Merton and Morris, 1975), Tutoko (Scown, 1976; Morris, 1976), Gulliver (Nilsson, 1975), and Esperance (Atkinson and Merton, 1974) have all been located on ridges, benches or avalanche fans generally high on the sides of these valleys in comparatively inaccessable sites.

Since Potts' report in 1873, the Kakapo population in the Milford Sound area has steadily declined and currently is present in critically low numbers in small isolated groups at comparatively high altitudes.

ii) Topography of Kakapo Territories in the Transit, Poseidon, Sinbad and Tutoko Valleys.

a) Transit Valley. The Transit River runs into the sea 3km south of the entrance to Milford Sound and extends some 3km in a south easterly direction in from the coast before curving sharply to the south south west penetrating a further 7km inland (Plate 2,p.5).

The low 450m hills which flank the valley on the coast rapidly rise to 1500m and overlook a thickly forested valley floor. A large open river flat spreads across the lower reaches of the valley but further inland a continuous forest canopy covers the 0.3 to 0.8km wide valley floor below the area occupied by the four known Kakapo in the valley.

A comparatively short razor back ridge abutting the range of mountains on the true right of the Transit

Valley, about 8km from the coast, supported two Kakapo. This massive rock buttress reached an altitude of 1130m at its highest point before dropping to a pass 30m below and there fusing to the main mountain range.

Two track and bowl systems were located on this ridge (Plate 4,p.14). The first (Plate 5,p.22) included seven bowls along 30m of ridgecrest near the highest point (1100m). The second bowl system began 50m further down the ridge below the first system and extended along 75m of the ridge linking 19 bowls. Four bowls in the upper and four in the lower system appeared to be in use during January and February 1976 (Anderson, 1976; Veitch, 1976a).

The third track and bowl system (Plate 4,p.14) was found in the vicinity of a gently sloping but thickly forested ridge 1km north of territories 1 and 2 at an altitude of 680m while the fourth system, also at 680m lay at the base of the rock buttress on which birds 1 and 2 were present (Plate 6,p.22).

b) Poseidon Valley (Plate 2,p.5). This tributary of the Arthur Valley extends 7.5km to the north north west towards the Llawrenny peaks. To the west a 1650m peak separates the head of the Poseidon Valley from the Transit Valley and to the east the vertical rockface (750m) of Mt.Terror (1800m) overshadows the upper valley.

A small lake lies half way up the valley (350m a.s.l.) and a series of waterfalls cascade from the head basin in the upper reaches of the valley.

Feeding sign of at least one, possibly two Kakapo was found near two track and bowl systems in January 1977 on the true right of the valley in the vicinity of a small gut 2km to the south of the valley cirque.

c) Sinbad Valley. The Sinbad Valley separates Mitre Peak from the Llawrenny Peaks. Orientated in a west north westerly direction this 7km long valley opens onto Milford Sound at the foot of the Mitre Peak ridge.

Like the Poseidon this valley adjoins the Transit Valley, has no deer, and opossum are absent from the upper reaches of the valley although they have been reported near the valley mouth and are suspected to be spreading slowly.

Three Kakapo were located between November 1974 and March 1975 in the head basin but one of these was found dead in the winter of 1975. Two of three territories were established on a major razor back spur rising south south east towards the Llawrenny Peaks (Plate 7,p.23). This ridge supported a tongue of silver beech forest to an altitude of 925m. The steep rocky terrain and frequent avalanches may have prevented the establishment of beech forest in adjoining areas of comparable altitude.

The uppermost territory was sited on the bush line with all bowls except one being under a beech canopy. At this track and bowl system the bird occupied 18m of ridge crest but the feeding sign

PLATE 5

(R.S. Gray)

Transit Valley - track and bowl system number 1

Foreground (about measuring tape) clipped clear of much vegetation by Kakapo

PLATE 6

(R.S. Gray)

Transit Valley, Kakapo territory number 4

Hide (left centre), positioned to overlook track and bowl system in scrub

PLATE 7

(D.V. Merton)

Sinbad Valley - Kakapo territories

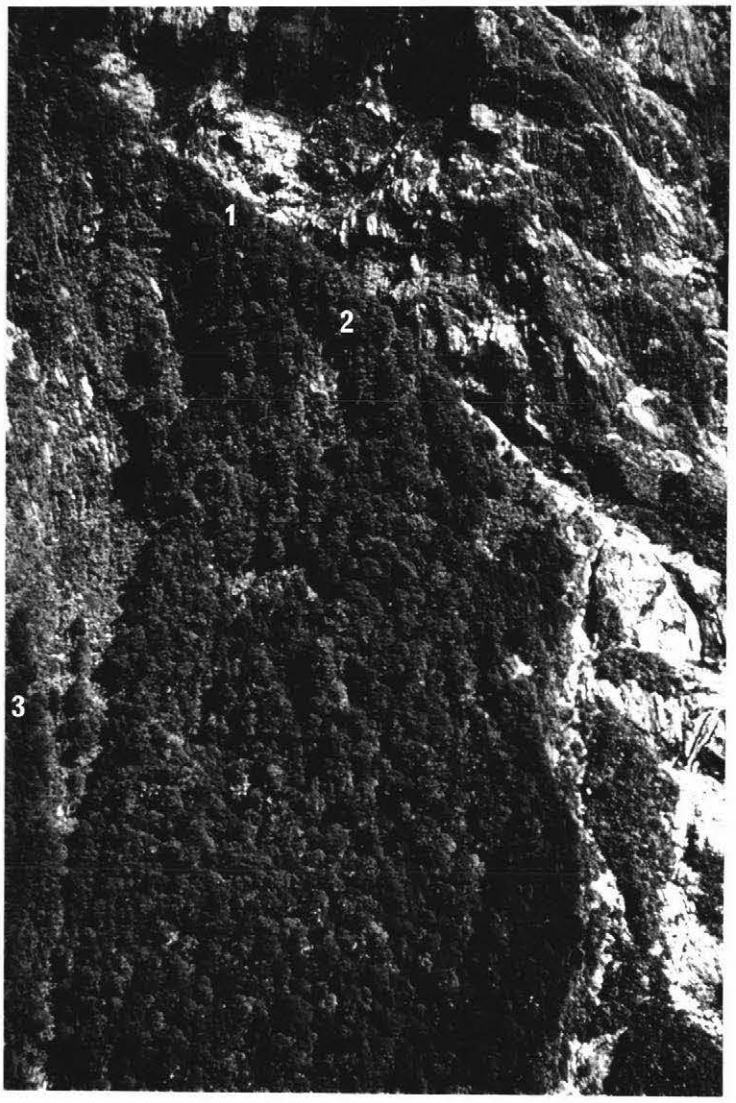
Nos. 1, 2 and 3 indicate general position of territories

PLATE 8

(R.S. Gray)

Tutoko Valley (Mt.Tarewa Spur) territory 1

Nos. 1 and 2 denote positions of track and bowl systems


1
2
3


2
1

extended down a further 20m. The lower territory (No.1) continued down the spur for 150m from an altitude of about 860m to 750m. Kakapo tracks and old bowls continued to below 650m a.s.l.

Following the death in the winter of 1975 of the bird in the lower territory only one territory existed on the ridge in the following two seasons.

The third territory was in such an area. The track and bowl system lay under a silver beech canopy on a steep minor ridge 0.5km east of the main spur at about 600m a.s.l.

Avalanches on either side of this minor ridge (on which track and bowl system 3 was situated) had wiped out the silver beech forest, and thick scrub was well established on the oldest of these sites. This 1.5ha area was known as the Kakapo Garden.

d) Tutoko Valley. The Tutoko Valley branches north from the base of the Cleddau Valley and penetrates 10km into the Darran Mountains. A small tributary, Leader Creek, flows west into the Tutoko River 5km up the valley. This creek and the upper half of the Tutoko Valley skirt the south and west sides of Mt.Tutoko (2770m), the highest peak in the Fiordland National Park.

One Kakapo was found in December 1974 on the morrain and avalanche debris at the foot of Mt. Tutoko and a year later in December 1975 three Kakapo were found on a 1.5km long bench (880-1120m) south of Leader Creek on the sides of Mts.Tarewa,

Mahere and Waitiri.

The main ridge of Mt.Tarewa which overlooks the Tutoko - Leader Creek junction was the site of territory 1 (Plate 8, p.23). Two track and bowl systems on the south face of this ridge between 1100-1200m were probably maintained by one Kakapo in December 1975 through to December 1976.

The upper of these two track and bowl systems, situated on a small south west sloping terrace above a steep broken rock face, was the highest occupied territory found in Fiordland (1200m). The terrace was strewn with rock, boulders and monoliths which were surrounded by a low but dense canopy of tussock and alpine scrub. The scrub was dense where sheltered by large rocks but the track and bowl system, however, had been excavated on an area where rocks were comparatively small and the vegetation predominantly grasses.

The second track and bowl system was about 50m of altitude below the upper system and was situated at the base of a steep bluff on the fringe of the silver beech forest.

The track and bowl system of the second Kakapo on the Tutoko High Bench (Plate 9, p.26) was located above a bluff at 1100m overlooking a lower silver beech covered section of the Bench beyond and below which lay the Tutoko Valley floor.

The third Kakapo occupied a track and bowl system 200m south of number 2 bird and 50m of altitude

PLATE 9

(R.B. Morris)

Tutoko High Bench

Track and bowl system number 2
located just above numeral 2

PLATE 10

(R.S. Gray)

Poseidon Valley - Kakapo feeding
area on alluvial fan


2

lower (1050m) on a minor ridge overlooking one of the small creeks crossing the bench. The well developed tracks were situated in comparatively dense scrub about 50m above bush line.

C. Kakapo and Maud Island

i) Suitability of Maud Island.

Due to the decline of Kakapo in the Fiordland valleys and their disappearance from all other regions, with the exception of Stewart Island, it was considered essential for the preservation of this species to move several birds to an off shore island free of predators and yet where the Kakapo feeding and breeding requirements would be catered for (Merton, 1976a).

Surveys of likely islands were carried out by Atkinson and Williams (1971, 1972). Maud Island was selected for several reasons: the absence of opossum, rats, mice and cats; the flora, though modified by burning and over sown with pasture grasses, included several stands of forest; and Kakapo food plants bracken, *Coriaria arborea*, hinau (*Elaeocarpus dentatus*), grasses and moss, as recorded by early observers, also grow on the island.

The island was bought from Mr.E.J.T. Shand by the Crown and the Royal Forest and Bird Protection Society of New Zealand in 1975 and is now a Reserve in the Marlborough Sounds Maritime Park (Merton, 1976c) for the Preservation of Flora and Fauna.

ii) Introduction and Establishment of Kakapo.

Three male Kakapo have been released on the island. Two of the birds, captured in the Esperance Valley, were released in April 1974. A third Kakapo, caught in the Gulliver Valley was released in March 1975 (Merton, 1976c).

The distribution of Kakapo feeding sign and droppings was noted during 1975 and 1976. It appeared that the birds enlarged their feeding range during this time (Chapter VI).

iii) Island Management and Stock.

In 1974 when the first two Kakapo were introduced, the island was being farmed. Cattle and sheep were grazed over the island, except for an 80ha reserve donated by Mr Shand 4 years prior to his selling Maud Island to the Crown. This reserve whose boundary is roughly outlined by the Ring Road occupied the central higher parts of the island (Fig.2,p.6). The road, cut around the contour of the steeply sloping terrain was to act as a 'fence'. The steep inner bank helped prevent stock climbing from the pasture below to the less fertile bracken covered slopes above.

Regeneration in these reserve areas was gradual due to the periodic invasion by stock but between 1975 and 1977 stock were removed from the island and active regeneration is well underway.

CHAPTER III

VEGETATION IN FIORDLAND KAKAPO TERRITORIES

A. Methods

i) Profile diagrams

Diagramatic representations of the vegetation, its structure, comparative height, predominant species and slope of the terrain across feeding areas and track and bowl systems is presented in 13 profile diagrams (Figs.3-12).

Specimens of the plant species recorded were obtained by permission of the Fiordland National Park Board. These plants were retained firstly for identification and confirmation of scientific names and secondly for the plant cuticle reference collection (Chapter VIII).

Data for 5 profile diagrams was obtained in the Transit Valley, 4 on the Tutoko High Bench and one in the Gulliver Valley.

A measuring tape calibrated in meters was stretched between two points A and B situated between 8 and 25m apart.

The species, the height and the structure of each plant was noted as it crossed the tape. In addition all species within 50cm of the tape were recorded. Three profile diagrams were obtained on Maud Island.

ii) Point intercept transects.

Plant species occuring at regular intervals

(in this study either 0.5m or 1.0m intervals) were noted along a transect line linking two points, A and B (Robbins, 1962).

With the knowledge and experience gained from the profile diagrams a more comprehensive study of the alpine scrub and high altitude beech forest occupied by Kakapo was undertaken in January and February 1977. These transects enabled the percentage cover of plant species to be estimated and species were again collected for the cuticle reference collection.

Six transects of 100-180 points and one transect of 63 points were undertaken in the 4 known valleys containing Kakapo in 1977. One transect was in the Tutoko Valley, two in the Transit Valley, two in the Poseidon Valley and two in the Sinbad Valley. Four of these transects passed through combined feeding areas and track and bowl systems. The remaining three spanned areas where Kakapo feeding sign was located.

The technique follows that used by Johnson (1976a) in the Sinbad Valley territories. At each transect point the presence of plant species comprising the canopy, the predominant ground cover, and plants occupying three tiers (0-30cm, 30-60cm and those above 60cm)were recorded.

This method demanded a close study of the vegetation within one meter of the ground where generally the variety of species is greatest and where Kakapo can be expected to obtain a large proportion of their diet.

B. Transit Valley.

i) General Vegetation description.

A brief description of the vegetation of the Transit Valley is included in the paper on Forests in Northern Fiordland, (Wardle, et al., 1971). No specific description of the valleys vegetation was given although the presence of silver beech - rata (Metrosideros umbellata)- kamahi (Weinmannia racemosa) - mountain beech (Nothofagus solandri var. Cliffortiodides) forest and tall Senecio scrub was noted (Wardle, et al., 1971). Beech forest (Nothofagus spp.) appears to cover most of the valley floor and where terrain permits, the beech forest rises to the expected tree line (c.1000m).

In the vicinity of the Kakapo territories the tree limit is of variable altitude (680-1050m) because of the steep rugged nature of the topography. Silver beech is the predominant canopy tree of the forest at tree line and may be classified as silver beech - Archeria - Senecio forest (association C1, Wardle, et al., 1971) and beech - Coprosma forest (association C2, Wardle, et al.,1971). The silver beech - Coprosma forest association is present as the tree line forest at low altitude e.g. Territory 4 (680m) where bluffs restrict higher altitudinal extension of the forest.

Thick Senecio - Dracophyllum - Olearia scrub (canopy height average 2m) occupies much of the steep terrain in areas where silver beech forest is

absent below 1050m. Exposed unweathered rock faces and avalanche scars are numerous between territories 1 and 3. Tussocks, grasses and herbaceous species are common on many of these sites.

ii) Territories.

a) Territory 1 and 2

Map Reference:	NZMS 1 S112 763104
Vegetation:	Tussock and alpine scrub
Site Type:	Prominent rock buttress
Altitude:	1100m
Slope/Aspect:	30° E-W

General Vegetation: From the valley floor 900m below the track and bowl systems of Kakapo 1 and 2, broken tongues of silver beech rise to the expected tree line altitude of 1000m despite the steep terrain. Above the tree line alpine scrub replaces beech forest wherever the substrate is suitable and encompasses the exposed, near vertical rock faces and rock outcrops which stud the higher reaches of the ridge. Grasses, predominantly Chionochloa crassiuscula and C. flavescens, cover the more gently sloping terrain south of the ridge above bush line and extend up the southern face to occupy small areas of the ridge west amongst the thick scrub.

General composition of alpine scrub:

Canopy height:	0.01 - 3.5m
General height:	1 - 2m

Four shrub species dominate the canopy on the sunny north face of the ridge, Coprosma crenulata, Dacrydium biforme, Dracophyllum longifolium and

D. uniflorum. Other common species were Senecio bennettii, Pseudopanax colensoi var. ternatum, Coprosma crenulata, C. astonii, Hebe subalpina and H. cockayniana. Flax (Phormium cookianum), Chionochloa flavescens and Astelia nivicola play minor roles as canopy species. A discontinuous and sparse understorey is present and includes Celmisia lanceolata, Anisotome haastii, Blechnum capense, Gaultheria crassa and Coprosma spp.

The vegetation cover varies on the shady damp southern side with Dracophyllum menziesii, D. fiordense and Olearia colensoi the predominant canopy species. Senecio scorzoneroides, S. lyallii, Anisotome haastii, Celmisia ramulosa, C. walkeri, Astelia nivicola and large Chionochloa flavescens clumps are common. Podocarpus nivalis is a notable absentee in the region.

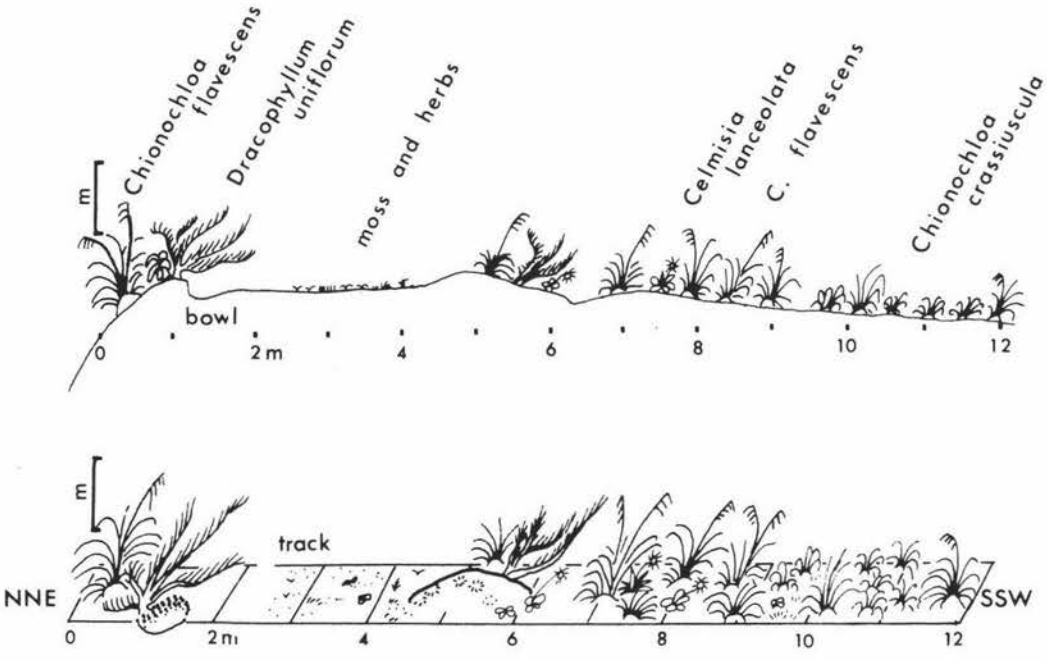
Along the ridge crest several small areas have been extensevely clipped by the Kakapo in and around the vicinity of the bowls (Plate 5,p.22).

Profile diagrams: Territories 1 and 2

The territory 1 profile diagram (Fig.3,p34) span parts of the same track and bowl system. Diagram 1 crosses the ridge crest (see Plate 5,p.22), and diagram 2 spans a small plateau on the north face of the territory just below the ridge crest.

A total of 37 species were recorded within 50cm of the tape along the first profile line in comparison

TRANSIT VALLEY
Territory 1, Profile diagram 1.



Territory 1, Profile diagram 2.

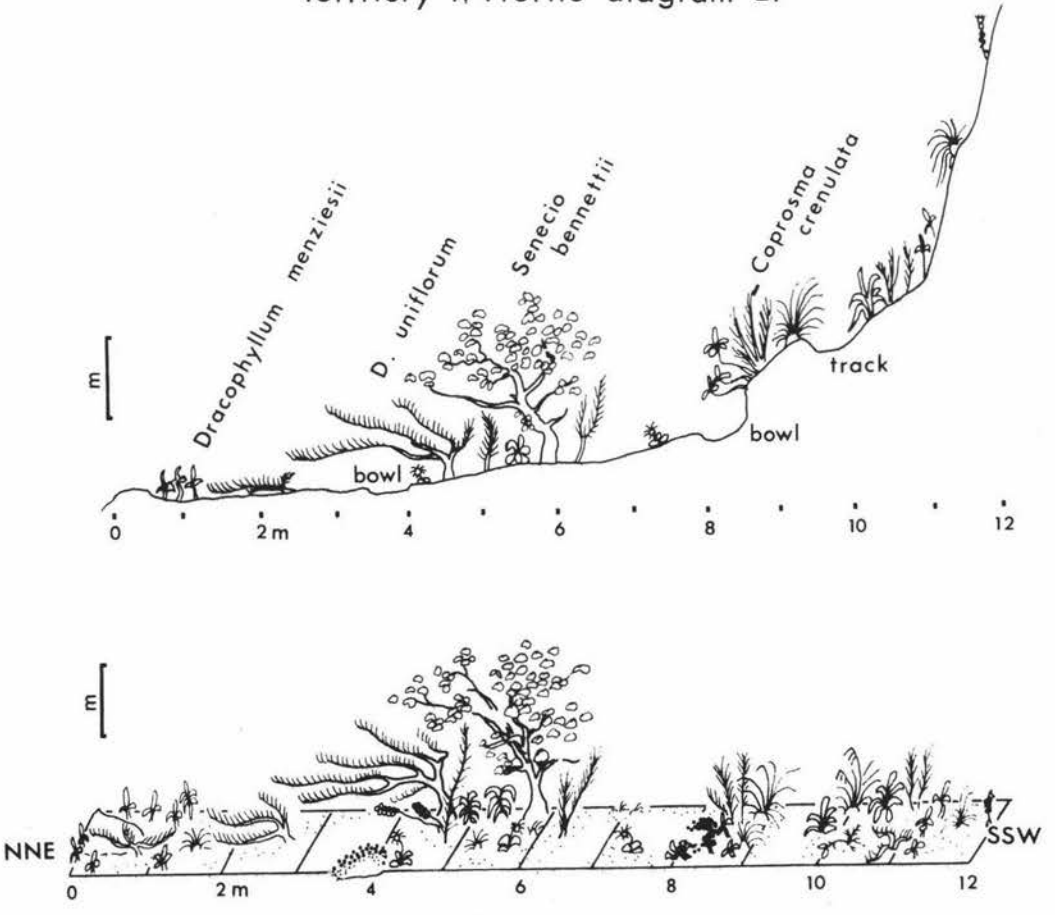


Fig. 3

TRANSIT VALLEY
Territory 2. Profile diagram 1.

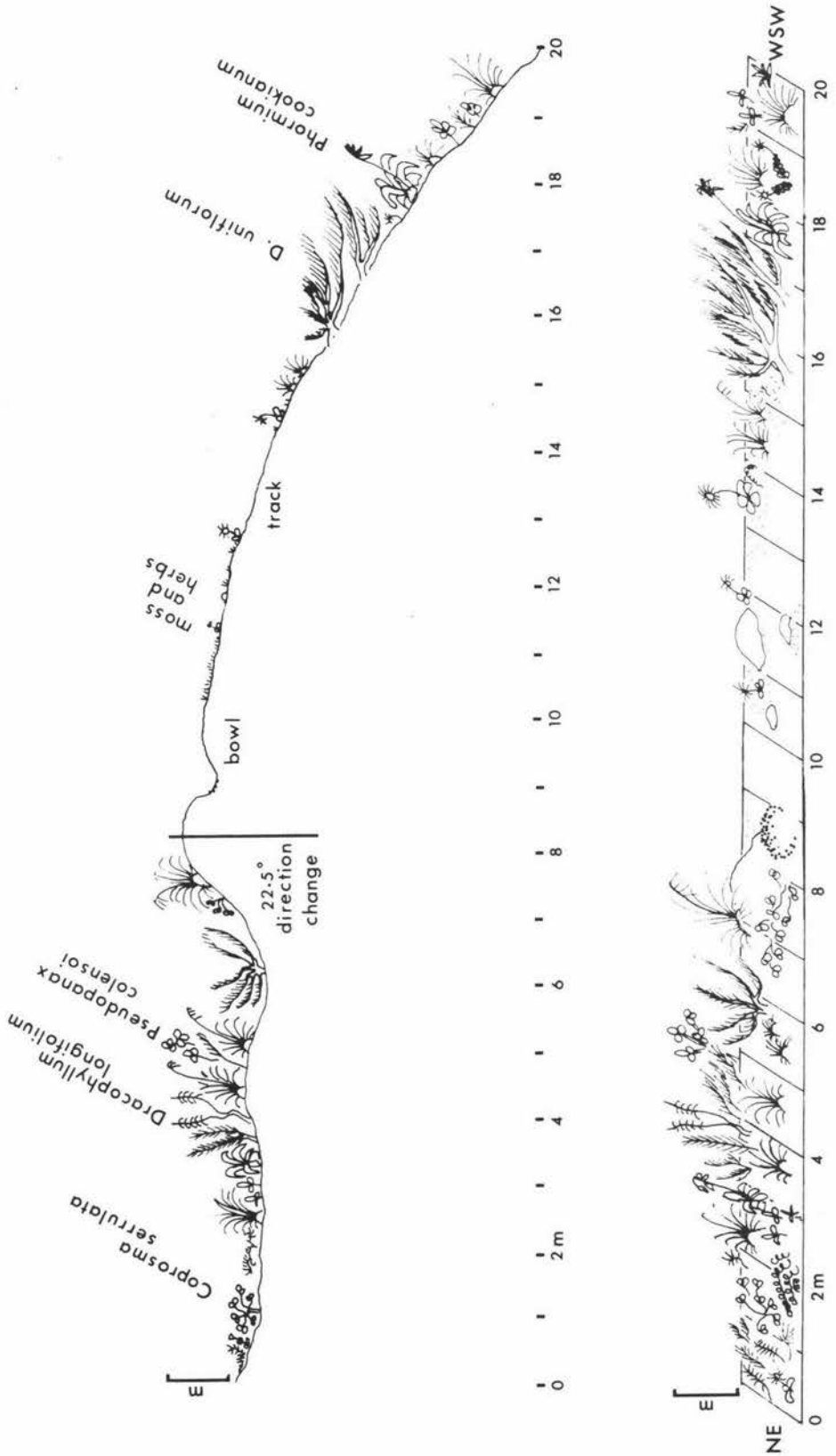


Fig. 4

to 21 species along a similar distance in the vicinity of profile diagram 2 (Fig.3,p.34).

In territory 2 the profile diagram (Fig.4,p.35) spans the track and bowl system on the ridge crest below territory 1.

Plant transects: Territory 1.

Point intercept transect involved two parallel lines across ridge crest:

Line 1, 18.5m; line 2, 12.0m; total transect 30.5m; 63 points, points 0.5m apart; direction, N-S.

A total of 50 vascular plants was recorded across the transect:

Woody shrubs 11, grasses 6, herbs and ferns 33.

Canopy height:

Range 0 - 1 meter.

Canopy composition:

Overall cover 94%, bare earth 4.5%, litter 1.5%, shrubs 14%, grasses 41.5%, herbs and ferns 16.0%, Cryptogams 22.5%.

Major canopy species:

Chionochloa crassiuscula 27%
Chionochloa flavescens 14% Rhacomitrium sp. 13%
Dicranoloma sp. 6.3% Dracophyllum uniflorum 6.3%
A further 12 species occupied 27% of the points.

Vegetation over 60cm:

At only 13% of the points was cover over 60cm this was predominantly C. flavescens which reached about 1m.

Vegetation between 60 - 30cm:

Plant covered 19% of the transect points
C.flavescens 13% D.uniflorum 4.7%
Olearia colensoi 1.3%

Vegetation between 30 - 0cm:

Plants covered 59% of the transect points

C. crassiuscula 24% D. uniflorum 8%

A further 10 species occupied 27% of the points.

Ground cover:

Overall cover 80%

Exposed rock 2%, exposed earth 9%, litter 9%

Cryptogams 53%, Astelia linearis 6.0%

A further 9 species occupied 21%.

b) Territory 3.

Map Reference:	NZMS 1 S112 764118
Vegetation:	Silver beech - rata - Coprosma forest
Site type:	Ridge of gentle slope
Altitude:	650m
Slope/Aspect:	20° N-W

General Vegetation: Territory 3 is situated on a thickly forested ridge of gentle slope 1km north of territories 1 and 2 (Plate 4,p.5).

Silver beech is the predominant canopy species but co-dominants, rata and broadleaf (Griselinia littoralis) are present as canopy species on the ridge west and down the steep, near vertical north face. Coprosma astonii and C. foetidissma along with Pseudopanax colensoi and P. simplex are principle shrubs. The ground cover consists of cryptogams, litter, Astelia nervosa and Uncinia sp. (Profile diagram, Fig.5,p.38).

Wardle, et al., (1971) classified this association as silver beech - Coprosma forest.

The track and bowl system on the ridge extended

TRANSIT VALLEY
Territory 3, Profile diagram

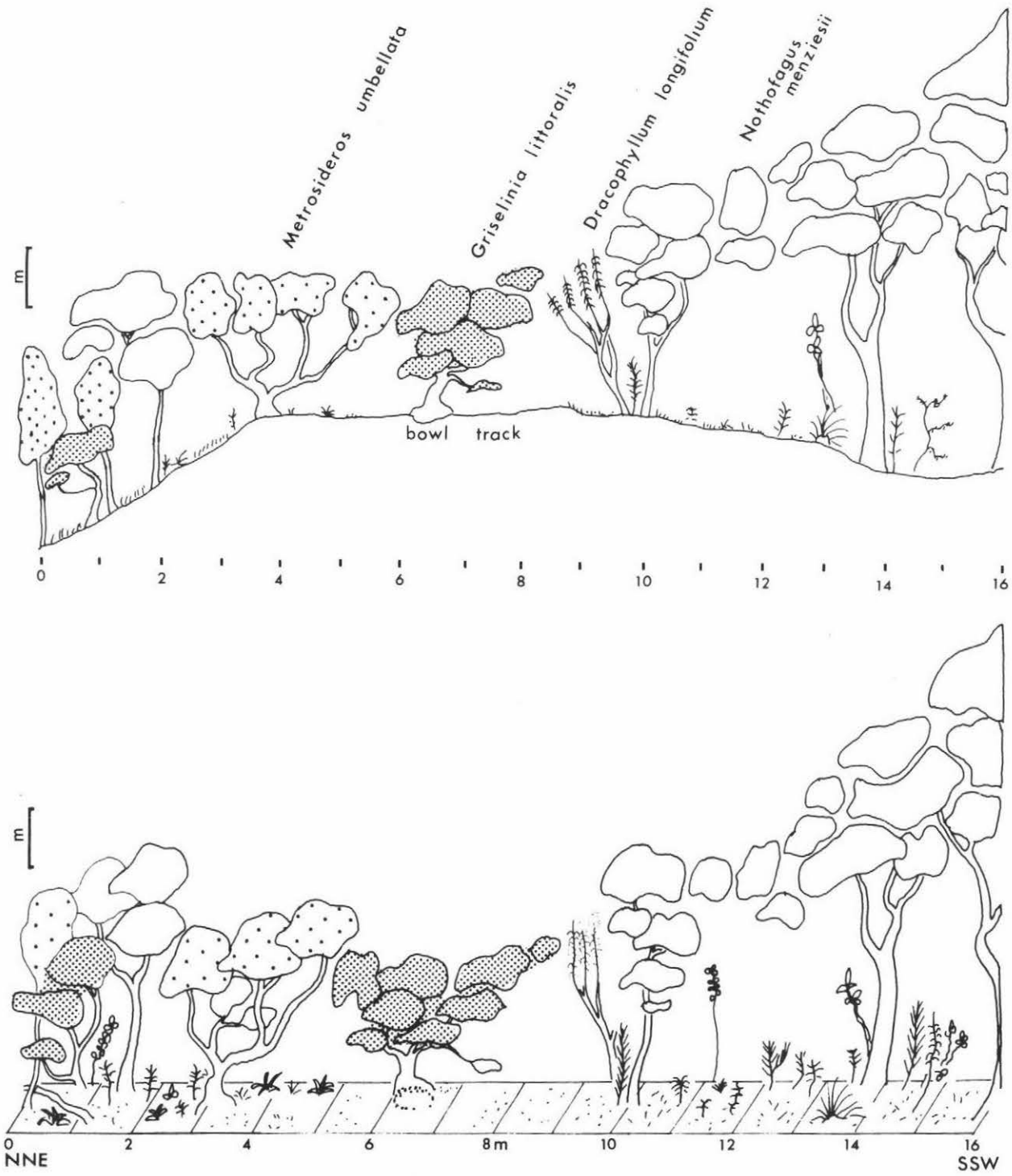


Fig. 5

along the crest for about 270m (550-680m a.s.l). Twenty four bowls were found along the ridge but only two appeared to be in use in March 1976.

Above the upper bowls shrub density increased and the forest structure resembled the silver beech - Archeria - Senecio forest (association C1, Wardle, et al. 1971) for about 30m before the silver beech canopy ceased as the slope of the ridge increased from 15° to 45°. Low Olearia colensoi scrub became the main canopy species.

c) Territory 4.

Map Reference:	NZMS 1 S112 763109
Vegetation:	Regenerating scrub and beech forest
Site Type:	Base of bluff, old rock falls and alluvium.
Altitude:	680m
Slope/Aspect:	10° E-W.

General Vegetation: Territory 4 is situated in an area where bush line was restricted to a comparatively low altitude (680m). Bluffs, 300m high, form the eastern boundary of the territory and determine the limit of beech forest. Presumably in the past rock falls from these bluffs had destroyed an area of 2ha and thick Dracophyllum scrub and grasses covered this area (Plate 6,p.22) (Profile diagram. Fig.6,p.40). Above the bluffs a small cirque, which contains a small unnamed lake, acts as a buffer to snow avalanches falling from the surrounding higher peaks (Plate 4,p.14) seepage from the bluffs and water flow following wet weather

TRANSIT VALLEY
Territory 4. Profile diagram

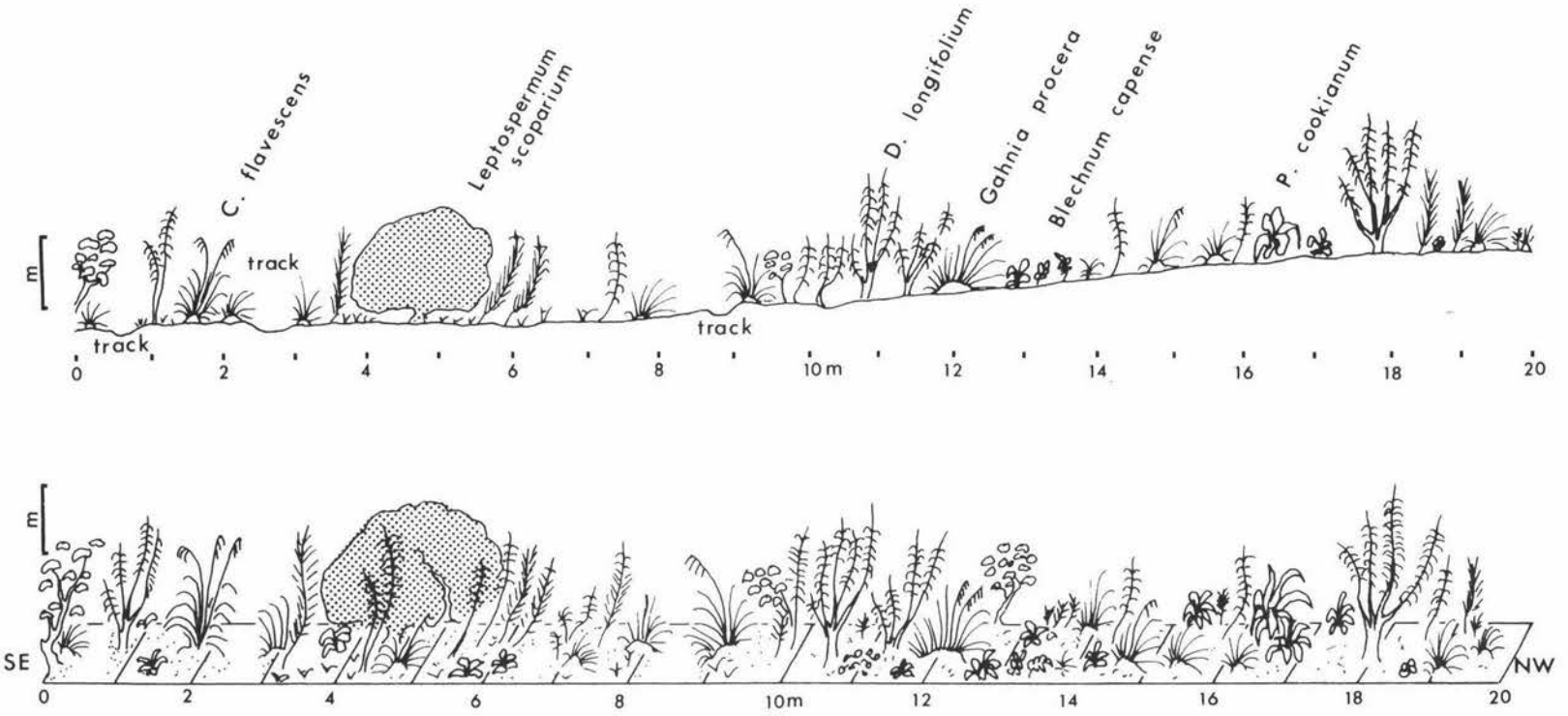


Fig. 6

has cut a small but deep stream bed between the rock face and avalanche debris. The resulting west bank of this stream bed takes on the appearance of a small ridge and it is along this that the track and bowl system has been developed.

Silver beech surrounds the 2ha area of scrub, except on the eastern side, and forms a continuous cover, down the steepening slope below the 'garden' area to the valley floor.

Plant transect:

Point intercept transect through track and bowl system and feeding area:

Transect 50m, 100 points, points 0.5m apart; direction of transect, SE-NW.

Total number of vascular plants recorded across transect: 44.

Canopy height:

Range 0.4 - 2.25m

General height 1 - 1.5m.

Canopy composition:

Overall cover 99%

Rock 1%, shrubs 62%, grasses 21%, herbs and ferns 15%, Cryptogams 1%.

Major canopy species:

Dracophyllum longifolium 27%

Chionochloa flavescens 15% Olearia colensoi 13%

Phormium cookianum 9% Pseudopanax colensoi 7%

Senecio bennettii 7% Gahnia procera 6%

Astelia nivicola 5%

A further 8 species occupied 10%.

Vegetation over 60cm in height:

Cover 69% : D. longifolum 23%

C. flavescens 13% P. cookianum 10%

O. colensoi 9% S. bennettii 7%

Four other species occupied 7% of the points.

Vegetation between 60 - 30cm:

Cover 86%

C. flavescens 16% D. longifolium 13%

P. cookianum 13% Blechnum procerum 11%

Astelia nervosa 8% G. procera 7%

A remaining 12 species occupied 19%

Vegetation between 30 - 0cm:

Cover 94%

B. procerum 28% C. flavescens 13%

A. nervosa 9% Gaultheria crassa 6%

P. cookianum 6% Lycopodium scariosum 5%

10 more species occupied 19%

Ground cover:

Cover 96%

Cryptogams 46%, Hymenophyllum 8%, litter 33%, open rock 4%

A further 6 species occupied the remaining points.

C. Poseidon Valley.

i) General vegetation description.

A canopy of silver beech covers much of the Poseidon Valley floor. From the air this canopy appears continuous in the lower half of the valley below a small unnamed lake. Above the lake lacebark (Hoheria glabrata), broadleaf, Fuchsia, Senecio and Olearia replace much of the silver beech canopy on the numerous talus slopes and avalanche prone areas. In the vicinity of the Kakapo territory the silver beech - rata forest extends to the top of the waterfalls which drain the head basin (680m) where the forest is replaced almost totally by mixed

Hoheria scrub, grasses, Sphagnum bog and herb field. Numerous small creeks cross this area.

On the exposed unweathered rock slopes below the cirque alongside the waterfalls of the main river which leave the head basin the canopy consists of manuka (Leptospermum scoparium) along with Dracophyllum - Senecio - Olearia scrub.

Kakapo sign was located in this area on Dracophyllum fiordense, D. longifolium and D. menziesii. The timber line is of variable altitude depending on slope, aspect, substate and susceptibility to avalanches. In fact at only one site in the upper reaches of the valley does silver beech rise to the expected timber line height at 1050m. Kakapo feeding sign was found in this area.

ii) Territories.

a) Feeding area 1

Map Reference:	NZMS 1 S120 and 121 784098
Vegetation:	Tussock grassland and alpine scrub
Site Type:	Minor ridge crest overlooking deep defile
Altitude:	950 - 1075m
Slope/Aspect:	10 - 30° NW-SE.

General Vegetation: Above bush line, on a ridge of gentle slope, a variety of plants were found to have been chewed by Kakapo. This ridge formed the southern boundary of a small terrace which overlooked a narrow precipitous defile to the south. Several small stands of silver beech were well established and are regenerating laterally on the lower reach of

the terrace. Here the bush line reaches the highest altitude in the upper half of the Poseidon Valley at 950m as a result of the sunny aspect and gentle slope.

On the bluffs below the terrace the canopy is still discontinuous and forms a mosaic of silver beech, alpine scrub and open rock face.

Above tree line winter snow is probably responsible for a mixed cover of tussock grassland and mixed alpine scrub. Several small basins have a thick scrub canopy but much of the terrace is open tussock with odd shrubs and alpine herbs.

Plant transect: (feeding area 1)

Point intercept transect:
50m, 100 points, points 0.5m apart, direction ESE-WSW

Total number of vascular plants recorded across transect: 51
A further 12+ species nearby

Canopy height:
Range 0.01 - 1.5m
General height 0.7m

Canopy composition:
Overall cover 94%
Litter and rock 4%, woody shrubs 42%, grasses 43%, herbs and ferns 9%, Cryptogams 2%.

Major canopy species:

Chionochloa flavescens	39%
Gaultheria crassa	13%
Dracophyllum menziesii	12%
Pseudopanax colensoi	6%

A further 12 species occupied 23% of the points.

Vegetation over 60cm:

Cover 33%

Chionochloa flavescens 13%

Dracophyllum menziesii 7%

Pseudopanax colensoi 5%

A further 5 species occupied the remaining 8 points.

Vegetation between 60 - 30m:

Cover 71%

C. flavescens 33% D. menziesii 15%

A further 23% was occupied by 11 species.

Vegetation between 30 - 0cm:

Cover 87%

Gaultheria crassa 18% C. flavescens 11%

D. menziesii 10% Celmisia petriei 7%

Coprosma serrulata 7% Senecio lyalli 5%

A further 29% of points were occupied by 16 species.

Ground cover:

Overall cover 56%

Cryptogams 28%, Hymenophyllum multifidum 15%, litter 32%, exposed rock 12%

A remaining 13% of points was occupied by 9 species.

b) Feeding area 2

Map Reference:	NZMS 1 S120 and 121 790097
Vegetation:	Regenerating scrub and silver beech forest
Site Type:	Alluvial fan, terrain generally unstable
Altitude:	550 - 610m
Slope/Aspect:	20° E-W.

General Vegetation: Alluvium washed down from a narrow deep defile has resulted in the formation of a typical triangular (delta) shaped fan of about 6ha

(Plate 10,p.26). Silver beech forest apparently spreading from the sides and base of the fan is established on about half this area. On the remaining 3ha, the upper section of the fan, regenerating shrub and grasses form a discontinuous cover because of the interlacing stream beds. Waterflow fluctuated with rainfall and flood damage on the fan is common.

Although the predominant canopy species in the forest surrounding the fans is silver beech the forest can be further classified into 3 associations (Wardle, et al., 1971).

The first is silver beech - Archeria - Senecio forest (association C1, Wardle, et al.,1971). This forest type occupies the northern ridge overlooking the fan on which track and bowl system 1 is situated. The 8m high canopy is occupied by silver beech and a dense shrub layer of Archeria traversii, Coprosma foetidissima, C. pseudocuneata, Griselinia littoralis, Pseudopanax colensoi, P. crassifolium and Senecio bennettii. Ground cover consists of Cryptogams, filmy ferns (Hymenophyllum spp.), Uncinia sp., Astelia nervosa and Phormium cookianum.

The second is silver beech - Coprosma forest (association C2, Wardle, et al.,1971). This is the most common forest association in the vicinity of the fan. It replaces the silver beech - Archeria - Senecio forest on the higher regions of the ridge north of the fan and extends down the northern side across the base of the fan and along the southern

edge, except where interrupted by dense Olearia, Fuchsia, and Coprosma scrub. An important component of this silver beech - Coprosma forest about track and bowl system 2 is the rata and kamahi to a lesser extent. The importance of rata as a canopy species increases on steeper rocky sites.

The canopy height was 20m at the base of track and bowl system 2. The main scrub species consisted of young kamahi, broadleaf, Coprosma astonii, C. pseudocuneata and Pseudopanax simplex. Ground cover includes Astelia nervosa, Blechnum fluviatile, Polystichum vestitum and Uncinia sp.

The third association is the silver beech - lacebark - Polystichum forest (association P2, Wardle et al.1971). This forest was found across the lower reaches of the fan close to the Poseidon River.

Plant transect (feeding area 2)

Point intercept transect:
180m, 180 points, points 1m apart, direction N-S across contour.

Total number of vascular plants recorded across transect: 50
A further 15 species were noted in the near vicinity

Canopy height:
Range 0.01 - 15m
General height of scrub 1 - 3m

Canopy composition:
Overall cover occupied 49.5% of points, Open rock 50.5%, trees and shrubs 42.8%, grasses 4.4%, herbs and ferns 2.3%.

Predominent canopy species:

Senecio bennettii 10% Olearia ilicifolia 7.2%
Fuchsia excorticata 5%
A further 27% of the points were occupied by 16 species.

Vegetation over 60cm in height:

Overall cover 33%
Senecio bennettii 6.7%
Griselinia littoralis 6.1%
A further 13 species occupied 22.2%

Vegetation between 60 - 30cm:

Cover 36.0%
Chionochloa conspicua 5.5%
The remaining 30.5% of the cover was occupied by 15 species.

Vegetation between 30 - 0cm:

Overall cover 39.4%
Coriaria plumosa 8.9% Blechnum procerum 6.1%
Polystichum vestitum 6.1%
A further 14 species occupied 18.3%

Ground cover:

28% of the points covered
Rock 61%, litter 11.0%, Cryptogams 20%.
A further 6 species occupied 8% of cover.

The 180m transect was orientated to span the area where feeding sign was most common. The terrain was comparatively unstable and 50.5% of the transect points passed over unvegetated, loose, unweathered rock alluvium (hornblende-garnet gneiss). The transect included a greater proportion of early scrub plant species (mosses, lichens, grasses, Raoulia tenuicaulis and Epilobium spp.) than is found lower down the fan where Olearia-Senecio scrub canopy formed a more continuous cover.

Of the 180 transect points 49.5% are covered by a plant canopy, 10% of which is composed of Olearia arborescens and O. ilicifolia, Senecio bennettii occupies a further 10% of the transect points while Fuchsia, Griselinia littoralis, Hebe salicifolia, Myrsine divaricata, Pseudopanax colensoi, Coprosma spp. and Coriaria plumosa occupy collectively 23% .

D. Sinbad Valley.

i) General vegetation description.

Silver beech forest covers the valley floor from the mouth of the valley to the head basin. As in the Poseidon and Transit Valleys, steep terrain and avalanches limit forest establishment, particularly on the steep faces of Mitre Peak on the northern side of the valley. At the mouth of the valley forest does rise up to approximately 900m on the Footstool - part of the main Mitre Peak ridge. The low slopes of the Llawrenny Peaks on the southern side of the valley enable a little forest and much scrub to cover the avalanche scarred mountain side.

The 3 birds located in the Sinbad Valley in the 1974-75 seasons were all in the head basin. Two birds occupied areas on a ridge which carried a tongue of silver beech forest to an altitude of 925m, far above the avalanche prone sites alongside (Plate 7,p.23).

East of this ridge 80° - 90° slopes restricted the establishment of forest until at an altitude of

625m avalanche debris fans and talus slopes formed a more suitable substrate and slope for the establishment of scrub and forest.

ii) Territories.

a) Kakapo Ridge

Map Reference:	NZMS 1 S112 797149
Vegetation:	Silver beech forest
Site Type:	Razor back spur
Altitude:	650 - 925m
Slope/Aspect:	45° N-S

General vegetation: This has been described in detail by Johnson (1976a). Silver beech is the dominant canopy species reaching a height of 8m. The forest is similar to that described by Wardle, et al. (1971) as a silver beech - Archeria - Senecio forest (association C1). At lower altitudes this association merges into a silver beech - Coprosma forest (association C2; Wardle, et al.,1971).

Plant transect:

Point intercept transect:

100m, 100 points, points 1m apart, direction N-S up ridge crest.

Total number of vascular plants recorded across transect: 31 (Johnson, 1976a records a total of 41 species on the ridge)

Canopy height:

Range 0 - 10,
general height of forest 8 - 10m

Canopy composition:

Overall cover occupied 99%
Open 1%, trees and shrubs 95%, grasses 1%, herbs and ferns 3%.

Predominant canopy species:

Nothofagus menziesii 80%

Pseudopanax simplex 7%

A further 11 species occupied 12 points.

Vegetation over 60cm in height (shrub layer)

Overall percentage cover 72%

Pseudopanax simplex 15% Griselina littoralis 10%

Coprosma foetidissma 7% Gaultheria rupestris 7%

Archeria traversii 5% Metrosideros umbellata 5%

Myrsine divaricata 5% Senecio bennettii 5%

A further 6 species occupied 13% of the transect points.

Vegetation between 60 - 30cm:

Cover 68%

Coprosma foetidissma 19% S. bennettii 9%

Coprosma pseudocuneata 6% G. littoralis 6%

A. traversii 5% Gaultheria rupestris 5%

12 species occupied a further 18% of the points.

Vegetation between 30 - 0cm:

Cover 77%

Blechnum procerum 17% Astelia nervosa 15%

Coprosma foetidissma 6% Phormium cookianum 6%

A further 17 species occupied the remaining 33%.

Ground cover:

Cover 64%

Cryptogams 35%, Hymenophyllum multifidum and H. sanguinolentum 25%, Uncinia sp. 3%, B. procerum 1%, litter 35%, open 1%.

b) Kakapo Garden

Map Reference:	NZMS 1 S112 799149
Vegetation:	Regenerating scrub avalanche detritus fan
Altitude:	600m
Slope/Aspect:	20° N-S

General vegetation: Johnson, (1976a) records a

total of 98 vascular plants species on this 1.5ha. fan at the base of Kakapo ridge. Canopy height had a mean of 2.5m and the canopy was shared by a variety of shrub species. Of the 37 tree and shrub species, 22 bear fleshy fruits.

Plant transect:

Point intercept transect 1 :
100m, 100 points, points 1m apart, direction NW-SE.

Total number of vascular plants recorded across transect: 55 (Johnson, 1976a records 98 in general area).

Canopy height:
Range 0.01 - 10m
General height 1 - 2m

Canopy composition:
Overall cover 99%
Open rock 1%, trees and shrubs 90%, grasses 0%, herbs and ferns 8%, moss 1%.

Predominant canopy species:

Olearia arborescens	17%	Myrsine divaricata	9%
Aristolelia fruticosa	7%	Fuchsia excorticata	7%
Pittosporum colensoi	7%	Hoheria glabrata	6%
Blechnum procerum	5%	Coprosma rugosa	5%
Nothofagus menziesii	5%	Pseudopanax colensoi	5%

A further 14 species occupied 26% of the points.

Vegetation over 60cm in height:
Cover 73%

O. arborescens	17%	Griselinia littoralis	10%
M. divaricata	8%	A. fruticosa	7%
F. excorticata	7%	P. colensoi	5%

A further 11 species occupied 20% of the points.

Vegetation between 60 - 30cm:

Cover 77%

O. arborescens 18% M. divaricata 8%
A. fruticosa 7% G. littoralis 7%
Coprosma foetidissma 6% B. procerum 5%
A further 15 species occupied 26 points.

Vegetation between 30 - 0cm:

Cover 91%

B. procerum 36% Polystichum vestitum 20%
Astelia nervosa 8% O. arborescens 7%
Phormium cookianum 5%
A further 10 species occupied 15% of the points.

Ground cover:

Cover 59%

Cryptogams 52%, Hymenophyllum multifidum 1%, litter 28%, open rock 6%.
Remaining 6% of points occupied by species.

E. Tutoko Valley

i) General vegetation description.

Valley floor: Beech trees (Nothofagus spp.) comprise the forest on most of the Tutoko Valley floor but are replaced on comparatively recent talus slopes by scrub species. The Kakapo territory located in 1974 on the valley floor at the foot of Mt.Tutoko was situated on one such talus slope. On the highest section of this fan, where the track and bowl system was found, grasses, herbs and low shrubs covered the finer shingle substrate amongst the larger rocks and boulders. Chionochloa flavescens was the predominant grass in the area but other Chionochloa species, Poa colensoi, Lachnagrostis spp. and Notodanthonia setifolia were present. Predominant shrubs in the

area include Carmichaelia grandiflora, Coprosma rugosa, Coriaria plumosa, Gaultheria crassa, flax and the fern Blechnum capense type. Although these were spread throughout the area they tended to form clumps amongst the rocks and boulders.

Canopy height was greatest near the Tutoko River but declined from 12m to less than 3m in the area surrounding the booming ground where species such as Aristotelia fruticosa, Coprosma spp., Fuchsia excorticata, Griselinia littoralis, Hoheria glabrata, Myrsine divaricata, Olearia arborescens, O. ilicifolia and O. colensoi formed a mixed scrub cover.

Mt.Tarewa Spur and Tutoko High Bench: High altitude silver beech forest forms a broken tree line between 900 - 1150m in the vicinity of the 3 Kakapo territories. Above tree line predominant shrubs - Dracophyllum uniflorum, Podocarpus nivalis and Olearia colensoi - form a patchy alpine scrub canopy amongst Chionochloa flavescens and C. crassiuscula.

ii) Territories:

a) Territory 1 (Plate 8, p.23)

Map Reference:	NZMS 1 S113 965165
Vegetation:	Silver beech forest - alpine scrub
Site Type:	Prominent spur
Altitude:	1075m
Slope/Aspect:	20° West.

General vegetation: Two track and bowl systems were used on this ridge, probably by the same bird. The first was situated on the silver beech forest tree

TUTOKO VALLEY
Territory 1, Profile diagram

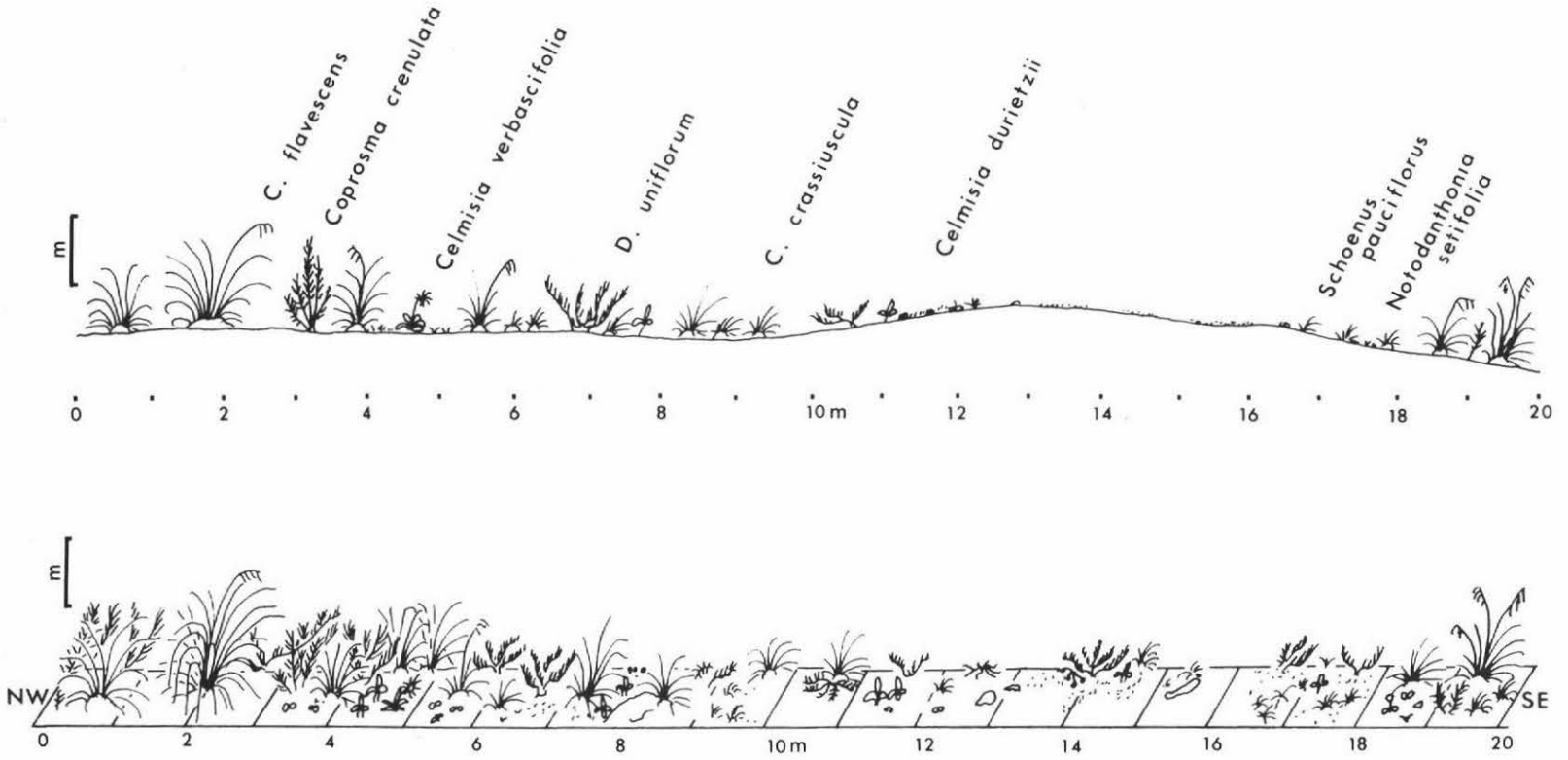


Fig. 7

line (1075m) at the base of a rocky bluff (Profile diagram Fig.7, p.55). Here silver beech forest is becoming established on what appears to have been tussock covered talus slope. North of the lower track and bowl systems silver beech reaches 1150m in a steep sheltered defile, but scrub and tussock are the predominant canopy species at this altitude. Olearia colensoi and Senecio bennettii are the main shrubs on the bluffs, but above these bluffs in the vicinity of the upper track and bowl system, low Dracophyllum uniflorum, Chionochloa flavescens and C. crassiuscula predominate.

Plant transect:

Point intercept transect across track and bowl system 1 :

50m, 100 points, points 0.5m apart, direction N-S down slope.

Total number of vascular plants across transect: 40

Shrubs 11 species, grasses 4 species, herbs and ferns 25.

Canopy height:

Range 0.01 - 0.9m

General height c. 0.5m.

Canopy composition:

Overall cover 92%

Open rock 7%, litter 1%, shrubs 23%, grasses 49%, herbs and ferns 20%.

Canopy species:

C. flavescens	30%	C. crassiuscula	19%
D. uniflorum	12%	Moss	7%
Schoenus pauciflorus	6%		
Hebe cockayniana	5%		

Vegetation over 30cm in height:

Cover 44%

Chionochloa flavescens 23%

C. crassiuscula 19%

A further 4 species occupied the remaining 9% of the points.

Vegetation between 30 - 0cm:

Cover 86%

Dracophyllum uniflorum 17%

C. crassiuscula 15% Celmisia walkeri 10%

C. flavescens 9% Coprosma cheesemannii 7%

S. pauciflorus 9% Olearia moschata 6%

A further 6 species occupied 13% of the points.

Ground cover:

Cover 75%

Cryptogams 39%, rock 16%, litter 9%

Hymenophyllum sp. 12%

Lycopodium fastigiatum 7% C. flavescens 6%

A further 6 species occupied 11% of the points.

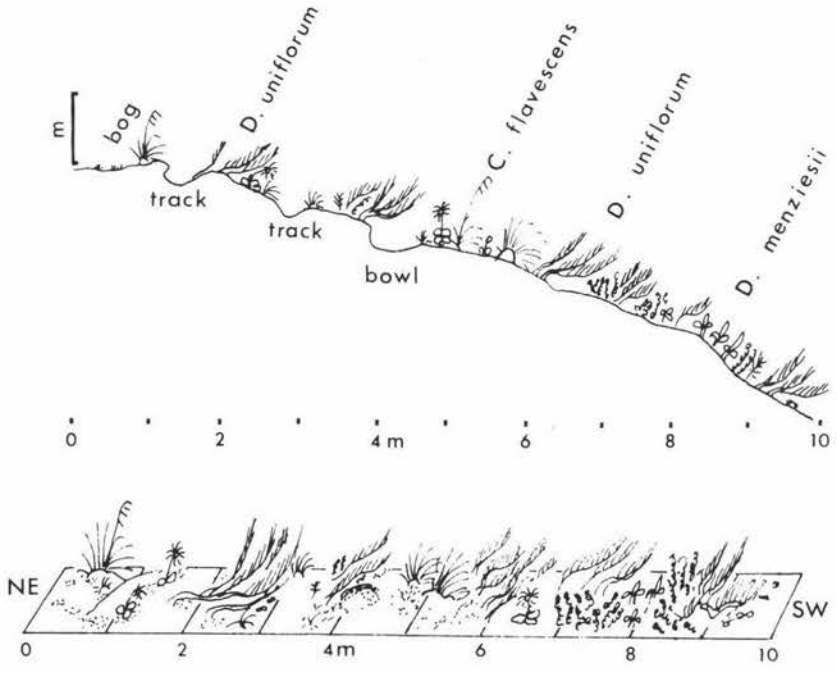
b) Territories 2 and 3.

Map Reference:	Track and bowl system 2: NZMS 1 S113 967156 Track and bowl system 3: NZMS 1 S113 967153
Vegetation:	Alpine scrub
Site Type:	Bench (Plate 9, p26)
Altitude:	1000 - 1050m.
Slope/Aspect:	5 - 20° West.

General vegetation: The altitude of the Bench corresponded with the expected tree line for northern Fiordland forest (Wardle, et al. 1971). On the Bench, silver beech forest forms a broken bush line, evidence of the variability of altitude, slope and sites prone to flood and avalanche damage. The northern and southern aspect of the banks flanking

TUTOKO VALLEY

Territory 2, Profile diagram 2.



Territory 3, Profile diagram

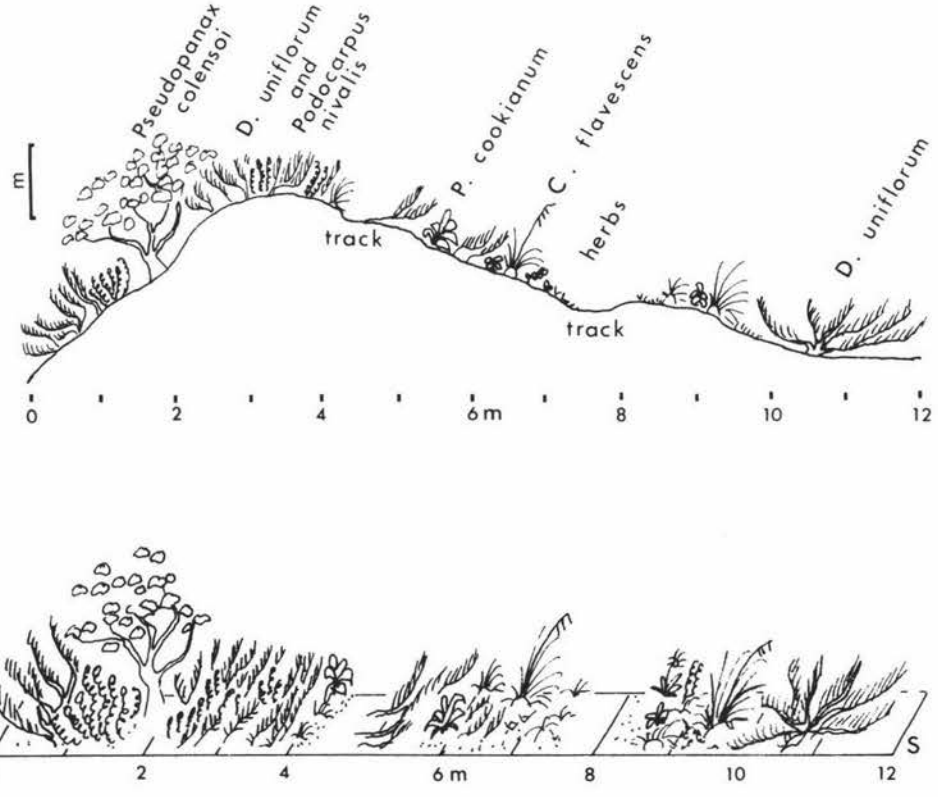


Fig. 8

TUTOKO VALLEY
Territory 2, Profile diagram 1.

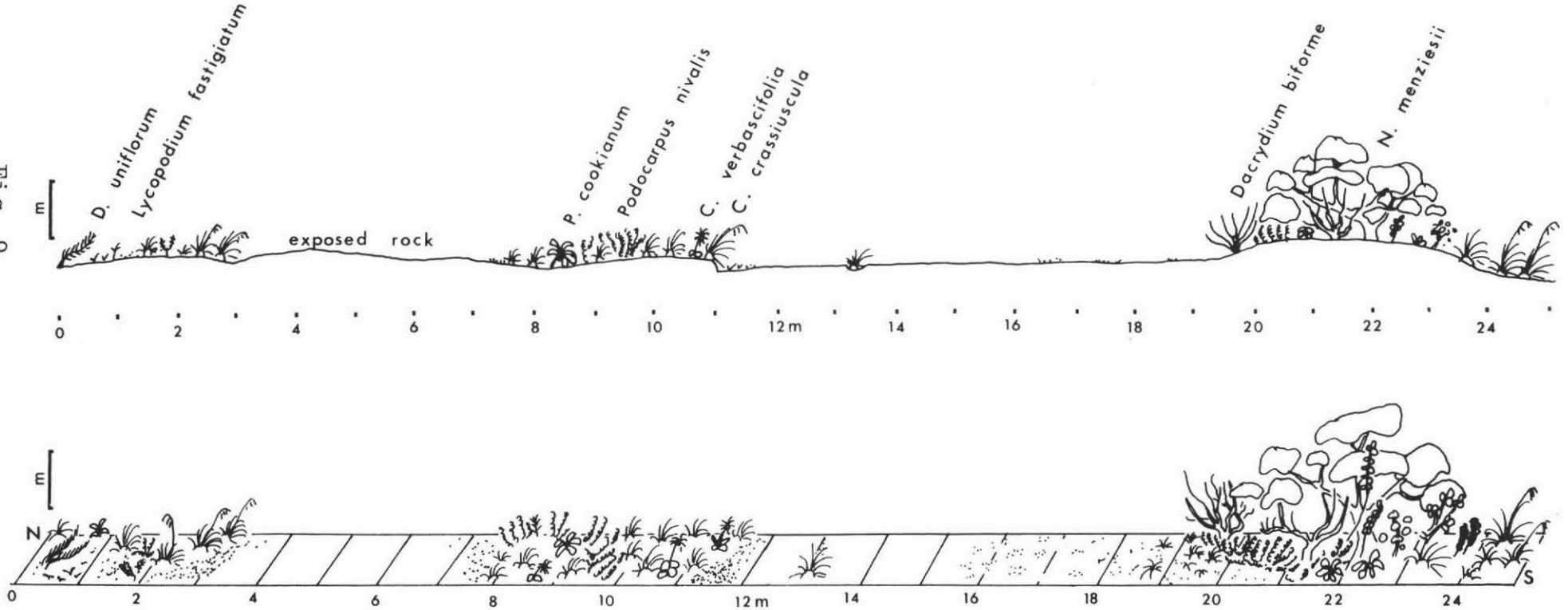


Fig. 9

the stream both noticably affect the vegetation. On the sunny northern sloping faces the scrub is higher and denser and includes such warmth loving species as flax and Pseudopanax colensoi.

Vegetation on the Bench near Kakapo track and bowl systems and feeding sign are grouped into three broad vegetation communities.

Firstly, the rolling tussock and scrub covered terrain which occupies the higher altitudes of the bench where such food plants as Podocarpus nivalis, Chionochloa spp., Aciphylla crenulata and Celmisia spp. are common (Profile diagrams, Fig.8,p.58).

Secondly, the open rock slabs in the vicinity of the track and bowl systems which form a mosaic with the mixed vegetation of silver beech stands, scrub, tussock and herbs (Profile diagram, Fig.9,p.59).

Thirdly, at lower altitudes on the Bench silver beech was an important canopy species.

F. Gulliver Valley

i) General vegetation description.

The area occupied by the Kakapo in 1975 was floristically similar to the Tutoko High Bench territories. The small terrace with the track and bowl system was located at the timber line at c.1000m altitude. Plant canopy species formed a similar mosaic of silver beech forest, alpine scrub in which Podocarpus nivalis is an important component, and tussock grassland (Profile diagram, Fig.10,p.61).

GULLIVER VALLEY
Territory 1, Profile diagram

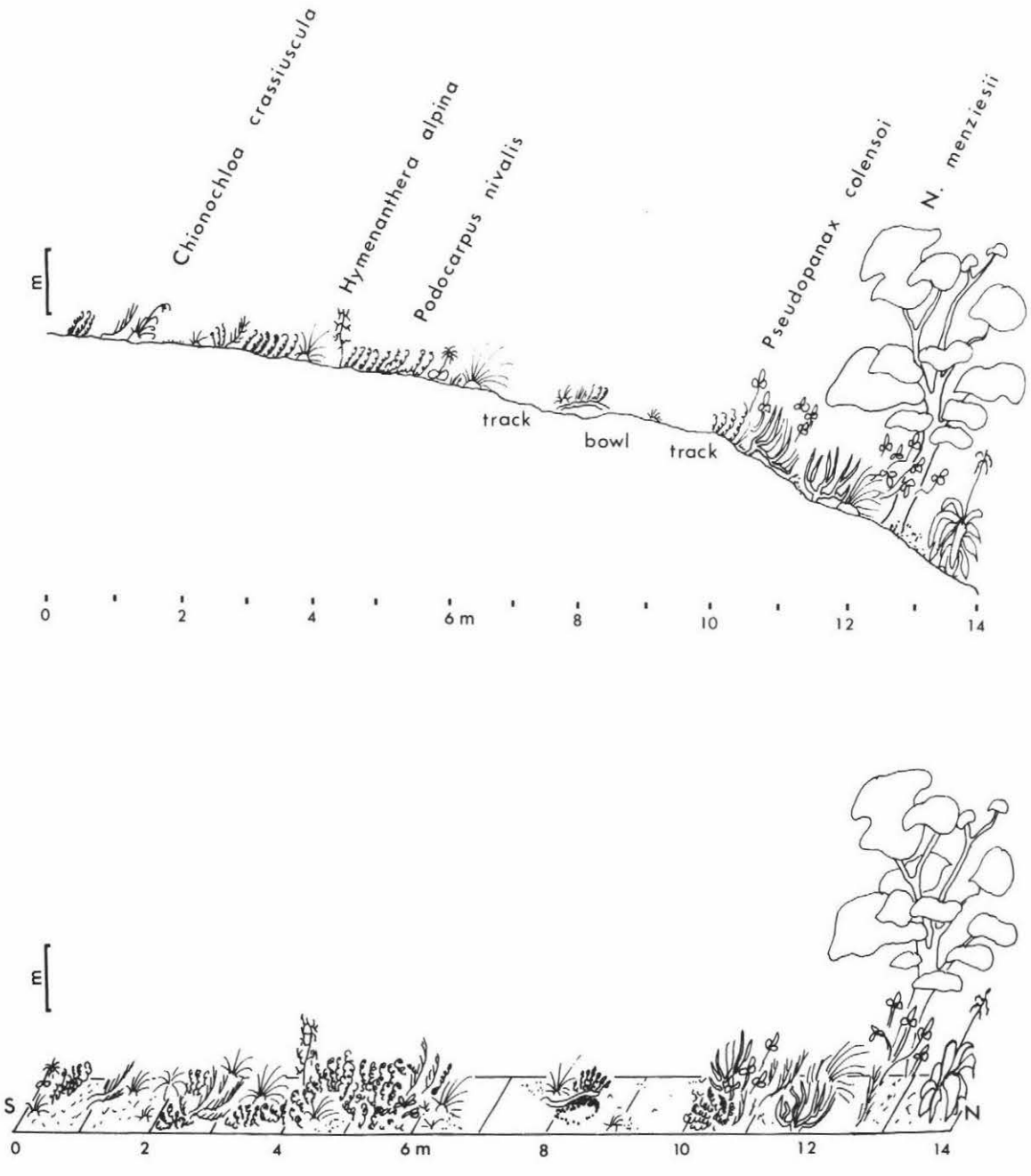


Fig. 10

ii) Territory 1:

This territory was occupied by Kakapo 'Richard Henry' now on Maud Island.

Map Reference:	NZMS 1 S122 958046
Vegetation:	Silver beech tree line and alpine scrub
Site Type:	Rock terrace
Altitude:	1000m
Slope/Aspect:	10 - 30° NW.

General vegetation description: As in i), p.60.

CHAPTER IV

VEGETATION ON MAUD ISLAND

A. Introduction.

During the ninety years prior to 1975 when it became a reserve Maud Island was a farm. The earliest farms in the region were established in the 1880s (E.J.T. Shand pers.comm.) and it is probable that stock were introduced to the Island about this time. A 15ha. (36 acres) stand of forest on the eastern slopes behind the jetty and two small forest remnants, one in Boat Bay and the second on the north west side of the Island (Fig.2, p.6) are all that remains of the broadleaf - podocarp forest, which from the existence of ancient stumps and fallen logs, seems to have originally covered most of the Island.

The present proportion of forest to grazing land (1 : 12) has probably remained static the last 40 years. Regular burning of bracken and grazing prevented forest re-establishment. Since 1970, however, 'burning off' of bracken has ceased and with the removal of stock in 1975 and 1976 active regeneration is taking place. Planning for regeneration control is at present being considered by the Wild Life Service.

B. General Vegetation Description.

i) Forest:

The dominant canopy species in the remnant forest

are tawa (Beilschmiedia tawa) marble leaf (Carpodetus serratus), kohekohe (Dysoxylum spectabile), hinau (Elaeocarpus dentatus), whiteywood (Melicytus ramiflorus) and miro (Podocarpus ferrugineus). A reasonably complete list of trees, shrubs and ferns has been compiled by Atkinson and Bell (1971) but grasses, sedges and herbs are incompletely recorded.

The principle shrub species in the forest stands include rangiora (Brachyglottis repanda), Coprosma australis, kawakawa (Macropiper excelsum), whiteywood, Olearia paniculata and O. rani. Kiekie (Freycinetia banksii) forms a dense shrub belt of variable width which spans the main forest from its southern to northern boundaries across the middle zone of the bush.

Much of the forest floor is stony and unstable; a variety of ferns (Atkinson and Bell, 1971) provides the principle plant cover. Patches of nikau seedlings (Rhopalostylis sapida) are locally abundant and their leaves appear to be an important food source for at least one of the two Kakapo on the Island. Hinau, kohekohe and tawa berries are widespread and common amongst the leaf litter. These appear to be readily available for most of the year.

ii) Grazing pasture:

Introduced pasture grasses are widespread and common but native grasses, silver tussock (Poa laevis) and a Notodanthonia sp. (Atkinson and Bell, 1971) are only occassionally found. Seventeen species of introduced grasses were collected on the Island in

1975-76 and samples were processed for the cuticle analysis reference collection.

On the less fertile, higher altitude pasture e.g. along the summit ridge, brown top (Agrostis tenuis) and sweet vernal (Anthoxanthum odoratum) predominate. Odd clumps of cocksfoot (Dactylus glomerata) are also present.

Several grass species, yorkshire fog (Holcus lanatus), common foxtail (Alopercurus pratensis), chewings fescue (Festuca rubra), canary grass (Pharlaris canariensis), Poa pratensis and Poa trivialis have established themselves on recently disturbed ground along roads and watertraps. Sheeps sorrel (Rumex acetosella) has likewise established on these sites.

A few grasses have been specifically sown as possible foods for Kakapo. For example oat (Avena sativa), Digitaria sp. and young toetoe Cortaderia sp.).

The lower pastures are comprised of grasses, legumes and introduced herbs. The grasses include brown top, perennial rye grass (Lolium perenne), soft brome (Bromus mollis) and barley grass (Hordeum muridum).

Three legumes predominate, white clover (Trifolium repens), red clover (T. pratense) and Lotus major. The common herbs are dandelions and allies, polygonaceous weeds and others included in Table XIII Appendix II and Atkinson and Bell, 1971.

Bracken covers a large proportion of pasture land, particularly on the steep shaded rocky slopes. Associated with this are several shrub species; Cassinia leptophylla, Hebe stricta var. macroura, manuka and on the north west side of the Island, a heath (unidentified).

A variety of forest species including five finger (Pseudopanax arboreum), Schefflera digitata and tutu (Coriaria arborea) are regenerating amongst the bracken. The diversity of regenerating species increases in the areas surrounding the forest stands. Pines (Pinus radiata) have been planted in a number of places around the Island (Profile diagrams, Figs.11 and 12 pp. 69 and 70).

The distribution of several Kakapo food species are of interest. Flax (P. cookianum) is confined to the coastal cliffs with the exception of two mature clumps; while tutu, five finger and Fuchsia (F. excorticata), grow in small localised areas outside the main forest stand. Seeds of these species found in fresh Kakapo droppings give some indication of the distances Kakapo travel in search of food (Chapters VI and VII).

C. Introduced Plants for Kakapo Foods.

Following the liberation of Kakapo some 400 fruiting trees and shrubs in addition to herbs and grasses have been planted (Table I, p,67).

TABLE I

Plants Introduced to Maud Island as Possible Kakapo Food Species (1974-76)

Aciphylla spp.	(spaniard)
Astelia nervosa	
Avena sativa	(oat)
Chionochloa spp.	(tussocks)
Coprosma propinqua	
C. repens	
various *Coprosma* varieties	
Corpus capitata	(dogwood)
Corokia spp.	
Cortaderia sp.	(toetoe)
Cotoneaster sp.	
Cytisus proliferus	(tree lucerne)
Daucus carota	(carrots)
Digitaria sp.	(millet)
Fragaria spp.	(strawberry)
Helianthus sp.	(sunflower)
Hordeum sp.	(barley)
Labernum spp.	
Lotus major	
Lupinus spp.	(lupin)
Malus spp.	(apple, crab apple)
Prunus spp.	(plum, cherry)
Phalaris canariensis	
Psidium guajava	(guava)
Ribes spp.	(current, gooseberry)
Rubus spp.	(raspberry, boysenberry)
Secale sp.	(rye)
Sorbus sp.	(mountain ash)
Symphoricarpus albus	(snowberry)
Tetragonia expanisa	(N.Z. spinach)
Trifolium spp.	(clover)
Triticum sp.	(wheat)
Vitex lucens	(puriri)
Vitis sp.	(grape)
Zea sp.	(corn)

D. Plant Transect and Profile Diagrams.

Plant Transect:

Point intercept transect:
120m, 121 points, points 1m apart, direction WNW-ESE down ridge from summit trig. Slope 20°

Total number of vascular plants recorded across transect: 29

Canopy height:
Range 0.01 - 1.5m.
General height 0.65m. (seeding grasses)

Canopy composition:
Overall cover 100%
Woody shrubs 6%, grasses 42%, ferns 15%, herbs 37%

Main canopy species:
Sweet vernal 24%, brown top 17%, bracken 8%, *Helichrysum bellidioides* 7%, cats ear (*Hyprochaeris radicata*) 7%,
Hypolepis tenuifolia 7%
hawk beard (*Leontodon taraxacoides*) 7%
Raoulia glabra 5%
A further 13 species occupied the remaining 18% of the cover.

Ground cover: (species rooted within 2cm of point)
Cover 98%
Moss 23%, brown top 22.5%, sweet vernal 16%, hawk beard 8%, *Hypolepis tenuifolia* 7%, cats ear 6%, bracken 5%, bare ground 2%.
A further 9 species occupied the remaining 10.5% of the cover.

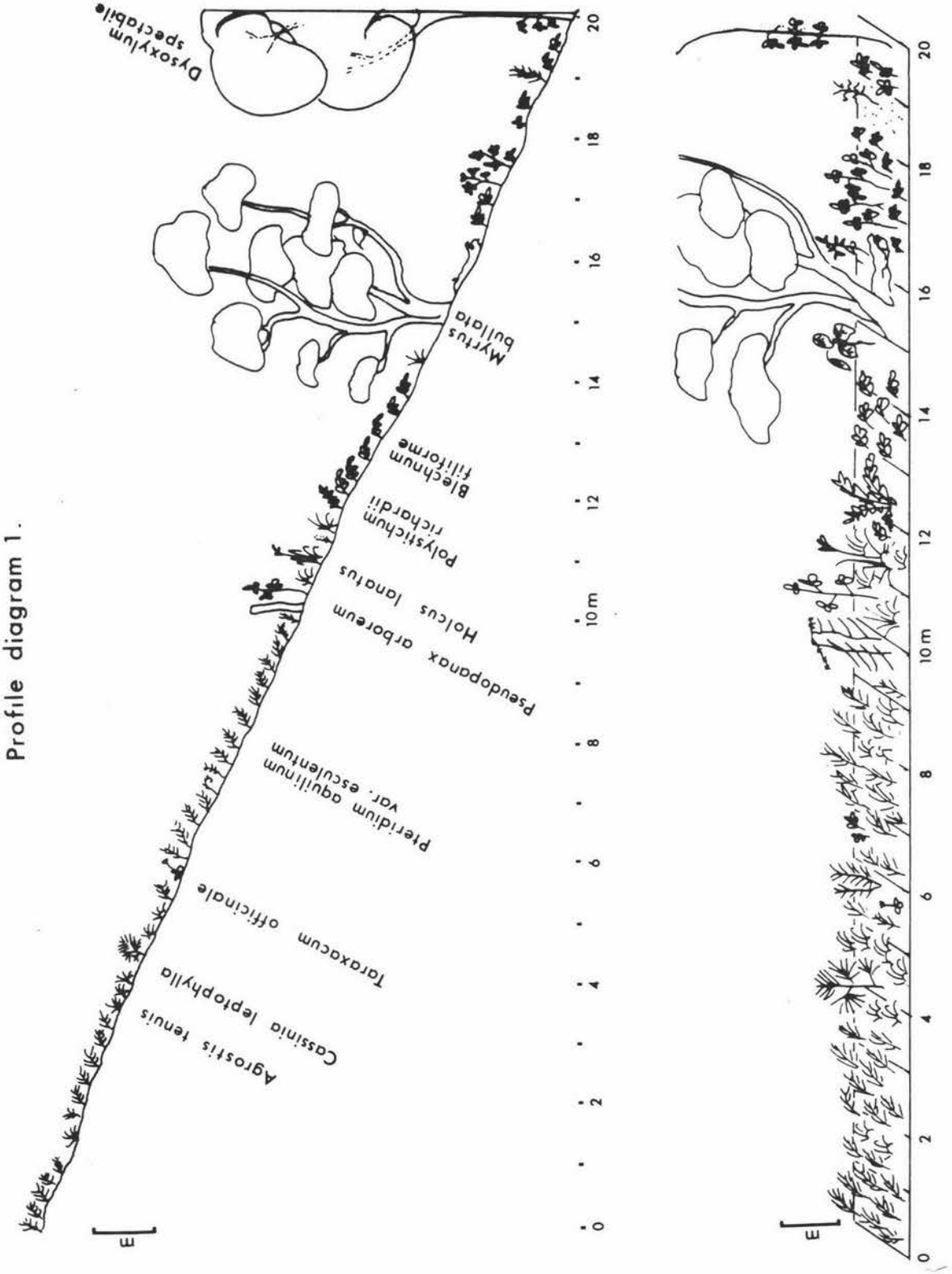

MAUD ISLAND
Profile diagram 1.
Dysoxylum spectabile
Myrtus bullata
Blechnum filiforme
Polystichum richardii
Holcus lanatus
Pseudopanax arboreum
Pteridium aquilinum var. esculentum
Tarraxacum officinale
Cassinia leptophylla
Agrostis tenuis
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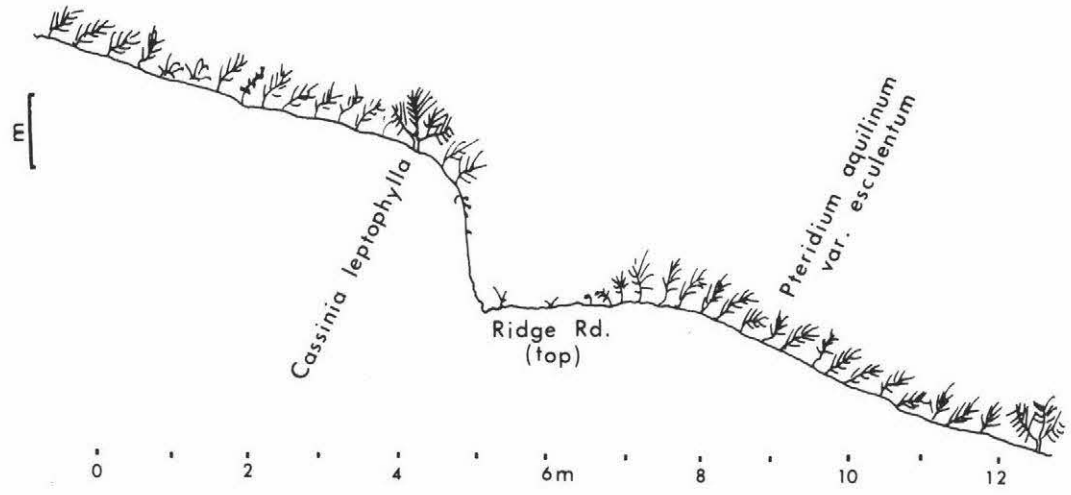
Fig. 11

MAUD ISLAND
Profile diagram 2



Profile diagram 3

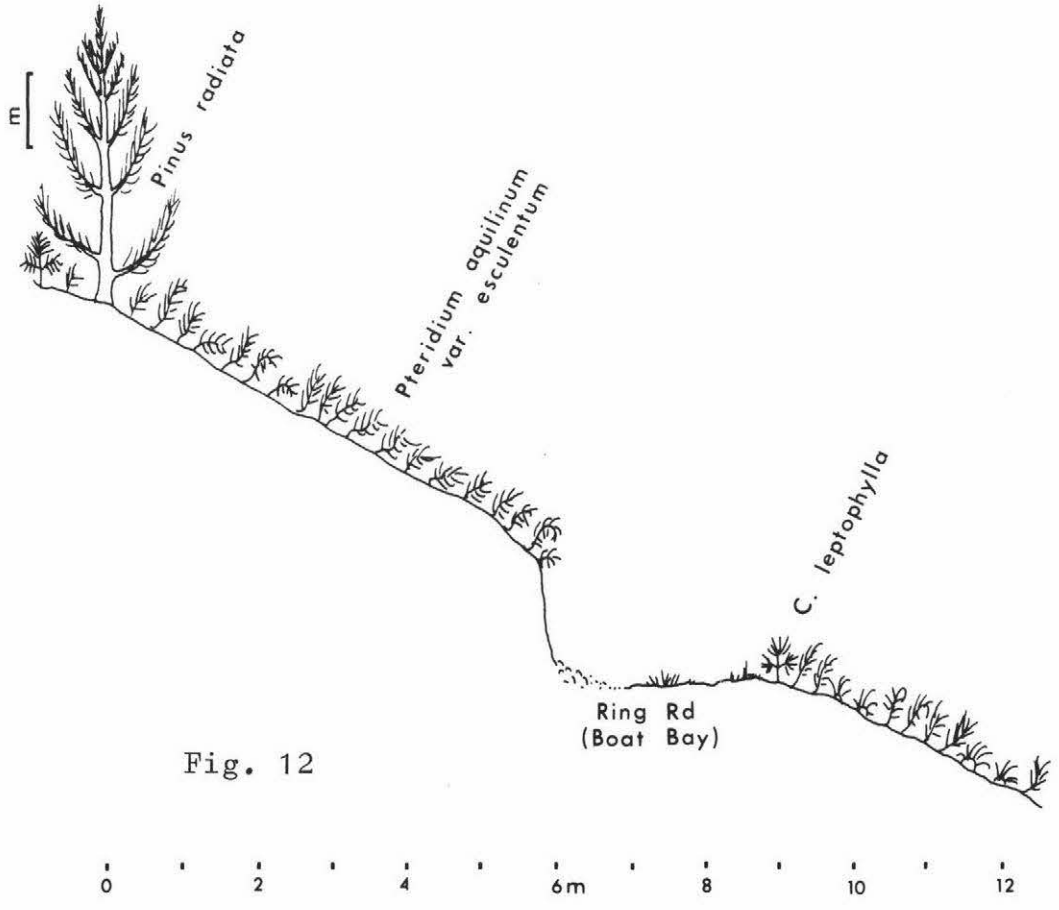


Fig. 12

CHAPTER V

FIORDLAND KAKAPO FEEDING SIGN

A. Introduction.

The Kakapo is a herbivor. Observations by early observers well acquainted with the bird (Haast, 1861, 1864; Potts, 1873; Henry, 1895-1908; Best, 1908; Douglas, 1957) record the Kakapo feeding on leaves, twigs, bark, nectar, berries, seeds, fern rhizome and fungi. Recent observations (1960-1977) by Wild Life Service expeditions in the Milford and Transit Catchment areas and the faccal analysis observations (Tables II, VII and X) have confirmed these early reports of the vegetarian diet of Kakapo.

However, von Hugel (1875) reported finding lizards in the crop of 1 old male Kakapo. This is the only recorded exception and is open to question since observation of Kakapo and their feeding sign have continually stressed the bird's habit of chewing and crushing its food and swallowing only small particles. Examination of the crop contents of the Kakapo killed on Maud Island in July 1977 revealed only fine vegetable matter. Hugel's observation appears uncharacteristic of the bird.

In Westland and Fiordland Kakapo have been reported as ranging from sea level to 1200m (4000') (Lyall, 1852; Hector, 1863; Reischek, 1884, 1930; Henry, 1903). The birds have been most frequently associated with grassland habitats (Brunner in

Pascoe, 1952; Lyall, 1852; Haast, 1864; Henry, 1903a; O'Donoghue, 1924) although they range over a wide variety of vegetation types. Henry (1903a) whose field experience is unrivalled reported that during the breeding season Kakapo frequented valley floors and land slips where berry producing trees and shrubs grew. During other times of the year the birds wandered widely. As noted by Atkinson and Williams (1971) Kakapo formerly inhabited podocarp/dicotyledon forest, beech forest, subalpine scrub and tussock grassland.

Observations between 1961 and 1977 have confirmed the presence of Kakapo in beech forest (Lavers, 1967; Gray, Merton and Morris, 1975; Veitch, 1976a and Gray, 1977b), subalpine scrub (Atkinson and Merton, 1974; Nilsson, 1975; Scown, 1975; Anderson, 1976; and Morris, 1976), tussock grassland (Scown, 1975; Morris, 1976; Gray, 1977b), avalanche slips and debris fans (Anderson, 1961; Roderick, 1963; Atkinson and Merton, 1974; McFadden, 1975; Gray, Merton and Morris, 1975; Johnson, 1976a), alluvial fans and river terraces (Atkinson and Merton 1974; Gray, 1977b), river flats (Anderson, 1961; Veitch, 1962; Lavers, 1967, Cheyne, 1969; Russ and Anderson, 1977a,b) and in Podocarp/broadleaf forest (Russ and Anderson, 1977a,b; Russ pers.comm.).

Within the Milford Catchment the decline in Kakapo numbers during the 1960 and early 1970s from lower altitude sites was monitored by the Wild Life Service expeditions (Wild Life files 46/61/1). In

the 3 summer seasons, November 1974 - March 1977 most feeding sign in Fiordland has been located between 650 - 1150m in the Sinbad Valley (Gray, Merton and Morris, 1975), Tutoko High Bench (Scown, 1975; Morris, 1976). Transit Valley (Veitch, 1976a) and Poseidon Valley (Buckingham, 1977; Gray, 1977b).

B. Fiordland Kakapo Food Plants.

Table II: pp. 74 - 77.

C. Seasonal Variations in Fiordland Kakapo Diet.

Table III: p. 78.

TABLE II

Fiordland Kakapo Food Plants

Food Species	Part[1] Eaten	Selected References[2]	Reference[3] numbers
Acaena sp.	L	Table VII	
Aciphylla prob. crenulata	L	Anderson (1961), Scown (1976) Morris (1976)	313608, 313621
A. takahea	L	Atkinson and Merton (1974)	286403, 286423 286452
Anisotome haastii	L, Lb P	Veitch (1976a), Morris (1977a)	286451, 313606 313615
Aporostylis bifolia	Fl	Table VIII	
Asplenium bulbiferum	L	Potts (1873), Table VII	
Astelia nervosa	L, Fr	Gray, Merton and Morris (1975) Morris and Russ (1976)	286401, 286406 286415
A. nivicola var. nivicola	L	Scown (1976)	286430
Blechnum capense	L, Rh	Murray (1974), Gray et al. (1975), Veitch (1976b), Morris and Russ (1976)	286408, 286429 286436, 286437 313628
B. penna-marina	L	Merton, (pers.comm.) Esperance aviary	
Caltha novae-zelandiae	L	Table VIII	
Carex coriacea	L	Johnson (1976a)	
Carex sp.	L		313601
Carmichaelia grandiflora	Sb	Fitzgerald and Atkinson (1974)	286405
Carmichaelia sp.	L	Potts (1873), Hector in Buller (1868)	
Carpha alpina	L	Nilsson (1975)	313601
Celmisia coriacea	L, Is	Scown (1976), Veitch (1976a)	
C. holosericea	L, Is	Gray (1977a)	313614
C. lanceolata	L	Veitch (1976a)	
C. petriei	L, Lb	Morris)1976)	286441-2
C. verbascifolia	L, Is	Scown (1976)	286447-9
Chionochloa conspicua	L, Sh	Murray (1974), TV. 1 (1977) Gray (1977b)	165032, 286419 286435
C. crassiuscula	L. .	Morris (1976), Gray (1977b)	
C. flavescens	L, Is Sh	Murray (1974), Gray et al. (1975), Morris (1976) Gray (1977b,c)	286417, 286427 286431, 286444 286446
C. ovata	L	Gray (1977a)	313612
C. pallens	L	Gray (1977c)	313605
Coprosma astonii	L, BT Fr	Merton, (pers.comm.) Esperance aviary	
C. parviflora	Fr	Merton, (pers.comm.) Esperance aviary	
C. pseudocuneata	Se	Atkinson and Bulfin (1974) Merton, (pers.comm.) Esperance aviary Morris, (pers.comm.)	
C. rugosa	Fr	TV. 1 (1977) Merton, (pers.comm.) Esperance aviary	

Table II continued:

Food Species	Part[1] Eaten	Selected References[2]	Reference[3] numbers
Cordyline indivisa	L	Oliver (1955)	
Cordyline sp.	L	Buller (1888)	
Coriara plumosa	Fr	Atkinson and Bulfin (1974), Table X	
C. sarmentosa	L, Fr	Haast (1861), Merton (1974), Table X	286404
Cyathodes juniperina	Fr	Table X	
Dracophyllum fiordense	Lb,Tb	Veitch (1976a), Gray (1977b), Garrick (1977)	286409, 286411 286412, 313613
D. longifolium	L, Tb	Veitch (1976a), Gray, Merton and Morris (1975)	286434
D. menziesii	Tb	Morris (1976), Veitch (1976a)	
D. uniflorum	Tb	Table VII	
Festuca matthewsii	L	Anderson (1961), Morris (1977a)	313604
Fuchsia excorticata	Fl,Fr	Haast (1864)	
Gahnia procera	Lb	Veitch (1976a)	313617
Gaultheria crassa	L	Table VII	
G. depressa	Fr	Table X	
G. rupestris	L	Table VII	
Gunnera monoica	L	Table VII	
Hebe prob. macrantha	L	Table VII	
H. subalpina	L	Table VII	
Hierochloe cuprea	Sh	Gray (Transit V.,1976,no ref.)	313616
H. recurvata	L	Merton (pers.comm.) Esperance aviary	
H. redolens	Sh		286418
Histiopteris incisa	L	Morris and Russ (1976)	313602
Hymenophyllum multifidum	L	Table VII	
Juncus gregiflorus	L	No ref. (Sinbad V. 1975)	286440
Metrosideros umbellata	Fl	Henry (1903a), Gray, Merton and Morris (1975)	
Moss spp.	L	Buller (1905), Gray, Merton and Morris (1975)	
Myrsine australis	Fr	Henry (1903b)	
Myrsine sp.	P	Table VIII	
Nothofagus menziesii	L	Tables VII and VIII	
Notodanthonia setifolia	L, Se	McFadden (1975)	
Olearia colensoi var. argentea	L, Tb	Gray, Merton and Morris (1975), Roxburgh (1975), Scown (1975), Gray (1977c)	286420, 286421 286443
O. ilicifolia x arborescens	BT	McFadden (1975), Merton (pers.comm.) Esperance aviary	286414
Pernettya macrostigma	Fr	Table X	
Phormium cookianum	L, Is	Henry (1903a), McFadden (1975), Gray, Merton and Morris (1975), Scown (1976)	286401, 286422 286432, 286433 286439, 313631
Poa cockayniana	L, Sh	Gray (1977b)	313610-11

Table II continued:

Food Species	Part[1] Eaten	Selected Reference[2]	Reference[3] numbers
P. colensoi	L, Sh	McFadden (1975), Gray (1977b)	313607
Podocarpus nivalis	L, Se	Veitch (1976b), Tables VII, VIII, X	
Polystichum vestitum	Lc	Morris (1976), Merton (pers.comm.) Esperance aviary	286428
Pseudopanax colensoi var. ternatum	L, Fr	Roxburgh (1975), Gray (1977c) Tables VII and X	
Pseudopanax simplex	Fr	Atkinson and Bulfin (1974) Table X	
Rubus cissoides	L, P	Table VII	
Schefflera digitata	Fr,BT	Potts (1873), Henry (1897)	
Schoenus pauciflorus	L	Gray, Merton and Morris (1975), Nilsson (1975)	286410
Scirpus habrus	Fr	Atkinson and Bulfin (1974)	
Senecio bennettii	L, BT	Roxburgh (1975), Gray (1977c), Veitch (1976a)	286438
S. revolutus	Ro	Merton (pers.comm.)	313603
S. scorzoneroides	Lb,Sb	Veitch (1976a)	286450, 313619
Todea superba	Lc	Lavers (1967)	286416
Uncinia spp.	L, Se	Gray et al. (1975), Morris (pers.comm.)	
List of Suspended Food Species[4]			
Bulbinella gibbsii var. balanifera	L	Scown (1976)	312618
Celmisia petiolata	Lb	Nilsson (1975)	
C. walkeri	Tb,Is	Jones (1977), Billing (1977)	
Coprosma cheesemanii	Fr		
ciliata	Fr	Table X	
colensoi	BT, L		
crenulata	Fr		
pumila	Fr	Table X	
Fungi		Henry (1903a), Russ (1975)	
Gentiana montana	Lc	Veitch (1976b)	
Microlaena colensoi	L		
Olearia arborescens	L	Gray,(Sinbad V., 1975,no ref.)	
Oreobolus impar	L	Nilsson (1975)	313635
Ourisia macrocarpa	P	Morris (pers.comm.)	
Prasophyllum colensoi	Sh	Nilsson (1975)	
Senecio lyallii	Lc	Morris (pers.comm.)	
Wahlenbergia sp.	Fl	Buckingham (1977)	313609

Footnotes to Table II:

1. Key:

BT	branches and twigs
Fl	flowers
Fr	fruit, berries and drupes
Is	inflorescence stems
L	leaves or pinnae
Lb	leaf bases
Lc	leaves clipped only
P	petioles
Rh	rhizomes
Ro	roots
Sb	stem bases
Sh	seed heads
Se	seeds

2. The first recorded reference of a species is listed and subsequent references of interest from different localities.
   N.B. Specific botanical names in the reference works may not always agree with the specific name listed in this Table as identification was not necessarily confirmed when the reference reports were originally written.
3. A reference collection is housed in the herbarium at Botany Division, DSIR., Christchurch, N.Z. The numbers listed refer to examples in this collection.
4. Where there is room for considerable doubt that a species has been consumed as food or where identification is doubtful, e.g. Coprosma seeds, then, the species has been placed in the Suspended List, p.76.

TABLE III

Seasonal Variations in Fiordland Kakapo Diets.

Trees, Shrubs, Herbs	Part[1] Eaten	Aug Sep Oct Nov Dec Jan Feb Mch Apr May Jun Jul
Aciphylla sp.	L	
Anisotome haastii	L	
Astelia spp.	L	
Astelia spp.	Fr	
Carex spp.	L	
Celmisia spp.	L	
Coprosma spp.	Fr	
Coriaria spp.	Fr	
Cyathodes juniperina	Fr	
Dracophyllum spp.	L	
Nothofagus menziesii	L	
Olearia colensoi	L	
Phormium cookianum	L	
P. cookianum	S, P	
Podocarpus nivalis	L, A	
Pseudopanax colensoi	S	
Schoenus pauciflorus	L	
Senecio bennettii	L	
S. scorzoneroides	Lb	
Uncinia spp.	S	
Ferns		
Blechnum spp.	L, R	
Histiopteris incisa	L, R	
Hymenophyllum spp.	L	
Polystichum vestitum	L	
Grasses		
Chionochloa spp.	L	
Chionochloa spp.	S	
Festuca matthewsii	L	
Notodanthonia setifolia	L, S	
Poa cockayniana	L, S	
P. colensoi	S	

Key

Fresh feeding sign identified in fresh droppings.

Feeding period estimated from old and recent feeding sign and droppings.

Suspected food source but insufficient proof.

1. A aril; Fr fruit; L leaf; Lb leaf base; P petiole; R rhizome; S seed.

D. Description of Feeding Sign.

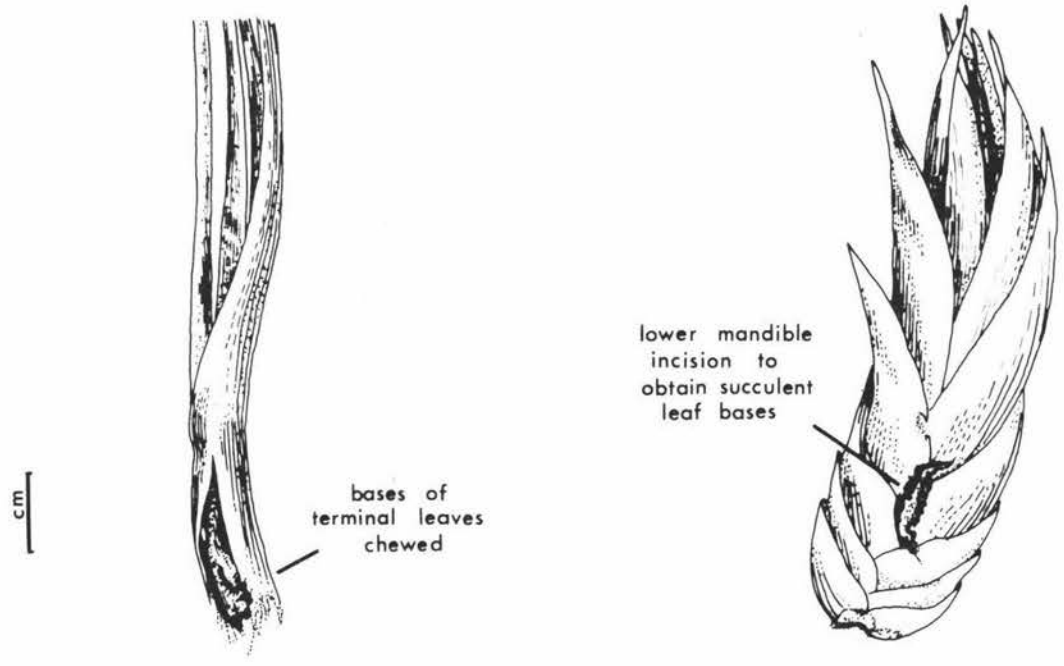
i) Leaves:

The leaves or tillers of eleven Fiordland grass species are recorded as Kakapo foods in Table II. The most frequent feeding sign on the leaves of tussocks and small grasses is the outer portion of the blade nearest the tip which is crushed and chewed.

The chewed fibrous plant tissue remaining may be left attached to the damaged blade and resemble a frayed, twisted and tangled hemp twine. Though initially light green in colour (some of the chlorophyll having been removed by the bird) the chewed section of the leaf eventually bleaches to a pale yellow or cream shade. Bleaching occurs within 30-48 hours if the chewed leaves are exposed to sunlight but in damp shady sites some green colouration may persist for several months. Chewed portions of leaf blades as long as 40cm still attached to the leaf have been collected from Chionochloa conspicua plants.

The chewing of grass leaves often results in the loss of the chewed section from the rest of the tiller. This is invariably the case with the small grasses such as Poa colensoi and Festuca matthewsii but to a lesser extent with the more fibrous Chionichloa species. In comparison with insect and deer sign (Fig.14,p.80 and Fig.15,p.81) the frayed character of the severed blade is characteristic of Kakapo although care needs to be taken in

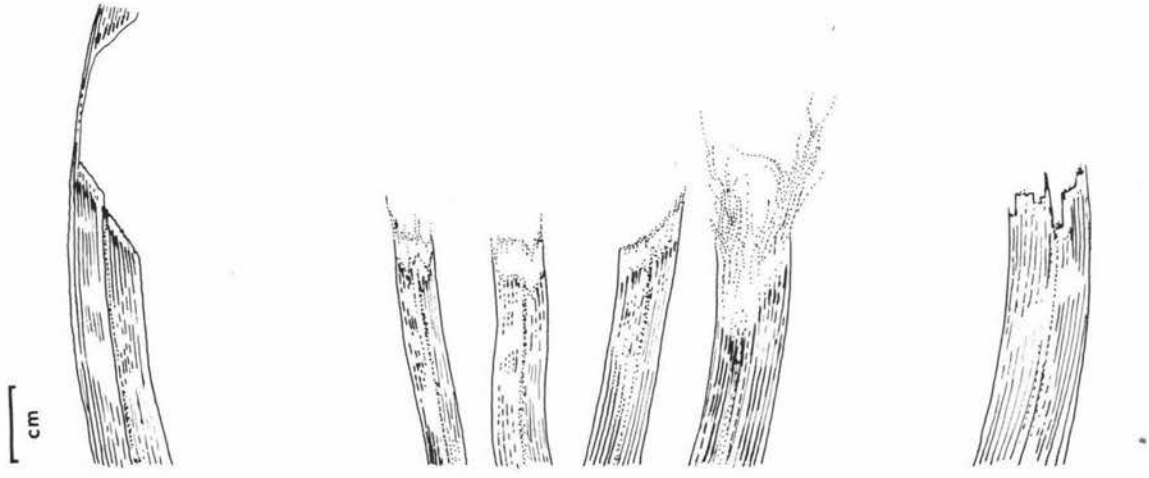
KAKAPO FEEDING SIGN



Dracophyllum longifolium

D. fiordense (lateral bud)

FEEDING SIGN ON CHIONOCHLOA GRASSES



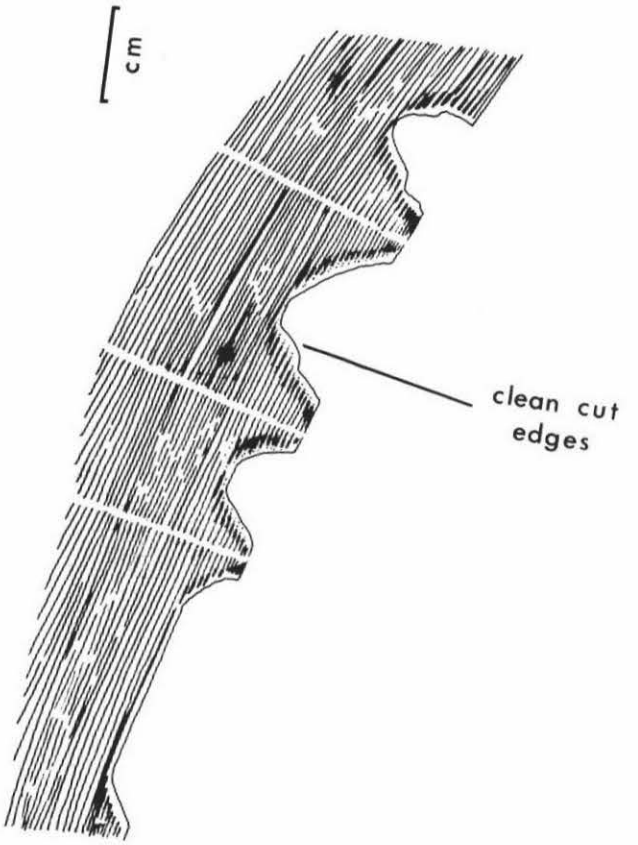
Insect sign on C. flavescens

Kakapo sign on C. ovata and C. flavescens

Deer sign on C. flavescens

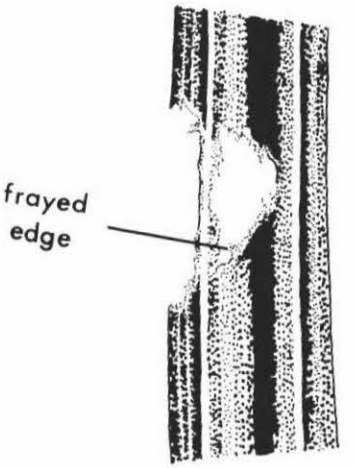
Fig. 13 (Top); Fig. 14 (Bottom)

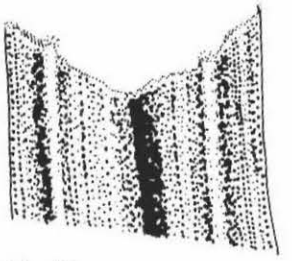
INSECT AND KAKAPO SIGN



Phormium cookianum

insect bites
from four leaves





Astelia nervosa

above: Kakapo 'A' bite
below: clipped lamina

Fig. 15

differentiating the evidence. In general neatly cut scolloping is characteristic of fresh Kakapo feeding sign on the leaf lamina and fern pinnae. Kakapo tend to cut leaves while deer and opossum pull and tear. The detached chewed remains of the leaves fed upon by Kakapo are scattered amongst the remaining leaves and around the base of the tussock or grass clumps (Plate 11, p.83). These chewed leaves are generally compressed in the bill to form a tight wad of fibre which is rejected from the bill with the aid of the tongue. These expelled pellets are termed 'chews'.

A variety of 'chew' types may be formed because of the variable fibrous content of the plant matter. For convenience three chew types are discussed.

The first are chews with little fibre which retain the kidney, or crescent shape curvative imposed by the Kakapo mandibles and in some cases they may even retain the 'ribbed' pattern from the roof of the birds palate (Plate 12, p.83). Chews of Olearia colensoi leaves which consist largely of the woolly tomentum from the undersurface of the leaf are typical example (Plate 13, p.83). Chews of ferns are similar but very fragile and disintergrate to a fine powder within a few hours (Morris, pers.comm.).

Secondly, the chews of Fiordland grasses and other monocotyledons of similar structure (Carex spp., Uncinia spp., flax and sedges) which consist of a large proportion of fine springy fibre do not

PLATE 11

(R.S. Gray)

Kakapo feeding sign on C. conspicua.
Blades clipped, bleached fibrous chews lie amongst base of leaves

PLATE 12

(R.S. Gray)

Kakapo chew lying amongst clipped pasture grasses. The 'ribbed' impressions from the upper mandible are visible over the surface of the chew.

PLATE 13

(Massey University Photographic Unit)

Kakapo chews

Olearia colensoi

Chionochloa flavescens

Senecio scorzoneroides

usually retain the kidney shape but expand into slightly flattened oval shaped chews (Plate 13, p.83).

Finally there are the woody chews typical of pithed inflorescence stalks of flax, Senecio scorzoneroides and Celmisia spp. which look vaguely rectangular in shape. These are mainly compressed lignfied xylem pith (Plate 13, p.83).

The leaves of Astelia sp. (principally A. nervosa) have frequently been collected with single bites taken out of the lamina. A characteristic feature of these bites is that the thick lateral vein, typical of Astelia spp. is left attached to the lamina which results in an 'A' shaped bite (Fig.15,p.81). A variety of plant species found had been sampled with single bites although care needs to be taken not to confuse insect damage with that from a Kakapo bill. Generally insect damage is more clear cut and that of Kakapo slightly frayed. This frayed appearance becomes more pronounced with time.

Leaves of several dicotyledon species play an important role in the diet in particular the Dracophyllum and Olearia species. It is suspected from observations in Fiordland and on Maud Island that a variety of seedling shrubs and trees are occasionally sampled but their contribution to the diet is considered a minor one at present. The young leaves of native Fiordland Dracophyllum species (D. fiordense, D. longifolium, D. menziesii

PLATE 14 (left)
(R.S. Gray)

Kakapo feeding sign on
Dracophyllum fiordense

PLATE 15 (right)
(R.S. Gray)

Kakapo feeding sign on
Olearia colensoi

PLATE 16
(P. Morrison)

Kakapo feeding on bracken in captivity

and probably D. uniflorum) (Plate 14, p.85) and the Olearia (O. colensoi) (Plate 15, p.85) provide a major source of food for Kakapo. Examples of this feeding sign have been collected in the Transit, Poseidon, Sinbad and Tutoko Valleys in Fiordland (reports in Wild Life files 25/3/4) and also in Stewart Island (Russ and Anderson 1977a,b) on D. longifolium and O. colensoi.

Examination of old and recent feeding signs on these species suggest that they are utilized during the spring (Table III, p.78). Kakapo appear to either clip the leaves surrounding the base of the young emerging Dracophyllum leaves or pluck at the young terminal leaves and chew the fleshy leaf base (Fig.13, p.80). A variation has been seen on D. fiordense where the fleshy leaf bases have been skilfully removed from the lateral buds. With O. colensoi the lamina of the young leaf is eaten and the petiole left attached to the shrub (Plate 15, p.85). Merton (pers.comm.) has found sign of older O. colensoi leaves, petioles and buds generally taken by Kakapo from one part of the shrub.

The pinnae of ferns and compound dicotyledon leaves e.g. (Anisotome haastii) are clipped (Plate 16, p.85). Delicate chews on ferns have been found but they fragment very quickly. From examination of damaged leaves and droppings the fine leaf tips of A. haastii appear to be clipped and swallowed whole. The cut or clipped leaf ends

may be slightly frayed or comparatively clear cut. Across the larger surfaces of Blechnum laminas a fluted edge resulting from several bites may be left (Fig.16, p.88). Opossums when feeding on the same food source leave an irregular ragged edge (Atkinson and Merton, in prep.).

ii) Petioles, twigs, fern rhachi and bark:

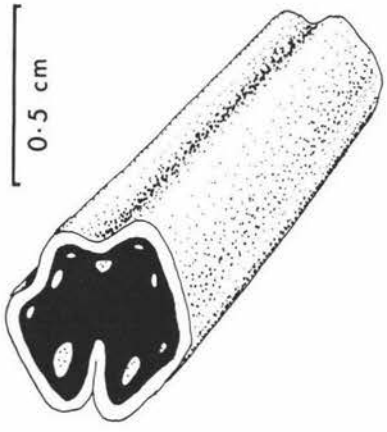
Kakapo clip petioles and twigs of vegetation, and gnaw branches and roots along the tracks which link the bowls. Observations of Kakapo track maintenance activity following the booming season in March 1976 in the Transit and Tutoko Valleys and observations of the Kakapo around its bowls in the Sinbad Valley during January - March 1975 (Gray, Merton and Morris, 1975), suggest that the clipped or broken petioles, twigs and branches about tracks are tossed haphazardly away and little if any are eaten.

Potts (1873) stated that the bark of Schefflera digitata was used as food by the Kakapo, but observations over the last three years have failed to verify this. Kakapo certainly remove the bark from roots exposed in the course of bowl excavations and likewise scar the bases of trees and low hanging branches close to the bowls and along tracks. It is not known, however, to what extent, if any, this bark is eaten.

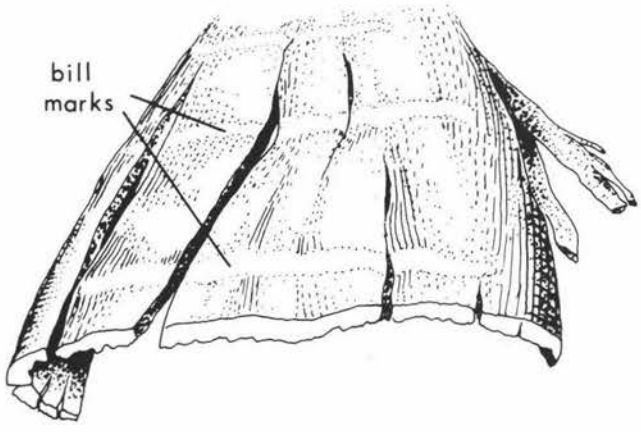
The piths of the petioles of Anisotome haastii and the rhachi of ferns (Blechnum capense and Histiopteris incisa) are utilized as foods. The

KAKAPO FEEDING SIGN

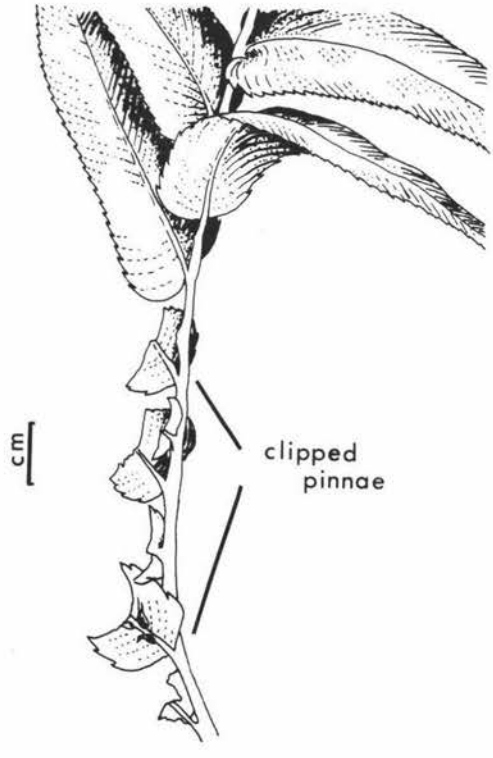
Blechnum capense

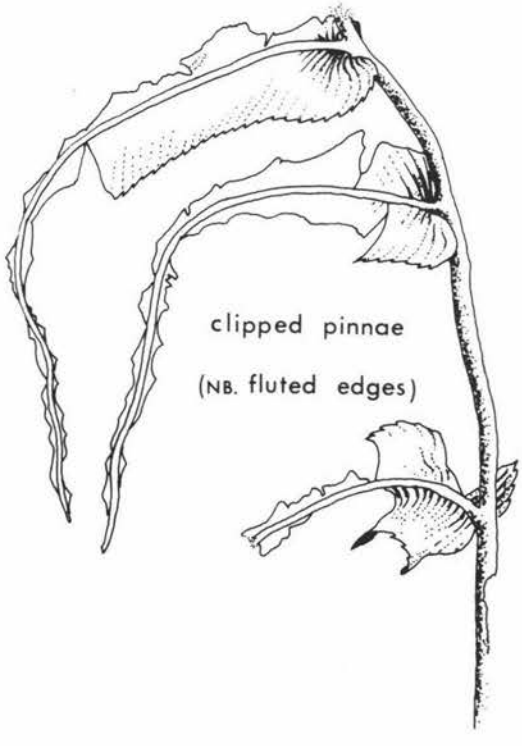


undamaged rhachis



rhachis pithed by Kakapo





Blechnum capense

Fig. 16

rhachi of Blechnum species, more or less circular in cross section, are split by Kakapo. Bill indentations which often occur at regular 5m intervals down the rhachis suggest that it is crushed, the pith removed and the exterior bark like tissue left (Fig.16,p.88). The petioles of A. haastii are 'pithed' in a similar way.

iii) Roots, rhizomes, stolons, leaf bases and bulbs:

Roots, like branches and twigs, are either snapped off or gnawed depending on thickness.

Lyall (1852) reported that Kakapo dig with their bills for food, Gray, Merton and Morris, (1975) observed Kakapo excavating bowls with their bills. The fleshy petiole bases of Celmisia species and to a lesser extent the swollen bases of Aciphylla crenulata, Astelia nervosa and the leaf bases of Chionochloa flavescens and Gahnia procera are taken as food by this method (Plate 17, p.90).

Kakapo tend to clip and chew their way into the fleshy centre rather than pull up the plant or remove the leaves as is typical of Kea but this requires more observation.

Fern rhizomes and the roots of Senecio revolutus are reported as being dug up by Kakapo (Table II, pp.74-77) in the Tutoko Valley. On Stewart Island many square meters of Lycopodium had been grubbed up by Kakapo and the roots chewed. The roots of flax and Carex adpressa were also reported to be taken by Kakapo (Russ and Anderson, 1977a,b).

PLATE 17

(P. Morrison)

Kakapo feeding on *Astelia* in captivity

PLATE 18

(R.S. Gray)

Kakapo droppings

Old weathered droppings lower left,
typical coiled droppings upper right

iv) Inflorescence stems:

The inflorescence stems of grasses, Celmisia species and flax are pithed in a similar way to the rhachi of fern leaves, although unlike ferns the woody chews (Plate 13, p.83) persist for several months after being fed upon. Specimens have been collected with the internode portion of grass stems crushed while in other specimens of Chionochloa flavescens the internodes had been specifically hollowed out.

The pith of flax inflorescence stalks are utilized as food from before their emergence from the sheath until the seeds mature. Stalks are frequently felled by the Kakapo while removing the pith.

v) Flowers, fruits and seeds:

Flowers also are eaten by Kakapo. Henry (1903a) reports rata flowers being taken by Kakapo and faecal analysis observations (Table VIII) have revealed orchid flowers (Aporostylis bifolia) had been ingested. Buckingham (1977) collected Wahlenbergia plants with the flowers chewed off, possibly taken by Kakapo although Kea were present in the region.

Fleshy fruits with small seeds (Coriaria spp., Gaultheria and Pernettya spp. and hybrids) are squashed and swallowed with the seeds passing through the gut largely undamaged. Large seeds with tough exocarps or major stone cell components (Pseudopanax spp. and Astelia spp.) generally pass through the bird undamaged. Morris and Russ (1976) found Astelia

berries with the fleshy mesocarp and some seeds consumed but the remaining seeds and exocarp had been rejected. Coprosma seeds are usually cracked and Podocarpus nivalis arils fragmented and swallowed.

Seeds of a wide variety of grasses and odd Uncinia species are stripped and chewed by Kakapo. No grass seeds have been located in Kakapo droppings so it could appear they are invariably crushed and expelled as 'chews' along with the other flower parts of the grass inflorescence. Examination of flax pods following removal of the seeds by Kakapo suggests that the pods are split by crushing, the exoccarp broken or torn away and the seeds removed, crushed and swallowed. Large numbers of flax seed fragments have been recovered in droppings.

E. Droppings.

Kakapo droppings vary in size, shape and consistancy according to the diet. Potts (1873) noted that Kakapo produce faeces of 'vast' size when on a fern diet and although recent observations have not associated large droppings necessarily with a fern diet large coiled droppings up to 10cm long have been collected.

The principal characteristic feature of many of the Kakapo droppings is the coiled, spagetti like structure and general curved contours (Plate 18,p.90). They are usually made up of very fine plant material and have only a faint odour.

F. Feeding Sign Transects (Sinbad Valley).

To obtain an estimate of the abundance of feeding sign along the ridge crest in Territory 1 and in the 'garden' area in territory 3 all feeding sign in an area 1m on each side of a 100m long transect tape was recorded. This enabled a list of sign in 200 square meters to be recorded.

Kakapo sign in two 2 x 100m transects:

i) Territory 1 - ridge crest

Species	Individual specimans	Sign and abundance
Astelia nervosa	9	9 leaves chewed
Blechnum capense	1	3 fronds pithed
Chionochloa conspicua	2	73 leaves chewed
C. pallens	2	8 leaves chewed
Dracophyllum longifolium	4	5 buds removed
Moss	2	(patches grubbed about a bowl)
Olearia colensoi	3	7 buds removed
O. colensoi	1	3 leaves eaten
Pseudopanax colensoi	1	1 stem chewed
Senecio bennettii	2	2 buds removed

ii) Territory 3 'garden'

Species	Individual specimans	Sign and abundance
Astelia nervosa	1	1 leaf bitten
B. capense	1	3 fronds pithed
C. conspicua	3	10 leaves chewed
D. longifolium	1	5 buds removed

CHAPTER VI

MAUD ISLAND KAKAPO FEEDING SIGN

A. Introduction.

Kakapo feeding signs located on Maud Island have given information that has supplemented that gained from feeding sign found in Fiordland. The three Kakapo moved to Maud Island from Fiordland have had to adapt to a new enviroment and vegetation quite different from that in the Gulliver and Esperance Valleys where the birds were captured. As Kakapo are herbivors a difference in vegetation must obviously alter their diet. During the 18 months of field observations and examination of droppings collected over a 2 year period on the island the change in the Kakapo diet has been monitored. The Kakapo on the island have learnt to feed on plants they had not previously encountered. Some of these plants species were reported by early observers such as Haast, Best and Henry as being taken by Kakapo. Many Fiordland plant genera, if not species, are represented on the island. These include many of the ferns (Blechnum spp., Asplenium spp.), flax, native grasses (Poa spp. and Notodanthonia sp.) and shrubs (Pseudopanax sp. Coriaria sp. and Coprosma spp.) some of which have gradually been sampled by the birds and included in their diet.

Foods such as apples which are foreign to Kakapo in the wild, have been widely used to help

determine the distribution and movements of Kakapo (Plate 19, p.99) on the island. Other fruits and vegetables have also been used but apples and kumura appear to be their favourites. Apples pegged out on roads and in the bush have indicated that Kakapo can cover several kilometers of ground in a night.

B. Maud Island Food Species.

Table IV : p.96.

C. Variations in Maud Island Kakapo Diet.

Chapter VIII : Fig.21.

TABLE IV

Maud Island Kakapo Food Plants

Food Species	Parts* Eaten	References	Reference* numbers
TREES, SHRUBS and HERBS:			
Acaena hirsutula	Sh	Gray, (Maud Is.Log)	
Astelia nervosa	L	Gray, Morris (Maud Is.Log)	313629
Beilschmiedia tawa	Fr	Morris, (Maud Is.Log)	
Cassinia leptophylla	L?,Se	Gray, (Maud Is.Log)	
Hypochaeris radicata	L	Gray, (Maud Is.Log)	
Knightia excelsa	L	Morris,(Maud Is.Log)	313626
Malus spp.	Fr	Gray, (Maud Is.Log)	
Melicytus ramiflorus	L	Gray, (Maud Is.Log)	
Rhopalostylis sapida	Lb	Brown, Gray, Morris, Wright, (Maud Is.Log); Table XIII	286424 286425
Rubus cissoides	BT	Morris, (Maud Is.Log); Table VII	
Rumex acetosella	BT Se	Brown, Gray, Morris, (Maud Is.Log); Tables XIII, XIV	313623
Taraxacum officinale	L	Gray, (Maud Is.Log)	313624
Uncinia uncinata	L	Morris, (Maud Is.Log)	313622
FERNS			
Arthropteris tenella	L	Morris, (1977)	
Asplenium flaccidum	L	Morris, (pers.comm.)	
A. lucidum	L	Morris, (Maud Is.Log)	
Hypolepis tenuifolia	L	Merton, (Maud Is.Log)	313627
Pteridium aquilinum	L, Rh	Atkinson, (Pers.comm.), Gray, (Maud Is.Log)	165034
GRASSES:			
Agrostis tenuis	L, Se	Brown, Mclay, (Maud Is.Log) Table XIII	313625
Anthoxanthum adoratum	L	Table XIII	
Avena sativa	L	Gray, Morris, (Maud Is.Log)	
Coraderia sp.	L	Merton, (pers.comm)	165033
Dactylus glomerata	L	Brown, Gray, McLay, (Maud Is.Log); Table XIII	
Digitaria sp.	L	Brown, (Maud Is.Log)	313633
Festuca rubra	L	Brown, Gray, McLay, (Maud Is.Log); Table XIII	286426
Holcus lanatus	L	Brown, Gray, McLay, (Maud Is.Log); Table XIII	313636
Lolium perenne	L	Brown, (Maud Is.Log)	
Phalaris canariensis	L	Brown, (Maud Is.Log)	313632
Suspected Food Species			
Asplenium bulbiferum	L		
Dysoxylum spectabile	Fr		
Elaeocarpus dentatus	Fr		

* For foot notes see Table II : p.77.

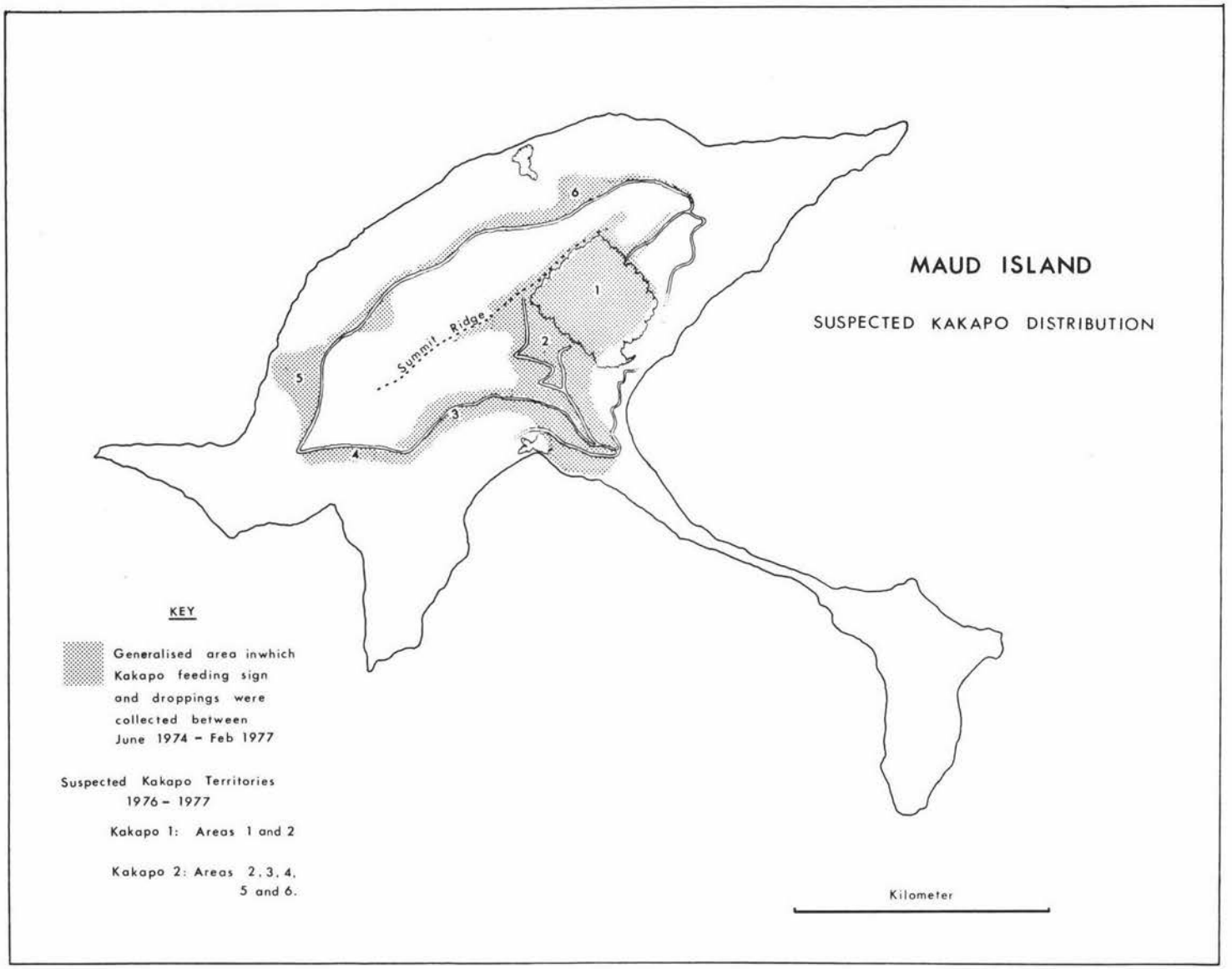

MAUD ISLAND
SUSPECTED KAKAPO DISTRIBUTION
Summit Ridge
1
2
3
4
5
6
KEY
Generalised area inwhich Kakapo feeding sign and droppings were collected between June 1974 - Feb 1977
Suspected Kakapo Territories 1976 - 1977
Kakapo 1: Areas 1 and 2
Kakapo 2: Areas 2, 3, 4, 5 and 6.
Kilometer

Fig. 17

D. Description of Feeding Sign.

i) Leaves:

Feeding signs on grass tillers (Plate 20, p.99), as in Fiordland was wide spread on Maud Island. Most feeding signs were found in the vicinity of the Ring Road, Ridge Road, Jill's Road and along the summit ridge (Fig.17, p.97).

On the large comparatively coarse canary grass (P. canariensis) feeding sign was similar to that found on Fiordland Chionochloa grasses. Tillers damaged by a feeding Kakapo had the typical frayed ends (as in Fig.14, p.80) and chews were scattered about and below the plant. This grass, although of limited distribution, was spreading rapidly during 1975 and 1976 along the roads. Despite the increasing abundance of this species it was scarce in comparison to the finer pasture grasses which cover much of the island. Feeding sign on brown top, yorkshire fog, and chewings fescue were frequently observed. Much of this sign resembled small areas of ungulate browse, where many tillers were removed, all clipped at a similar height. Chews were usually scattered about (Plate 22, p.99). In August 1977, following the removal of sheep from the northwest side of the island over 200 grass chews from the fine pasture grasses were collected along the Ring Road in the vicinity of Woodlands. Many chews on these fine grasses retain their 'kidney' shape after being compressed in the bill and frequently the 'ribbed'

PLATE 19
(R.S. Gray)

Kakapo feeding sign on apple

PLATE 20 (left)
(R.S. Gray)

Kakapo feeding sign on Oat

PLATE 21 (right)
(R.S. Gray)

Kakapo feeding sign on sorrel seed heads

PLATE 22
(R.S. Gray)

Kakapo chews scattered over clipped pasture grasses

pattern from the upper mandible serrations persisted (Plate 12, p.83).

The few examples of feeding sign found on other monocotolyedon herbs, the Astelia sp. and Uncinia sp. were identical to that of Fiordland sign: leaves with 'A' bites in the Astelia nervosa leaves and crushed leaves of Uncinia uncinata.

Herbaceous dicotyledons form an important fraction of at least one Kakapo diet, as estimated from faecal analysis samples (Chapter VIII). Field signs have, however, proved very difficult to find. Only a few examples of feeding signs on such leaves have been found on Maud Island. The first; a dandelion (Taraxacum officinale) plant with one chew was collected. The second, an inflorescence stalk of a catsear (Hypochaeris radicata) was crushed; and the third example was a single biddybid (Acaena sp.) chew found amongst a scattering of grass chews. Morris (pers.comm.) found clipped Acaena plants following the release of Kakapo, but sheep were still present at this time.

Several seedling shrubs showed evidence of one or more bites. A kakapo was observed taking a bite from the lamina of a whiteywood (Melicytus ramiflorus) seedling on Ridge Road (Gray, Maud Island Log). Morris (pers.comm.) collected in the bush a Knightia excelsa seedling with several leaves chewed.

On completion of this study in 1977 there was no indication that leaves of any particular shrub

were being substituted for the Fiordland Dracophyllum spp. and Olearia spp. From the data available from Maud Island it would appear that herbaceous dicotyledons and pasture grasses are being used as substitutes by at least one of the Kakapo.

The pinnae of ferns which include bracken, Hypolepis tenuifolia, Asplenium lucidum, A. flaccidum, A. bulbiferum and Arthropteris tenella, are clipped in a similar way to those in Fiordland. Chewed bracken, H. tenuifolia and A. tenella have been collected along with delicate chews. The rhachis and midribs of the pinnae are usually left intact. As with fern feeding sign in Fiordland, fern damage by Kakapo on Maud Island has been located only occasionally but over a wide area.

ii) Petioles, twigs, fern rhachi and bark:

On Maud Island no data has been found comparable to the sign on fern rhachi or plant petioles, collected in Fiordland. Bark, twig and branch damage associated with Fiordland track and bowl systems have been found once on the island. A Cassinia bush overhanging a 'bowl', on the Ring Road in Boat Bay, was found freshly clipped about the time a Kakapo was heard booming at this site (Morris, 1975).

iii) Roots, rhizomes and leaf bases:

No feeding signs on roots were found between 1974-77. however, the rhizomes of bracken were a major food of at least one of the Kakapo during this period. Bracken rhizomes exposed during the

construction of Ridge, Jill's and Ring Roads, and the small frequent slips exposed fresh rhizomes and these were available to the Kakapo.

In the main bush stand extensive areas of young nikau seedlings were taken by one Kakapo. The bases of these leaf stalks were chewed close to ground level which resulted in the detachment and death of the seedling.

iv) Inflorescence stems, flowers, fruits and seeds:

The consumption of fruits and seeds can be most readily ascertained by examination of faeces (Table X). It is then possible to examine the specimens of the plant species in the vicinity where the dropping was collected to see if any further feeding signs are obvious.

In the pasture and scrubland, grass (Agrostis tenuis) and sheeps sorrel (Rumex acetosella) were found stripped of seeds (Plate 21, p.99). Coprosma pumila, C. rhamnoides, Pseudopanax arboreum and Coriaria arborea seeds were also taken but no feeding signs on the shrubs themselves, could be found.

In the main bush stand (Fig.2, p.6) the fallen unripe berries of tawa are reported by Morris (Maud Island Log and pers.comm.) to be widely taken by one Kakapo; ripe fruits were too hard and were left untouched. It is also likely that fallen seeds of Dysoxylum spectabile and probably hinau were also sampled. Other forest species, Coprosma and Macropiper seeds have been found in droppings but no

feeding signs on these species have otherwise been found.

No feeding signs have been found on flowers although it is likely Kakapo sample Fuchsia flowers besides taking the Fuchsia berries (Table X).

E. Kakapo distribution as determined by feeding sign and droppings:

Three Kakapo were liberated on Maud Island between March 1974 and March 1976. To reduce the chance of upsetting the birds and hindering breeding (it was hoped initially that one bird, Jill, was a female but it was later found following the death of this bird in July 1977 that it was male) disturbance was kept at a minimum and no attempts to trap the Kakapo were made until September 1976. One bird, Jill, was caught above the Woodlands bush (area 6; Fig.17, p.97) and held in the aviary situated at the bottom eastern corner of the main bush stand. Before being released Jill was banded (Merton, Maud Island Log). No fresh droppings or feeding signs were collected on the roads while the bird was in captivity for 2 weeks.

A second attempt at trapping was undertaken by Morris in May 1977 (Maud Island Log). The bird, Jill, was retrapped on the Ring Road and a second bird (Richard Henry) was caught in the main bush stand and banded. Both birds were held in the aviary for several days. There was no indication that a third bird was still living on the island (Morris, pers.comm.).

This data provided a basis for the interpretation of feeding signs and droppings collected between March 1974 and December 1976. Initially it was suspected that the 3 birds occupied comparatively small areas, one near the summit, the second on Jill's Road, the lower section of Ridge Road and part of Boat Bay. The third bird was believed to occupy the Starvation Bay area. In late 1975 and during 1976 examination of droppings which at any one time were of similar consistency and composition, coupled with the distribution of apples sampled by Kakapo and several observations of a bird(s) gradually dispelled this assumption. During 1976 it appeared that one bird ranged over Ridge Road, part of Jill's Road, Ring Road in Boat Bay, Starvation Bay and was gradually extending its range up the northwest side of the island as far as Woodlands after the sheep had been removed.

Several droppings collected on Ridge Road in April 1976 exhibited a conspicuous difference in content (nikau and Asplenium cuticle, and a berry excocarp). It was thought at the time that the bird occupying the roads was making odd forays into the bush which could account for the chewed nikau seedlings. In the light of the capture of the bird in the bush in May 1977 it was more likely that the territory of this bird (Richard Henry) overlapped Jill's territory on part of Ridge and Jill's Road (Fig.17, p.97).

CHAPTER VII

OBSERVATIONS OF KAKAPO

A. Feeding in the Wild.

The Kakapo is generally a nocturnal feeder (Potts, 1873; Buller, 1888; Henry, 1903a; O'Donoghue, 1924), a habit which has hindered observations of feeding in the field. Haast (1864) reported seeing Kakapo twice in daylight, on one occasion the bird seen was feeding in a Fuchsia tree. Henry (1908) also records birds feeding in daylight and implies that this was due to food shortage.

During the booming seasons in the summers of 1974-75 and 1975-76 three Kakapo were seen moving about during daylight hours. One of these birds (Sinbad Valley, territory 2) was seen on two occasions by Morris (Gray, Merton and Morris, 1975), once in the early afternoon (1400hrs) in wet misty weather on the booming ground. On the second occasion the same bird was encouraged to remain on its booming ground until 0900hrs by the observer approaching the Kakapo bowl thus inducing the bird to display.

The bird in territory 2 on the same ridge was observed by Morris in the early evening (1700hrs) breaking twigs in a rata tree.

The third Kakapo, one of the 3 male birds on the Tutoko High Bench, was seen by Scown (1976, and pers.comm.) shortly before sunset (2000hrs) in thick alpine scrub.

These observations are of interest when considering Henry's (1908) implication that food shortage is responsible for daylight feeding. In the 3 instances cited above I consider it more likely that because many hours are spent booming at night during the booming season, feeding times may well have to extend into daylight hours both before and after dark, particularly if light intensity is low, as in the case in wet or misty weather. On Stewart Island in July 1977 warm droppings were collected during an afternoon (Russ pers.comm.) and it was suspected that birds were feeding in the late afternoon.

No daytime sightings have been reported on Maud Island, although Brown (Maud Island Log, 1975) disturbed a Kakapo on Jill's Road in the early evening and it glided down a slope off the road. Some 6 other sightings of the bird, have all been during hours of darkness on Jill's, Ridge, and the Ring Roads.

At the Mt. Bruce aviary the only bird which survived for any length of time was strictly nocturnal (P. Morrison, pers.comm.). The remaining 4 birds were diurnal; and Morrison suggests these 4 were probably suffering from disorientation and concussion.

Climbing: Although a ground bird the Kakapo is a skilled climber. Its wings permit only short glides and some degree of control when leaping from a height. Dieffenbach (in Gray, 1847) mentions that

the Kakapo occupy the low branches of trees, while O'Donoghue (1924) reports the Kakapo is a 'splendid climber' and that 'it frequently finds its way into the tops of medium sized shrubs and trees, when climbing much use is made of the powerful beak'.

Both Haast (1861, 1864) and Henry (1903a) report seeing Kakapo in trees. Henry records them sunning themselves on branches and Haast (1861) records Maoris capturing the birds in Coriaria shrubs.

Kakapo under observation in the Sinbad Valley between January and March 1975, and the Maud Island birds, have also been observed climbing trees and shrubs.

In the Sinbad territory 2 of the males when disturbed on two occasions climbed low shrubs: on one occasion an Archeria traversii bush, and on another a Senecio bennettii shrub. Morris, (Gray, Merton and Morris, 1975) as previously mentioned saw a Kakapo in a rata growing nearly horizontally from a steep bank.

In early February Kakapo number two was seen in a silver beech tree above the track and bowl system on two consecutive nights. It was suspected that this bird was investigating a hide platform that was being constructed in the tree. Morris (Gray, Merton and Morris, 1975) observed this same bird moving up hill some 20m at a height of 7m above ground through several low beech trees growing on steep terrain. The bird climbed up to

the beech canopy using bill and feet. On the uphill side the bird moved out along the outer most branches and grasped the terminal twigs of the next tree and pulled itself over. Wings were not used except for balance by means of occasional flapping.

On Maud Island Kakapo have been seen climbing Cassinia shrubs and two forest trees. Morris (Maud Island Log) on two occasions saw Kakapo in trees after they had been released from the aviary. The first was in April 1974 when a Kakapo was seen approximately 3m above ground on the trunk of a Dysoxylum spectabile tree inclined at 45 degrees. The second sighting followed the release of Kakapo 'Richard Henry' from the aviary in May 1977. In this instance the bird climbed the vertical trunk of a D. spectabile and continued climbing into the 7m high canopy. Trunks of D. spectabile in this forest stand are comparatively smooth and straight but the tree climbed by the bird supported a fine rata vine (Metrosideros sp.) leading up to a narrow cleft 1.5m above ground. It ran up the trunk and enabled the bird's bill and feet to gain purchase. The bird balanced itself by intermittent flapping of its wings which may also have provided lift.

At Mt. Bruce one Kakapo frequently climbed the wire netting enclosure of the aviary up one side, across the roof hanging upside down, and down the other side. (P. Morrison pers.comm.). Russ and Anderson (1977b) found roosts of Stewart Island Kakapo up

to 3.5 above the ground in manuka scrub.

Wings: A Kakapo is unable to use its wings for flight because the sternum is incomplete and the flight muscles are undeveloped.

A Kakapo disturbed by Brown (Maud Island Log, 1975) leapt from a road verge on Maud Island and glided approximately 6m down a steep slope approximately 40cm above the ground before it landed awkardly in the bracken and slipped quietly away. On a second occasion one of the Maud Island Kakapo when disturbed over a more gently sloping terrain (c.25°) left the road and jumped in a series of 2m bounds down a grass covered slope (Gray, Maud Island Log). The bird appeared to thrust itself forward into the air with its legs, the wings were spread and a brief glide ended in a heavy landing. The process was repeated until the bird reached bracken cover.

Haast (1864) recorded that when a Kakapo runs the wings are held slightly open for balance. This has also been noted with the Kakapo seen on Maud Island (e.g. Kakapo 'Richard Henry' when released from the aviary; Morris, pers.comm.).

When climbing and clambering through scrub and fern the wings are again frequently used for balance (Gray, Merton and Morris, 1975; TV.1 documentary film; Gray, Maud Island Log).

Haast (1864) observed a bird that when disturbed in a tree 'fell as if shot'. A similar example was noted in the Sinbad Valley (Gray, Merton

and Morris, 1975) territory 2: the Kakapo when attempting to climb an observer's leg was shaken off, and the bird fell over a 6m bluff. A second member of the party climbing up from below reported that the bird 'parachuted' over his head and down into the scrub. Upon landing the bird promptly walked back up the 'track' leading to the booming area from where it had been dislodged.

Fiordland feeding observations: Observations of Kakapo feeding in the wild have been extremely rare during this study, and likewise in the 70 years prior to 1974 there has been an almost complete absence of reported observations. Of the many thousands of man hours spent in the field by Wild Life Service personnel volunteer workers and others looking for Kakapo in Fiordland and Stewart Island (Wild Life file nos. 46/61/1 and 25/3/4) there is only one reported observation of a Kakapo feeding on natural foods (apples and vegetables offered to comparatively tame birds excluded). Morris (Gray, Merton and Morris, 1975) observed a Kakapo briefly pause and rapidly strip and chew the seed head of a Uncinia species alongside one of the bird's tracks.

Maud Island feeding observations: From Maud Island 3 sightings are of interest (Gray, Maud Island Log; 1975-76). The first was in the late evening when a bird was disturbed as it fed on bracken roots protruding from a bank alongside a road cutting. The

bird shortly afterwards clambered over the bracken. It held its wings out from its body and used them for balancing. They appeared also to aid movement. Two 1m high Cassinia leptophylla shrubs were climbed by this bird. The feet and bill were used to pull branches to within reach so that the bird could browse the terminal leaves of the branches. Close observation of these areas the following day, however, revealed no damage to the plant. It was uncertain what the bird had obtained.

The second sighting was from a hide through a starlight scope (zeniscope) when the bird was in view for several minutes. It moved into the field of view very rapidly and resembled an elderly man jogging. After pausing several minutes to eat half an apple the bird jogged rapidly along Jill's Road, paused to nibble at a grass or herb plant and then continued on out of sight. The plant which appeared to be eaten could not be located when the area was examined closely for feeding sign. Five minutes later the bird returned and subsequent checking indicated another apple had been half consumed during this period. The bird loped on past the hide with a rapid but easy gait and on up a track leading to the summit. The impression gained from these brief observations was the Kakapo's rapid movement and the considerable distances that it could cover in an evening.

The distribution of fresh droppings on the roads

of Maud Island tend to support the fact that the birds cover considerable distances, at least several kilometers in a night. Similarly on the Tutoko High Bench in the winter of 1976 (Morris and Russ, 1976) fresh Kakapo tracks were widespread over the snow in a windfall area amongst silver beech where the birds recent movements could be followed for considerable distances. The Kakapo in this area was making use of fallen trees as 'walk ways' or bridges which spanned vegetation which might otherwise be difficult and wet to pass through. Trampling of snow about fruiting Coprosma bushes suggested the birds were feeding upon these drupes.

B. Feeding in Captivity.

i) Fiordland:

Four birds were held in an aviary constructed in the Esperance Valley. Three of the birds held were obtained from three nearby territories (Plate 2, p.5) and were held until their removal to Maud Island. A fourth bird captured in the Sinbad Valley was held for several days for filming purposes. Observations of these birds while in captivity are included in a paper by Atkinson and Merton (in prep.). Food fed to and sampled by these birds while in the aviary are listed in Table V, p.113.

ii) Maud Island:

Here the 3 Kakapo were briefly held captive before their initial release. Subsequently two birds

TABLE V

Indigenous Plant Foods Offered to Kakapo in the Esperance Valley Aviary (March 1974)
(Atkinson and Merton, in Preparation)

Plant Species	Part Offered
Aciphylla sp	leaves
Anisotome haastii	leaves
Aristotelia fruticosa	(fruit)
Asplenium flaccidum	(leaves)
Astelia sp.	fruit*
Blechnum capense	leaves, rhizomes*
B. penna-marina	leaves
Carmichaelia grandiflora	leaves, stems
Celmisia sp.	leaves
Chionochloa conspicua	leaves, seeds*
C. flavescens	leaves*
Coprosma astonii	fruit
C. parviflora	fruit
C. pseudocuneata	fruit
C. rugosa	fruit
Coriaria plumosa	leaves, fruit
C. sarmentosa	leaves, fruit
Fuchsia excorticata	fruit
Gaultheria spp.	fruit
Hierochloe spp.	(leaves)
Hoheria glabrata	(fruit)
Moss	(leaves) ?
Phormium cookianum	leaves, seeds
Poa colensoi	(leaves)
Podocarpus nivalis	(fruit)
Polystichum vestitum	leaves
Pseudopanax sp.	(leaves, fruit)
Schoenus pauciflorus	leaves*

( ) plant part offered but not eaten.
* appeared to be a favourite food.
no asterisk : small amounts eaten.

were retrapped, one of them twice. The first bird, 'Jill', was held in September 1976 for two weeks to obtain developing feather papillae for hormonal tests to determine the bird's sex. It was released after being banded with a white band.

During May 1977 'Jill' and 'Richard Henry' were trapped, both were dosed for worms and the latter / banded with a red band. No observations of feeding were recorded as the birds fasted for considerable periods. The few foods they sampled were Hypolepis tenuifolia, nikau seedlings and introduced grasses which were growing in the aviary, and portions of apple, potato and kumera.

iii) Mt. Bruce:

The longest surviving Kakapo at Mt. Bruce was regularly observed but only limited records were kept of feeding and behaviour (Reid, 1970; Roderick, 1976; Morrison, no date). The food preferences at any one time according to Morrison (pers.comm.), who had the Kakapo under his care for 9-10 months, were varied and sporadic. The Kakapo would take a sudden liking to one item of fresh food supplied and eat this for a time to the exclusion of other foods. This habit of frequently taking only one or two food species in an area at any one time has been confirmed by field observations.

At Mt. Bruce honey water (1 heaped desert spoon on honey to 0.28l ($\frac{1}{2}$ pint) of water) and apples were most frequently taken, but even these the Kakapo

TABLE VI

Plant Foods Fed to Kakapo at Mt. Bruce.

Plant Species		Part Offered
Aristotelia serrata	(wineberry)	(L),St.
Astelia cunninghamii		L
Avena sativa	(oat)	Se*
Carex spp.		L
Chionochloa spp.	(tussocks)	L
Cortaderia sp.	(toetoe)	L
Daucus carota	(carrot)	R
Fragaria sp.	(strawberry)	(Fr)
Hebe salicifolia		L*,St.
Helianthus sp.	(sunflower)	S*
Honey water		**
Hordeum sp.	(barley)	Se
Japonica sp.		L
Juncus maritimus		L
Lycopersicon sp.	(tomatoes)	Fr*
Malus sp.	(apples)	Fr**
Metrosideros scandens?	(rata vine)	L*
Microlaena avenacea	(bush rice grass)	L
Nothofagus fusca	(red beech)	L*
Pittosporum eugenioides	(lemonwood)	Fr,St.
Polygonum sp.	(willow weed)	Se*
Pseudopanax arboreum	(five finger)	(Fr,L),St.
Pyrus sp.	(pear)	Fr*
Ribes sp.	(currents)	(Fr)
Ripogonum scandens	(supplejack)	Fr
Rubus cissoides	(bushlawyer)	L*
Rubus sp.	(raspberry)	(Fr)
Rumex sp.	(dock)	Se,R
Salix sp.	(willow)	L**
Schefflera digitata	(pate)	(Fr,L),St.
Weinmannia racemosa	(kamahi)	St**(L)

Table VI continued:

Plant Species - Ferns	Part Offered
Asplenium bulbiferum	L
A. falcatum	L
A. flaccidum	L
Blechnum capense	L*
B. discolor	L*
B. fluviatile	L
B. lanceolatum	L
Cyathea dealbata	L
Dicksonia squarrosa	L
Dryopteris pennigera	L
Histiopteris incisa	L*
Microsorium diversifolium	L*
Polystichum richardii	L
Pteridium aquilinum	L*, St*
Pyrrosia serpens	L
Todea hymenophylloides	L?

Key

Fr	fruit	L	leaves
R	roots	Se	seeds
St	stems and petioles		

( ) plant part offered but not eaten

** food a favourite

* food commonly eaten

no asterisk: food rarely or only occasionally eaten.

ceased to sample for periods of several weeks. The petioles of kamahi and the kernal of oat seeds were likewise Kakapo favourites (Table VI, p.115).

Bracken was sampled by the Mt. Bruce bird at a particular stage of maturity. The fronds were taken when fully opened but before they became brittle and 'woody'.

C. Cine Film Observations.

One Kakapo from territory 3 in the Sinbad Valley was captured in March 1975 (Gray, Merton and Morris, 1975; Russ, 1975), flown to the Esperance Valley aviary, and held there for several days to film for a Television One documentary. Film sequences of the Kakapo feeding on Coprosma rugosa berries and Chionochloa conspicua seeds were obtained.

i) The chewing of a Coprosma rugosa drupe:

The Coprosma drupe (berry) appeared to be selected on sight. Once selected, the bird stretched its neck and head towards the desired food and simultaneously opened its bill. The upper mandible is hinged (kinesis) in Kakapo as with other parrots enabling movement of both mandibles (Forshaw, 1973; Smith, 1975). With the bill wide open the upper mandibles were then closed and the drupe was delicately held against the upper mandible by means of the lower mandible and then rolled deeper inside the mouth following the curve of the serrated palate (Fig.18, p.118). The tongue then appeared to be used to manipulate the Coprosma drupe while the lower

KAKAPO CHEW FORMATION

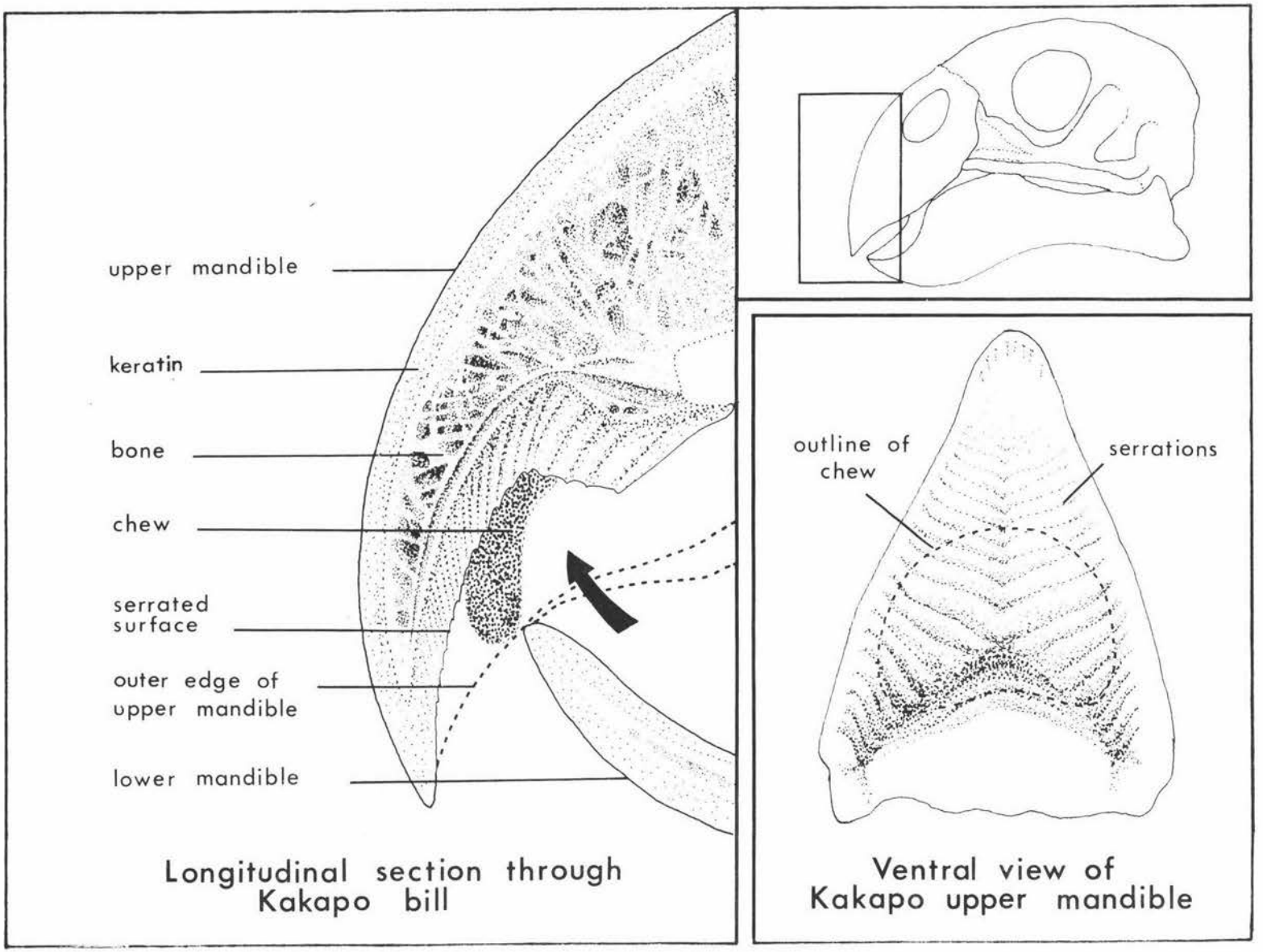


Fig. 18

mandible was lowered before a rapid upward crushing movement.

Following this initial crushing action there was considerable minor movement of the lower mandible as if a rasping or crushing action was in progress. This continued for about 10 seconds then ceased.

According to Forshaw (1973) this method of manipulation and crushing of seeds and fruits is typical of a great many parrot species.

ii) Chinochloa grass seed-removal and chewing (Fig.19, p.120):

The kakapo grasped cut inflorescence stalks of Chionchloa conspicua in its left foot while its right clasped the branch on which it perched. The bird lowered its neck and head and selected one or two inflorescence stems and held them lightly in its bill below the seed head (position A. Fig.19, p.120). The bird then rapidly raised its head in a sweeping arc slipping its bill along the inflorescence stem and so on over the seed head. Seed stripping by the bill involved two stages: first, a rapid 0.9 second movement, (22 frames at 25 f/sec.) followed by a brief pause at position B (Fig.19, p.120) before the second stage began. The head was then raised further and the neck stretched to position C. (Fig.19, p.120). The entire sweeping upward movement of the head lasted just under two seconds (43 frames at 25 f/sec.) before the head returned to position B and a rapid masticatory action began with the tip

STRIPPING OF GRASS SEED BY KAKAPO

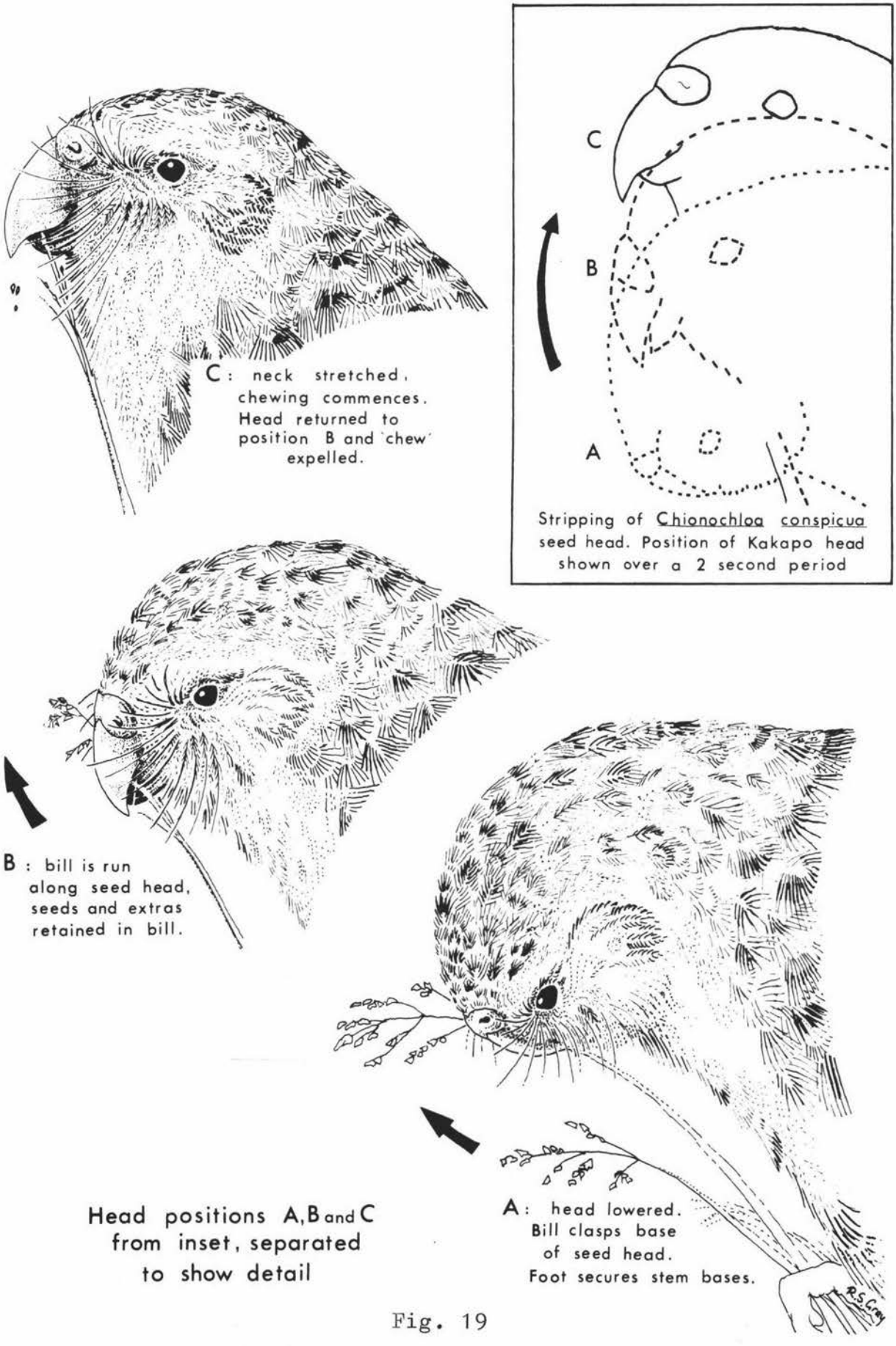


Fig. 19

of the inflorescence stalk still in the mouth. The masticatory action continued for nearly 2 seconds (47 frames at 25/sec.) before the inflorescence was rapidly pulled out and a chew expelled. Chewing continued for another 1.5 seconds after which the head was lowered to take another inflorescence and a similar process repeated.

During the second cine sequence 14 masticatory 'bites' occurred and a fragemented 'chew' was expelled after the tenth or eleventh mastication.

Morris (Gray, Merton, Morris, 1975) observed the Kakapo - Territory 1, Sinbad Valley stripping the seeds from an Uncinia sp. in a similar way to that described for C. conspicua.

iii) Chew formation and mastication:

The formation of 'chews' is an important characteristic of the Kakapo's feeding habit. Once in the mouth leaves and other flexible plant matter are compressed against the serrated upper mandible by the lower mandible (Fig.18, p.118). This results in the food being crushed, much like being flattened between a hammer and anvil. In the Kakapo, the upper mandible resembles the anvil, the lower mandible the hammer. Serrations on the upper mandible probably help secure the chew between successive bites. Henry (1903a) suggests that the serrations acted as a file. This is probably true to some extent but more extensive observations would be necessary to determine this and opportunities for such observation have not so far occurred.

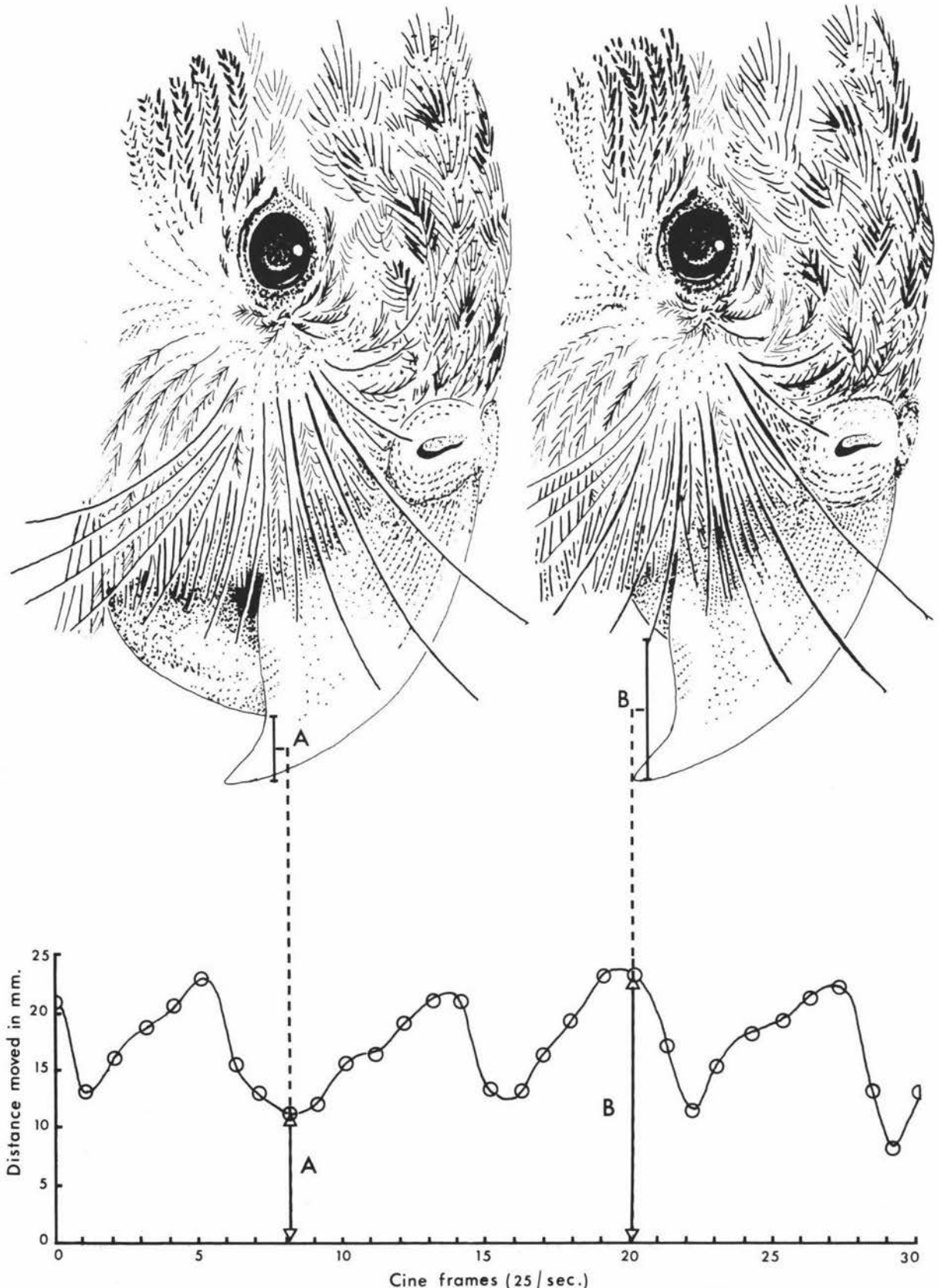
The crushing of food between the two mandibles enables a portion of the available nutrients to be removed (Chapter IX: Table XVII) and the more fibrous portions of the food are expelled as chews. This is an interesting adaption as it means the lignified and presumably indigestable celluloses and hemicelluloses are only consumed in limited quantities while the most readily available plant fractions pass into the crop. Few bird species are capable of breaking down cellulose. In chickens and grouse some cellulose break down is believed to occur in the caecum (Morrison, 1959; McBee et al.,1969; Farner and King, 1971) but Psittaciformes do not possess a caecum (Smith, 1975). A suggestion has been made by Farner and King (1971, Vol.II: p.356) that the large crop of the Kakapo may have an important role in this respect, not unlike the Hoatzin (Opisthocomus hoatzin). The unusually large crop of Strigops is apparently an interesting anatomical feature. Haast (1863) reports that some crops weighed several ounces.

The regular masticatory action of the Kakapo crushing a Coprosma drupe is illustrated in Fig.20 (p.124). A similar mode of chewing was observed on the cine sequence of the formation of Chionochloa conspicua chews. Observations of the bird in the field chewing apples suggest that this type of chewing action is typical. The sequence recorded was longer than that shown in the graph

Fig.20, p.124) and continued for nearly 6 seconds. Initially the action of the lower mandible was irregular, due possibly to the presence of seeds. After the first second (25 frames) mastication became more regular and cyclic as shown (Fig.20, p.124).

It may be noted that a slight hump is evident as the lower mandible rises and closes. This suggests that the closing of the lower mandible occurs in two stages, first the bite, then the compression of the chew.

KAKAPO MANDIBULAR ACTION



Regular chewing action of lower mandible

Fig. 20

CHAPTER VIII

FAECAL ANALYSIS

A. Introduction.

The microscopic analysis of faeces has been widely used to help determine qualitatively the diets of a wide variety of animals and birds (Adams, 1957; Adams, 1962; Baumgartner et al., 1939; Croker, 1959; Dusi, 1949, 1952; Scott, 1941; Voth, 1973). Faecal analysis is a helpful method when it is desirable to keep disturbance to the animal or bird at a minimum. The method is especially useful with Kakapo living in their natural habitats where steep terrain, high rainfall, the generally low, thick vegetation in feeding areas and the birds' nocturnal habits make observations extremely difficult.

B. Methods.

i) Field collection:

Field parties of the Wild Life Service were requested to collect all fresh and recent Kakapo droppings and samples of old Kakapo faeces from dry roosts in Fiordland. In most cases the droppings were sealed in plastic bags and labelled with data on location, number of droppings, estimated age and date collected. Droppings were eventually forwarded to Massey University for analysis.

a) Fiordland Kakapo faeces: Less than 30 fresh Kakapo droppings were collected during three summer

seasons (14 months field work) and these were found on track and bowl systems.

A number of fresh droppings were collected during the winter trip to the Tutoko High Bench in June 1976, at roost sites in silver beech forest 300 meters below a track and bowl system (Morris and Russ, 1976).

Recent droppings (several weeks old) and old droppings (over one month old) were collected from feeding areas near track and bowl systems, particularly on open rock slabs, rock outcrops and tracks leading to bowls where vegetation, when present, was short.

The majority of faeces were collected from roosts amongst the exposed roots mainly of Nothofagus and more commonly under dry rock overhangs.

b) Maud Island Kakapo faeces: Collection of droppings on Maud Island was confined mainly to the 'roads' - rough tracks excavated by bulldozer in 1974 (Fig.2, p.6). Initially vegetation was absent on these freshly excavated tracks and although grass, bracken and other species gradually established themselves walking tracks were maintained. Sheep were permitted to graze much of the road which circled the island until they were removed in spring 1976.

It was fortunate that Kakapo often used these roads, either to feed on or to move from one area to another. Droppings, therefore, were comparatively easy to find and could be regularly collected. Use

of roads by Kakapo was encouraged by placing apples and more occasionally other potential Kakapo foods at various points along the roads.

On arrival at Maud Island, field parties were encouraged to check all roads, collect all droppings and place an apple at each of several 'feeding stations' (usually 5-12). Generally it was several days before the apples were found and sampled by the Kakapo and subsquently fresh droppings found and collected.

ii) Age of faeces:

The age of droppings collected in the field varied enormously. Fresh droppings, those assumed to be less than 72 hours old, were rarely found in Fiordland.

On Maud Island a small number (1-8) of fresh droppings were usually collected during a 5 day visit every 5-6 weeks. The regular visits to the island in 1975 and 1976 enabled seasonal variations in the Kakapo diet to be monitored to some degree. In Fiordland this was more difficult as collections of droppings were generally confined to summer and autumn. The ages of most droppings, particularly those collected under dry rock overhangs and shallow caves were suspected to be many years old, possibly 50 years or more.

iii) Storage of faeces:

Faeces were kept in plastic bags until their arrival at Massey when they could be frozen.

iv) Plant cuticle reference collection:

Plants were pressed in the field or stored in plastic bags until moved to the laboratory. Plant cuticles of 130 Fiordland plant species from 85 genera were collected, the majority from Kakapo territories (Appendix 1). From Maud Island plant cuticles from 60 species were collected (Appendix 2).

Reference cuticles were prepared by the Chromic/Nitric Acid method (Zyznar, 1969; Dunnet et al., 1973) which involved a 50:50 mixture of 2N Nitric Acid (HNO_3) and a saturated solution of Chromium trioxide (CrO_3).

Basically, the leaves of each species were processed in acid and with many species cuticle preparations in addition from petioles, twigs, stipules, inflorescences, exocarp and petals were prepared. A reference collection of microscopic accessory structures including hairs (trichomes), scales, and fern palea was also prepared.

Plant parts were cut into small portions several millimeters in length and left for varying lengths of time (10 minutes - 48 hours) in the acid, depending on the size, thickness and moisture content of the leaf. The cuticle and remaining material was then washed and bottled in FAA (70% alcohol, 90pts; glacial acetic acid, 5pts; 40% formaldehyde, 5pts).

v) Identification aids:

a) Photographs: Initially it was hoped all cuticles could be photographed and that satisfactory

identification could be made from photographic points of the abaxial surface of the leaves (Davies, 1959; Storr, 1961; Zyznar, 1969). This method, however, proved of value only as a general guide to the plant species involved.

b) Tabulated cuticle characteristics: Because of the large number of species in the reference collection, a chart of plant cuticle characteristics limited the reference cuticles which had to be checked and compared with the unknown cuticles in the droppings. On the chart, characteristics such as cuticle, and cell wall thickness; cell and stomata size, shape, segmentation and arrangement amongst other features were noted.

c) Sketches: Scale diagrams (similar to Davies, 1959) of trichomes (hairs, scales, palea) and some cuticles proved helpful and supplemented the photographs.

d) Semi-permanent slides: Some reference cuticles were mounted in glycerine and the coverslips sealed with nail varnish. Although satisfactory, bottled reference cuticles in FAA which could be readily mounted in water, examined and then returned to the preservative, were preferred.

vi) Cuticle analysis proceedure:

a) Sampling: Fresh and recent droppings were examined individually as well as old droppings if they had been found singly. In many instances, however, quantities of old droppings were collected from roosts.

These were bulked, mixed and then sampled.

Although many roosts were dry, humidity in Fiordland is high (Gray, Merton, Morris, 1975) and break down of droppings continues slowly. Thus many droppings and fragments were included in a fine silt of faecal material. Keas and small animals (rodents, mustelides and opossum) occupied or visited these sites and care was needed when taking samples of droppings.

For analysis work a few typically coiled Kakapo droppings were selected (10 or less).

b) Wet preparations: Samples of dry droppings were crumbled between the fingers into a petri dish containing water, while moist samples from fresh droppings were whisked in water with tweezers. These preparations were examined under a binocular microscope magnification 0.7 - 4.0 times. When present, seeds, leaf fragments, large pieces of conductive tissue and other items of interest were removed for later identification. The wet sample was then filtered in a coarse grade filter paper and set aside for Chromic/Nitric Acid treatment.

c) Chromic/Nitric Acid process: Faecal samples were macerated in a similar fashion to the leaves according to the following method:-

1.1 Wet sample of faecal material placed in watch glass.

1.2 Sufficient acid added to immerse sample.

1.3 Acid left to 'work' at room temperature for up to 20 minutes depending on content and age of dropping.

1.4 Filtration of acid and washing of sample.

1.5 Cuticles and remaining plant material removed from filter paper and preserved.

d) Examination of cuticles: To become acquainted with the variety of cuticles and other plant material present a methodical examination of all material on several slides was undertaken. The more diverse the sample the more slides were examined. If the acid treatment seemed to have been too severe or insufficient for identification more samples were prepared. A list of the names of known and suspected cuticles were listed. Unknown cuticles were given a number and a scale sketch drawn. It was intended that as one became more familiar with variations in the cuticles within a species, and as new species were added to the reference collection, so eventually a name might be supplied. (For reference collection cuticles see Appendices 1 and 2.)

Once acquainted with the cuticles and plant cells in the sample an estimate of the contents in the processed dropping was undertaken. Generally several dropping samples were combined and 5 to 8 slides examined. A transect method was used where either 100 or 200 points, depending on the diversity of material were examined. In each slide an area of medium density was selected. The first 20-30 items to pass under the centre line of the grid scale as the slide was scanned were listed.

This enabled an estimate of the percentage total cuticle present, the percentage of individual species,

and the amount of fibrous plant matter (Stewart, 1967). Before the count was made seeds and massed conductive cells when present were removed with tweezers and a coverslip positioned over the sample.

vii) Preservation of processed faecal samples:

a) FAA preservative: Processed faecal material was bottled in FAA so that it could be re-examined as names were given to diagrams of previously unnamed cuticles.

b) Semi permanent slides: A few samples of particular interest were mounted in glycerine and sealed with nail varnish for later reference.

c) Permanent slides: During the early stages of the investigation faecal samples were mounted as permanent slides in xylol prior to examination but this method was too time consuming.

C. Results from Kakapo Faeces.

i) Introduction:

Attempts have been made to quantify the results from faecal analysis of a number of herbivorous animals (Stewart, 1967; Sparks and Malechek, 1968; Dunnet et al., 1973). The cuticles of leaves have been used as a basis for the estimates. Results indicate that care is necessary in the interpretation of these studies. Stewart (1967) has suggested that different species of grasses break into fragments which differ significantly in size. In view of this he suggests a point quadrat method of sampling, which

though tedious, reduces the chance of a significant difference being found between expected and estimated leaf epidermises. Sparks and Malechek (1968) proposed a statistical method based on the presence or absence of cuticle and this method has been used successfully with grasses, although Slater and Jones (1971) using grasses and legumes reached less convincing conclusions. Their results showed that clover may be undetected in sheep faeces, a result which differs from that obtained by Hercus (1960).

Experiments in which opossum were fed 39 species of New Zealand native plants showed that all species were detectable in their faeces (Dunnet et al., 1973), although the persistence of cuticles varied between plant species. The estimated cuticle content of faeces was found to vary between animals of the same species fed identical diets (Stewart 1967; Dunnet et al., 1973).

Young leaf cuticles of 5 plant species appeared to be less persistent than mature leaves (Dunnet et al., 1973) and abaxial and adaxial leaf surfaces showed differing persistence in some species of grass (Stewart, 1967).

Although these experiments had been carried out on herbivorous mammels and marsupials the warnings are relevant to my attempt to predict a Kakapo diet from faecal material without feeding trials on a number of these birds. The problem is heightened by the bird's characteristic habit of forming

'chews' (Chapter V, 82-4) containing high proportions of fibre and cuticle which are expelled from the bill.

ii) Fiordland:

a) Plant cuticles and accessories: Examination of Kakapo faeces revealed the presence of a wide variety of leaves in addition to other plant tissues. Leaves eaten included those of trees, shrubs, ferns, herbs and grasses. Indications in Table VII, p.135 and Appendix 3, that Cryptogams (Moss spp.) may have been eaten was not always certain as these were sometimes associated with old droppings on which Cryptogams become established after deposition. Leaf cuticles from 24 different genera (2 doubtful) are listed in Table VII and Table VIII. Unidentified cuticles are not included; thus Tables VII and VIII are not complete. The unidentified cuticles probably included both new species and species already listed but the cuticles may have been a part of a plant's anatomy which was not included in the reference collection (petal etc.).

From droppings collected the cuticles occuring most frequently in the 11 valleys listed in Tables VII and VIII were Fern spp. which were present in droppings from all 11 locations, Blechnum spp. being the most common. Grass cuticle was recorded in droppings from 6 valleys, Anisotome haastii (a herb) from 6 areas; and Dracophyllum spp. (a subalpine shrub) from 5 areas.

There was no indication that Kakapo eat

TABLE VII

Plant Cuticles from Fiordland Kakapo Faeces

	Caswell Sd.	Donne V.	Gulliver V.	Harrison V.	Poison B.	Poseidon V.	Sinbad V.	Surprise Ck.	Takahe V.	Transit V.	Tutoko V.
Number of faeces analysed	c.6	16	20	10	5	20	73	25	10	35	120
Leaf Cuticles											
Acaena sp.				+							
Aciphylla crenulata											+
Anisotome haastii					+	+	+	+		+	+
Aristotelia fruticosa							?				?
Astelia sp.						+	+			+	+
Carex sp.			+					?		+	
Celmisia sp. (*C. lanceolata* and/or *C. verbascifolia*)										+	+
Chionochloa sp.			+								+
Coprosma sp.							+				
Dracophyllum sp.					+	+	+			+	+
D. menziesii							+			+	+
D. uniflorum										+	
Fern spp.	+	+	+	+	+	+	+	+	+	+	+
Asplenium sp.							+	?			
Blechnum sp.		+	+	+	+	+	+	+		+	+
Polystichum sp.		+		+			+			+	
Gaultheria sp. (*G. crassa* and/or *G. rupestris*)					+					+	+
Grass sp.		+	+	+			+		+	+	+
Gunnera monoica							+				+
Hebe prob. *macrantha*					+						
H. subalpina				+			+			+	
Hymenophyllum sp.	+	?		?			?	?	?	?	+
H. multifidum	+									?	+
Nothofagus menziesii		?				+	+	?	?	+	+
Moss		?	?				?				?
Olearia colensoi							+				
Phormium cookianum						+					
Podocarpus nivalis			+								+
Pseudopanax colensoi		+									?
Rubus cissoides										+	
Senecio scorzoneroides											?

TABLE VIII

Plant Cuticles From Fiordland Kakapo Faeces

	Caswell Sd.	Donne V.	Gulliver V.	Harrison V.	Poison B.	Poseidon V.	Sinbad V.	Surprise Ck.	Takahe V.	Transit V.	Tutoko V.
Number of faeces analysed	c.6	16	20	10	5	20	73	25	10	35	120
Plant Cuticles other than leaves											
Aporostylis bifolia (flower)											+
Astelia sp. (exocarp)											+
Astelia sp. (scales)			+							+	+
Caltha novae-zelandiae (leaf hairs)											+
Coprosma sp. (exocarp)											+
Coprosma sp. (petiole)							+				
Cyathodes juniperina (exocarp)										+	
Cyathodes juniperina (bract)										+	
Gaultheria sp. (petiole)				?			?				
Nothofagus menziesii (petiole)				?			?				
Myrsine sp. (petiole)							+				
Podocarpus nivalis (aril)											+
Exocarp (unknown)				+		+	+			+	
Petiole (unknown)	+			+			+				+
Pollen sacs (unknown)											+
Tomentum hairs (unknown) (prob. Celmisia, Olearia, Senecio spp.)			+	+			+				+

anything other than plant matter. Odd insects and insect exoskeletons have been located in old droppings but it seemed highly probable that insects occupied the droppings subsequent to deposition.

An attempt has been made to estimate the composition of droppings in terms of plant conducting tissue, cuticle and other vegetable matter. The number of droppings examined in each group ranged from 1-20 and groups were divided according to age and location. A total of 42 groups of droppings were examined (Appendix 3). As mentioned in the introduction to this section C (p.132-3) although the results cannot be interpreted as a quantitative indication of Kakapo diet, they supplemented information from field observations.

A high proportion of conducting tissue was present in faeces. This is not unexpected as 'pithed' flower inflorescence stems (of flax, Senecio and Celmisia spp.), bases, nodes of grasses, rhizomes and stems of fern, and petioles of shrubs were found in Kakapo feeding areas.

It was of interest to note 5 contrasts between faecal and field observations. First, the regular occurence of Podocarpus nivalis in droppings on the Tutoko High Bench. Of the 18 groups from the Bench (Appendix 3), Podocarpus nivalis occurred in comparatively high proportions in 14 of the 18 groups. This species was absent in the flora further west but faecal samples were insufficient in numbers

to suggest what substitutes were eaten by birds in the Poseidon, Sinbad and Transit Valleys.

Second, Anisotome haastii was recorded more frequently in the Transit Valley droppings than in those from the Tutoko High Bench, but samples were small. The regular occurrence of Anisotome haastii in droppings from the Tutoko Valley (13 out of 19 groups) and other valleys (Appendix 3) is more frequent than field observations had suggested.

Third, feeding sign on the leaves of silver beech, Gaultheria spp. and Hebe spp. had previously not been recorded for Kakapo in the wild although Jackson (1960) reports juvenile Keas feeding on young silver beech leaves. Morrison (pers.comm.) reported captive Kakapo fed on red beech (N. fusca) and Hebe at Mt. Bruce (Table VI, p.115).

Fourth, high figures for Hymenophyllum spp. in droppings from Caswell Sound and Tutoko High Bench indicated that this was a food plant. However, low figures from droppings from other areas were presumably due to colanization of old droppings by filmy ferns after they have been excreted.

Fifth, grass spp. and Aciphylla cuticle figures were lower than might have been expected from field observations and feeding sign. This was probably due to the fibrous structure of these plants and the Kakapo's characteristic method of expelling as chews such fibre and much associated leaf cuticle.

A small number of Kea (23), opossum (19),

deer (3), and chamois (2) droppings were examined. The ungulate droppings contained many cuticles which I was unable to identify but the opossum faeces contained many species utilized by Kakapo (Table IX, p.140).

b) Seeds: In over 500 droppings examined from Fiordland, seeds were present in between 40-50 droppings (Table X, p.141). This was in marked contrast to 23 Kea droppings collected in the same area (Table XI, p.142) in which seeds were present in all droppings.

The absence of grass seeds (Chionochloa spp., Poa spp., and Notodanthonia sp.) in Kakapo faeces was of interest and was unexpected in view of field observations (Table II, pp.74-77). For example, Kakapo had been observed stripping and chewing inflorescences of grasses and many hundreds of grass seed heads have been found stripped by Kakapo; also Kakapo expectorate large numbers of chews. One captured bird produced over 100 chews each night (Merton, pers.comm.). The absence of seeds in faeces therefore may be the result of the seeds being either expelled with the chews or were so damaged and ground so finely that they were unidentifiable in the faeces.

Kakapo are perfectly capable of crushing large seeds: flax seeds and Podocarpus nivalis arils are invariably crushed and ground; Coprosma seeds in faeces are frequently cracked, and occasionally

TABLE IX

Plant Cuticles in Kea, Opossum, Deer and Chamois Faeces

Plant Species	Kea faeces	Opossum faeces	Deer faeces	Chamois faeces
Leaf Cuticles				
Anisotome haastii		+		+
Coprosma spp.		+	+	
Cotula sp.		+		
Fern sp.		+	+	
Asplenium sp.		+	+	
Blechnum sp.		+		
Polystichum sp.		+		
Grass spp.	+			+
Hoheria glabrata		+	+	
Moss spp.		+		
Nothofagus menziesii				
Olearia sp.		?		
Podocarpus nivalis		+		
Pratia sp.	+			
Pseudopanax colensoi		+	+	+
Rubus cissoides		+		
Senecio bennettii		+		
Unknown cuticles	+	+	++	++
Conducting tissue		+		
Exocarp (unknown)	+			
Tomentum hairs (unknown)		+	+	
Seeds	+*	+**		
Insect parts	+			

* Table XI : p.142 ** Table XII : p.142

TABLE X

Seeds in Fiordland Kakapo Faeces

	Gulliver V.	Poseidon V.	Sinbad V.	Surprise Ck.	Transit.V.	Tutoko V.	Esperance V. (Atkinson and Bulfin, 1974)	Seeds split or crushed
Number of Faeces Examined	32	c.20	c.70	c.25	c.80	c.190		
Number of Faeces with Seeds	c.2	c.4	c.3	c.2	10	c.25		
Seed Genera and Species								
Astelia spp. (prob. A. nervosa and A. nivicola)		a	a*	a	a	b*		(+)
Coprosma spp. (resemble C. astonii, C. ciliata, C. pumila)		a	b*	b		b	p	+
Coriaria spp. (prob. C. plumosa and C. sarmentosa)		b	b*			a*		
Cyathodes juniperina					b*			
Gaultheria / Pernettya spp. (G. antipoda, G. depressa, P. macrostigma and hybrids)			a		b	b*	p	
Phormium cookianum			a		a*	c*		++
Podocarpus nivalis	b					d*	p	++
Pseudopanax colensoi var. ternatum		a	?	a	a*	b*	p	
P. simplex					a*		p	
Uncinia sp.		a°						
Unknown sp.						a*		+

Key

a	1	faece
b	2-4	faeces
c	5-10	faeces
d	25-30	faeces
(+)	occasionally	
+	often	
++	typically	

* seeds common to abundant in individual faeces.

o seed may not have passed through gut.

p present. See Atkinson and Merton, in prep. for further details.

N.B. No seeds were located in faeces from Caswell Sd. (12); Donne Valley (16); Harrison Valley (c.50); Poison Bay area (c.5); and Takahe Valley (c.10).

TABLE XI

Seeds In Fiordland Kea Droppings

	Gulliver V.	Harrison V.	Leader Ck.	Transit V.	Tutoko V.	Caswell Sd.
Number of faeces	5	2	1	5	10	1
Seed species						
Astelia sp.	+					
Coprosma spp.	+			+	+	
C. astonii				+		
C. foetidissma	+			+	+	
C. pseudocuneata	+					
C. pumila	+			+	+	
C. prob. *rugosa*				+		
Coriaria spp.				+	+	
Dacrydium laxifolium	+					
Gaultheria / *Pernettya* spp.				+	+	
Myrsine spp.	+	+	+	+	+	
Pittosporum crassicaule	+					
Podocarpus nivalis					+	
Pseudopanax colensoi	+	+		+	+	+

All Kea droppings examined (c.23) contained seeds. In some cases seeds were abundant in droppings.
Insect exoskeletons, fruit exocarp, grass cuticle, *Pratia* sp. cuticle, caterpillars and 2 unknown plant cuticles were also observed.

TABLE XII

Seeds In Fiordland Opossum Faeces

Seed species	Milford Sd.	Tutoko V.
Coprosma sp.	+	
C. foetidissma	+	
Pseudowintera colorata	+	
Gaultheria / *Pernettya* spp.		+

One dropping was examined from Milford Sound and 5 from the Tutoko Valley. A further 12 droppings from the Harrison (4), Gulliver (1) Valleys and Poison Bay (2) yielded no seeds.

Astelia, although generally the Astelia, Cyathodes juniperina and Pseudopanax spp., are passed with the exocarp intact as are smaller seeds such as Coriaria spp. and Gaulthera/Pernettya spp. The endocarp of many seeds would seem to appear to be available for digestion by Kakapo and this is in contrast to Keas where, in the droppings examined (Table XII, p.142), all seeds with the exception of 1 cracked P. nivalis aril were passed intact.

Coprosma and Astelia seeds were abundant in one fresh dropping collected in late March 1976 approximately 780m below the track and bowl system number 2, on the Tutoko High Bench. Fresh droppings collected in the same vicinity in June 1976 (Morris and Russ, 1976) also contained large numbers of Coprosma and Astelia seeds.

It seemed that Coprosma and Astelia fruits play a more important role in the Kakapo diet in winter.

In opossum droppings only a limited variety of seeds were found (Table XII, p.142). No seeds were located in deer or chamois faeces.

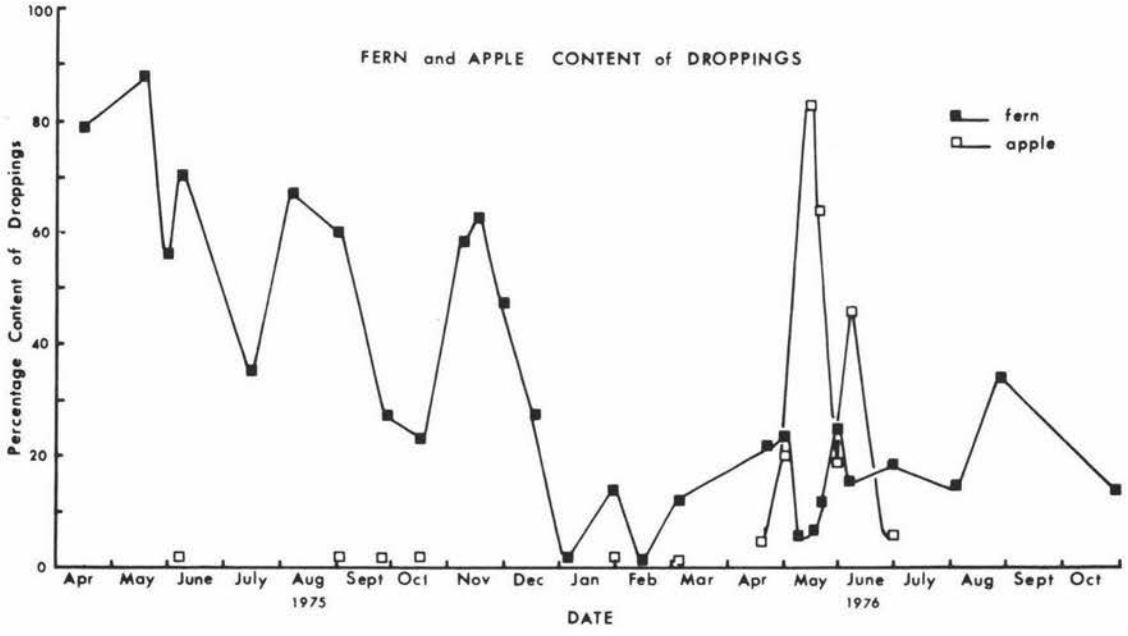
iii) Maud Island:

a) Plant cuticles and accessories: As in Fiordland Kakapo droppings, fern was also an important component in Maud Island Kakapo faeces. Fern was recorded in droppings regularly over the 21 month period from April 1975 - December 1976 either as cuticle or conductive tissue (predominantly Pteridium aquilinum rhizome).

It was difficult to interpret seasonal variations in any one bird's diet. This was because most of the faecal samples (over 90% from the road) could have come from one or more bird's grazing mainly in the bush or on the road. For example, the new roads provided a suitable habitat for several plant species used as a food source by Kakapo. Sheeps sorrel (Rumex acetosella) and 2 grasses, yorkshire fog (Holcus lanatus) and Festuca rubra which, like sorrel establish on disturbed ground. Excavations during road construction exposed much bracken rhizome and subsequent slips during wet weather exposed fresh rhizome on which at least one Kakapo was observed to feed. Feeding sign was regularly found on this fern rhizome. Similarily, the initial road excavation and subsequent slips may have accounted for the variation in fern conducting tissue and cuticle content of droppings, (Fig.21, p.145). The fern content generally declined through 1975. Likewise apple cuticle contributed to an irregularity in results and was partially responsible for fluctuations in 'natural' Maud Island foods.

Grasses and herbs were present in larger proportions in Maud Island droppings in comparison with those collected in Fiordland, although there was considerable variation in the contents of monthly samples. Despite the samples being from an unknown proportion of monthly Kakapo faeces and the

KAKAPO FAECAL CONTENTS
Maud Is. 1975-76



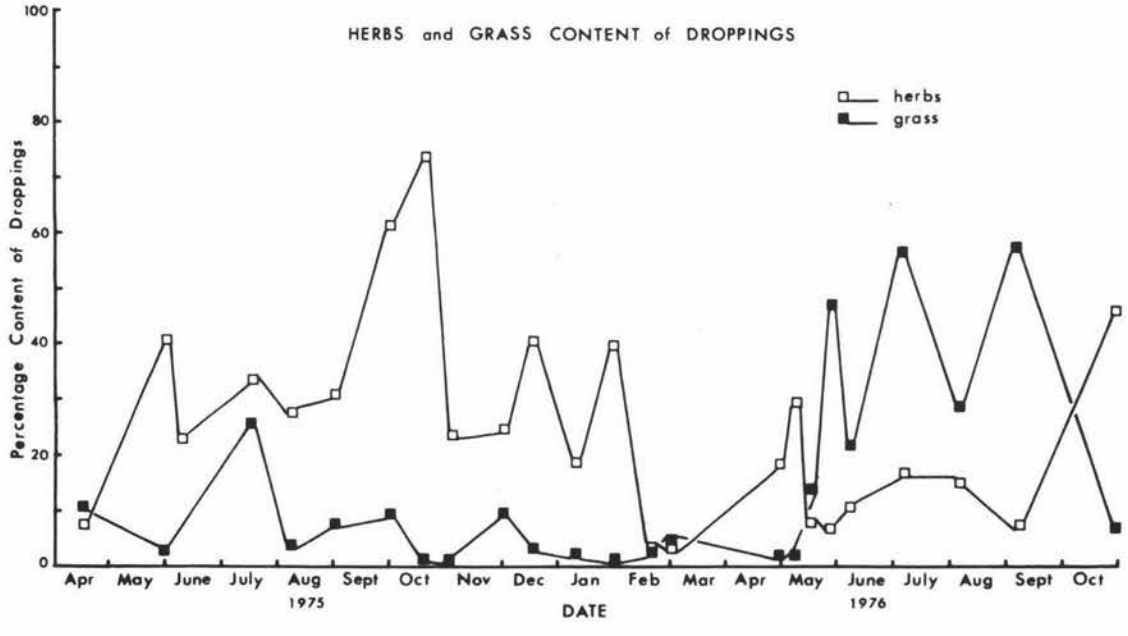


Fig. 21

influence of an erratic supply of supplementary foods such as apples, several trends revealed in the graphs (Fig.21, p.145) are worthy of comment.

Both herb and grass cuticles were present in faeces throughout the year, although they were sometimes scarce, particularly in mid summer.

The proportion of grass cuticle in droppings increased from April and May through to July and August in both years. The highest grass cuticle content of faeces was in winter and early spring both in 1975 and 1976.

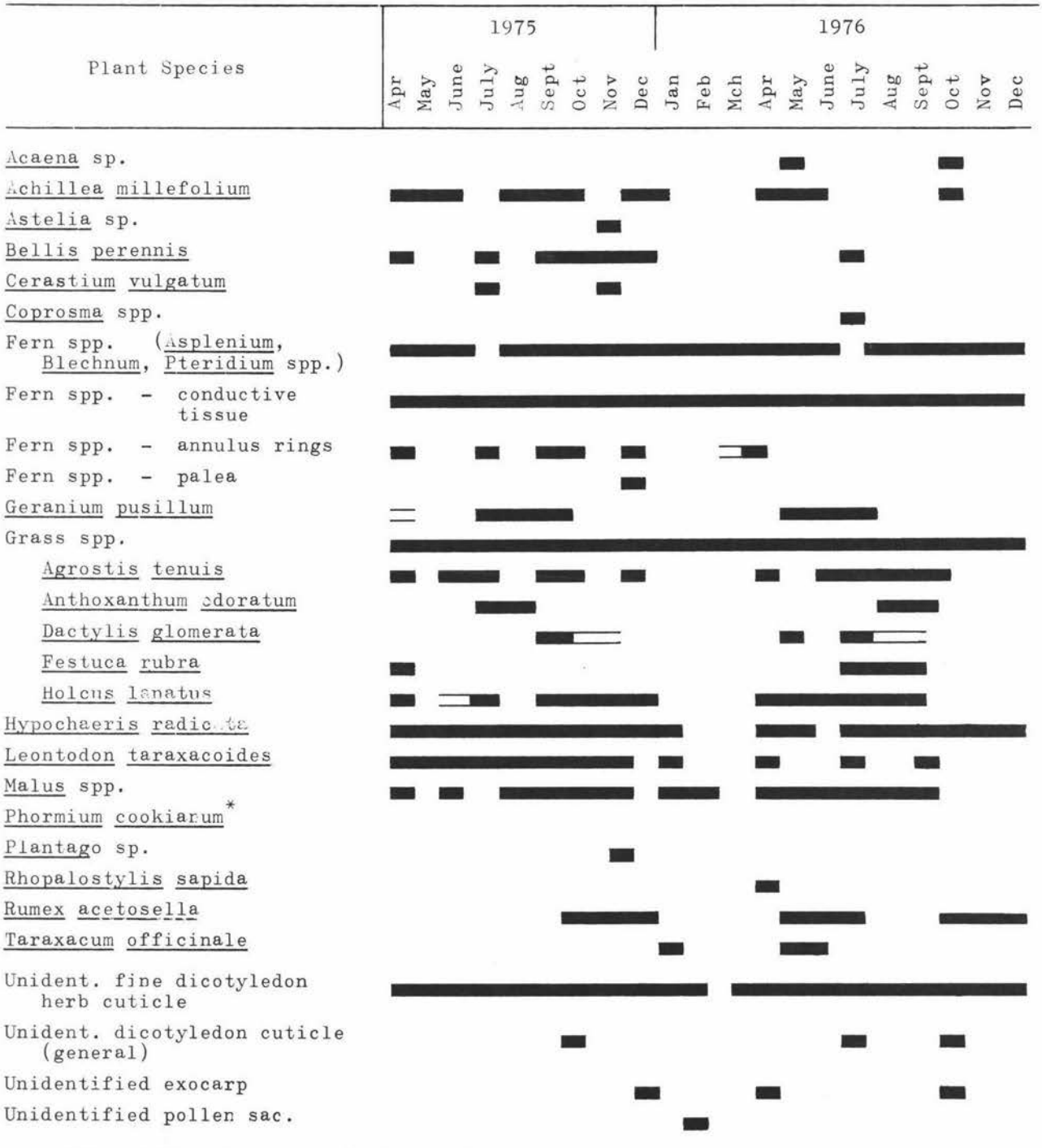
In general herbaceous dicotyledons (mainly exotic weeds) formed a greater proportion of the faeces cuticle content than grasses, with the exception of May to September 1976. The herb content in the droppings remained comparatively constant in the winter months in both years but increased following the grass content 'peaks'. Both in 1975 and 1976 herbaceous type cuticles 'peaked' in October, about a month after the grasses.

The higher proportion of grass cuticle in Kakapo faeces from May to September in 1976 in comparison with the same period in 1975 may have been caused by one Kakapo occupying a new area near Woodland's bush, following the removal of sheep from the north west side of the island. It is suspected that the droppings collected at that time were from one particular bird.

Table XIII (p.147) includes few indigenous

TABLE XIII

Plant Cuticles and Other Plant Material
From Maud Island Kakapo Faeces



*Faeces were also collected in June 1974. These contained Acaena, Achillea, Bellis, Fern, Grass, Leontodon, Phormium cookianum and unidentified exocarp.

forest species. Nikau (Rhopalostylis sapida) and Asplenium spp. (included under Fern spp.) were recorded in one fresh dropping in April 1976. Large numbers of young nikau seedlings (c 20cm high) had been pulled and the bases chewed in typical Kakapo fashion.

It is difficult to assess to what extent the results in Table XIII reflect the total diet of all 3 Kakapo.

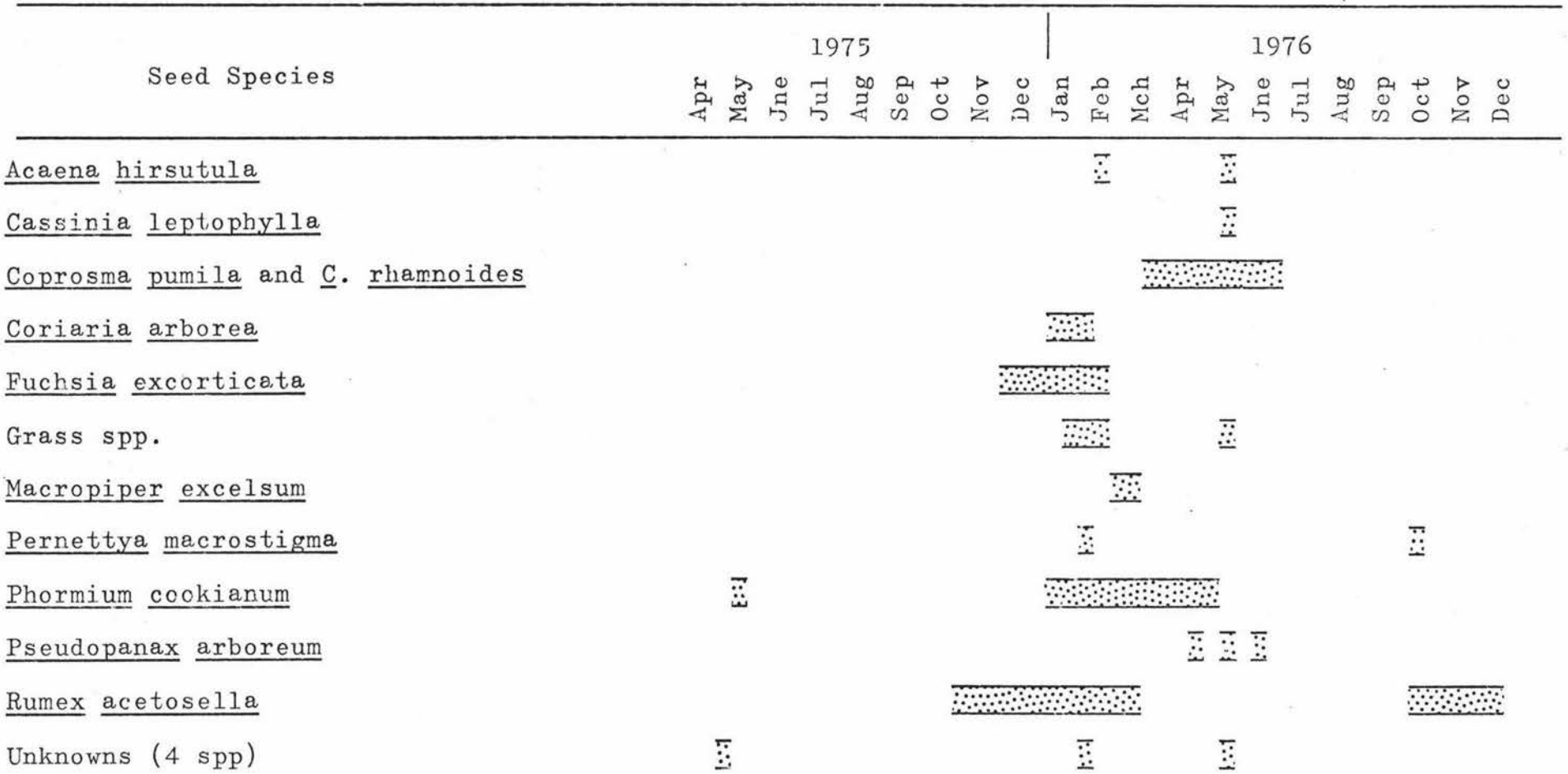
b) Seeds: Seeds from 5 species occur regularly in droppings collected over the summer and autumn months (Table XIV, p.149). These species were sheeps sorrel, Coprosma (C. pumila and C. rhamnoides), flax and Fuchsia. A further 11 seed species were recorded in low numbers from droppings usually collected in the first half of the year.

A comparison of seeds from droppings between April and June in 1975/1976 is of interest. The number and diversity of seed species in 1976 is greater. There are probably several reasons for this.

Most of the listed plant species had a localized distribution; and it is likely that the three Kakapo had taken some time to find seeds. It should be noted that with the exception of sheeps sorrel, Macropiper excelsum, and probably the seeds of the four unidentified species, the remainder were all of genera found in Kakapo territories in Fiordland.

TABLE XIV

Seasonal Range of Seeds Taken as Food by Kakapo on Maud Island



Bielschmiedia tawa seeds were found eaten in April and May 1977

Sorrel was a primary colonizer on disturbed ground and probably was only just becoming established on the recently excavated roads in early 1975.

Flax and Coprosma, and probably Fuchsia were subject to 'good' and 'poor' seeding years. In Fiordland, in both 1975 and 1976 flax inflorescences were abundant but in 1977 they were comparatively scarce. On Maud Island, flax which was confined to the coastal cliffs (with the exception of 2 bushes) seeded prolifically in 1976 but no information is available for 1975. It is of interest to note that flax suddenly appeared in droppings in May 1975, the end of the flax seeding season. It is probable that one or more Kakapo located flax along the cliffs at this time.

CHAPTER IX

PLANT NUTRIENTS IN SOME KAKAPO FOODS

A. Introduction.

A selection of known and suspected Kakapo food plant species were collected, mostly between December 1975 and February 1976 in Fiordland and on Maud Island. The selection of species (Tables XV and XVI) was based on the diet as was surmised from field data collected in the single low altitude Tutoko Valley territory, the 3 Gulliver/Esperance Valley territories and the 3 Sinbad Valley territories.

Considering the subsequent feeding observations from the Tutoko High Bench, Transit Valley and Poseidon Valley Kakapo territories, the Maud Island field work, and faecal analysis results, the choice of plant species selected for the study of nutrients is not as representitive as was originally thought.

With hind sight it can be said that the investigation of the nutritional components of Blechnum capense rhizome and stems, Chionochloa conspicua, C. crassiuscula, C. flavescens, bases of Dracophyllum menziesii shoots and leaves of Anisotome haastii from Fiordland, and a comparison with bracken rhizomes, brown top, Festuca rubra, yorkshire fog leaves and a selection of herbs and legumes (catsear, dandelion, Leontodon and Trifolium spp.) from Maud Island would in fact have been of more interest than were some of the plants analysed in Tables XV and XVI.

Much data were available on grasses and legumes associated with pasture. The nutritive values of pasture grasses and some legumes are well documented (National Academy of Sciences, publication 1232; Morrison, 1959). Recent work by Bailey and Connor, (1972); Connor, et al., (1970); Macraw and O'Connor, (1970); Molloy and Connor, (1970); and Williams, et al. (1976a,b); has furnished some information on most of the New Zealand tall-tussocks (Chionochloa spp.). Although there was a lack of data on the nutritional value of weeds associated with pasture, and New Zealand native woody plants, ferns, herbs and small grasses.

From research data available trends in the nutrient concentrations both intra and inter species as well as variations within a single plant were of interest. Raymond, (1969) Williams, et al., 1976b, and Mills and Mark (in press) report that the nutritional values of grasses and legumes vary between different fractions of the same plant.

A considerable range in element concentration exists within a species (Connor, et al., 1970; Mills and Mark, in press) which reflect soil profiles and properties (Williams, et al., 1766a; Wells and Saunders, 1960). Seasonal variations in concentrations of elements are also evident (Connor, et al., 1970; Mills and Mark, in press). In Chionochloa tussocks Williams, et al., (1976b) reports significant differences in the concentrations

of elements between the 6 species examined. Similarly Connor, et al., (1970) observed that cellulose and hemicellulose levels in Chionochloa leaves differed between species.

Young leaf blades were found to be always more digestable than mature blades in ruminants. Digestability of plants is reported to decrease with their advancing maturity. The stems of grasses mature more rapidly than their leaves (Terry and Tilly 1964 in Raymond, 1969). Burton, et al., (1964) reports that young leaves have a higher crude protein value and less lignin than older leaves on the same culms, although they do not differ in cellulose or total available carbohydrate values.

That these variations in nutrient content depend on species, age, site, season and section of plant was of interest when Kakapo diet and feeding behaviour was examined. These variations also draw attention to the care that needs to be taken concerning the part of the plant collected and the site and time of year of collections.

B. Collection of Samples.

A total of 14 Kakapo food species were collected where practicable 454gms (c.1 lb wet weight) samples were obtained from a number of individual plants. To minimise deterioration of the samples they were collected close to the time of departure. When transportation to the laboratory was expected to take

several days, drying of some species was begun. Samples were dried in the sun when possible or pressed between newsprint, then in the laboratory they were placed in a warm air drier to complete the process.

No reports have been sighted on the possible deterioration of material stored in this way and an element of uncertainty exists as to what chemical changes may have taken place between the time of collection and air drying and whether these may have influenced results. Plant samples, with the exception of Phormium tenax, Agrostis tenius and Holcus lanatus, were collected in Kakapo territories at a time when the plant species were being eaten by Kakapo. The flax and grasses, although collected outside the study areas.

C. Analytical Methods.

Methods of analysis followed standard proceedures (Horwitz, et al., 1970). All results were repeated until duplicated samples varied less than one percent.

Moisture content determinations: Wet weight of plant matter was recorded immediately following collection, and the dry weight after 24 hours in an air oven at 58°C. Plant material was then ground and passed through a 1.0mm grid and dried in a vacuum oven at 14mm Hg and 62°C for 5 hours. Loss in weight between fresh wet weight and weight of sample after the second drying is exposed as percentage water.

Crude Protein (C.P.) determinations: The crude protein content of samples was determined by the Macro Kjeldahl method. The nitrogen value obtained was multiplied by the standard figure of 6.25 to obtain an estimate of crude protein.

Ether Extract (E.E.) determinations: Fats were extracted by refluxing samples with ethal alcohol in a Soxhlet apparatus for 14 hours.

Crude Fibre (C.F.) determinations: This is defined as the loss on ignition (at 580°C for 30 minutes) of dried residue remaining after digestion of the sample with 1.25% H_2SO_4 and 1.25% NaOH solutions under specific conditions. The value obtained approximates the proportion of feed which is indigestable, which are predominantly celluloses, with the exception of lignin which is included under N.F.E.values as a nondigestable carbohydrate.

Ash determinations (Inorganic component): A 5gm (dry weight) sample was incinerated in a muffle furnace at 600°C $\pm$ 15°C for 3 hours or until a constant weight was obtained.

Nitrogen Free Extract (N.F.E.) determinations: This is a measure of the digestable and nondigestable carbohydrate fraction in the food sample.
% N.F.E. = 100 - (% H_2O + % C.P. + % E.E. + % C.F. + % Ash). Accumulated errors made this value the least reliable of the 6 fractions analysed.

D. Kakapo Food Nutritional Values.

Tables XVa, XVb and XVI : pp. 156-7.

TABLES XV a,b.

Nutritional Components of some Kakapo Food Plants

Table XVa Fiordland

Plant Species	Part Tested	% Water	% Crude Protein	% Ether Extract	% Nitrogen Free Extract	% Crude Fibre	% Ash
Aciphylla crenulata	L	86.40	1.25	0.20	6.63	4.38	1.14
Chionochloa conspicua	L	62.58	2.28	0.70	19.67	12.89	1.88
C. predom. flavescens	Sh	51.76	5.28	1.33	28.51	11.26	1.86
Coriaria plumosa	Fr	96.39	0.45	0.28	2.32	0.46	0.10
Olearia colensoi	P	89.57	0.94	0.28	4.90	3.37	0.94
O. colensoi	L	86.04	1.53	0.42	6.61	4.51	0.89
O. ilicifolia	L	75.20	2.73	1.36	12.49	6.86	1.36
O. ilicifolia	T, P	86.95	1.41	0.62	6.30	3.76	0.90
Phormium tenax	Ip	96.30	0.05	0.02	1.64	1.78	0.21
P. tenax	Sp	87.29	1.51	0.95	5.09	4.46	0.70
Schoenus pauciflorus	L	78.12	1.67	0.53	11.67	6.77	1.24

Table XVb Maud Island

Agrostis tenuis	I	64.58	3.31	0.85	17.39	11.21	2.66
Festuca rubra	L	83.42	2.98	0.50	7.40	4.05	1.65
Holcus lanatus	I	74.45	2.60	0.75	12.14	8.10	1.96
Hypolepis tenuifolia	Ls	63.46	2.43	1.40	17.69	13.70	1.32
Pteridium aquilinum	R	79.05	0.71	0.11	13.36	5.04	1.73

Key

Fr	fruit	I	inflorescence
Ip	inflorescence pith	L	leaves
Ls	leaves and spores	P	petioles
R	rhizomes	Sh	seed heads
Sp	green pods and seeds	T	twigs

TABLE XVI

Comparison of Chewed and Non-chewed Nutritional Components in some Kakapo Foods

(Results expressed as % dry weight)

Plant Species	Section Analysed	% Crude Protein	% Ether Extract	% Nitrogen Free Extract	% Crude Fibre	% Ash
Aciphylla crenulata	green leaves	9.21	1.45	48.25	32.19	8.90
	chewed leaves	4.21	0.99	36.94	57.05	0.81
	max % consum.*	5.00	0.46	11.31		7.09
Chionochloa conspicua	green leaves	6.10	1.87	52.32	34.68	5.03
	chewed leaves	4.36	1.14	52.18	40.38	1.94
	max % consum.	1.74	0.73	0.14		3.09
Phormium cookianum	green leaves	5.47	2.13	41.26	46.94	4.20
	chewed leaves	4.98	0.52	35.51	58.20	0.79
	max % consum.	0.49	1.16	5.75		3.41
Schoenus pauciflorus	green leaves	7.63	2.40	53.20	31.12	5.65
	chewed leaves	6.34	0.33	49.01	41.00	3.32
	max % consum.	1.29	2.07	4.19		2.33
Maud Is. grasses (predom. Festuca rubra)	green leaves	17.95	3.04	44.49	24.58	9.94
	chewed leaves	13.59	1.53	45.01	32.12	7.75
	max % consum.	4.36	1.51			2.19

* maximum percentage (dry weight) consumed by Kakapo, (green leaf weight — chewed leaf weight).

N.B. Where percentage component figures for chews exceed that of the green leaves (e.g. crude fibre) max % consum. values are not listed as they are negative quantities. The crude fibre content of the chews is proportionately higher than that of the green leaves.

E. Discussion.

A comparison of the results in Tables XVa and XVb with other sources was limited to the grasses, as figures for the other species were unavailable.

Nitrogen (crude protein ÷ 6.25) and ash percentages for Chionochloa conspicua were within the range of percentage figures of 4 other Chionochloa species presented by Connor (1970).

The percentage nutrient values for Festuca rubra when compared with American grass nutritional values (Nat. Acad. Sci., publ. 1232, 1964) fell amongst the highest values presented for Avena spp., Festuca spp., Phalaris spp., Phleum spp. and Poa spp.

In Table XVa a comparison of several species is of interest. Both the two Olearia species, O. colensoi and O. ilicifolia had a higher moisture content in the petioles and consequently a lower nutrient concentration than the leaves. Olearia colensoi was more abundant in the Fiordland Kakapo territories than O. ilicifolia. The leaves of the former had been eaten by Kakapo (chews were collected) in the Tutoko, Transit, Sinbad and Poseidon Valley territories. Little feeding sign had been found on O. ilicifolia but this may be due to its scarcity or absence in many of the Kakapo areas since its high nutrient content suggests it would be an excellent food.

The fruits of Coriaria plumosa and the pith of Phormium tenax had the highest moisture content of the species analysed. In proportion to other nutrients,

nitrogen free extracts were high, particularly in C. plumosa.

Crude protein values were highest in the Chionochloa seed heads, and ether extracts likewise were high. The green pods and seeds of P. tenax also had high E.E. values while the leaves of O. ilicifolia had exceptionally high E.E. levels in comparison with all other species in Table XVa.

The highest N.F.E. values in Table XVa were present in the more fibrous plant fractions as in Chionochloa leaves and seed heads. These high proportions were probably due to nondigestable carbohydrates such as lignin. Likewise crude fibre percentages were highest in these fibrous plant fractions as was the ash content.

A comparison between Tables XVa and XVb is of limited value as the species analysed were not representative of those taken by Kakapo in Fiordland or on Maud Island. The Maud Island Table XVb includes some of the main ferns and grasses eaten by Kakapo but omits the herbs since it was not realised at the beginning of this study how important a role they played in the diet. For the same reason it must be conceded that the list of Fiordland species analysed is not typical of a Fiordland Kakapo diet. Nevertheless, a comparison between Tables XVa and XVb is still useful. The percentage values of nutrients (C.P., E.E., N.F.E., C.F., and ash) for the Maud Island plants analysed were on average higher than

Fiordland samples. Although these data are limited it was likely that Kakapo on Maud Island had available to them a more nutritious and readily obtained food source than in Fiordland.

The analysed plant fractions as reported in Tables XVa and XVb are not necessarily all consumed by the Kakapo. For all the species listed, with the exception of bracken root (Pteridium aquilinum), a proportion of the plant contents were extracted. The results of an attempt to compare 'chewed' and 'unchewed' leaf samples are tabulated in Table XVI. Some results for chewed plant fractions were obtained from small quantities of material and were therefore more prone to error.

In all the chews (chewed samples) there was a greater proportion of crude fibre which suggested that little is consumed. All other nutrient levels in the chews were lower with the exception of some N.F.E. levels indicating that they may have been used by Kakapo. As the N.F.E. value included nondigestable carbohydrates, such as lignin, much of this was probably left by the bird in the fibrous conducting tissue that was expelled in the chew.

The levels of crude protein, ether extract and ash were generally markedly lower in the chews. Between 8-54% of the crude protein was removed (average 26% 30-83% of the ether extract (average 56%), and 22-80% (average 56%) of the ash content was removed from the 5 species of chews reported in Table XVI.

CHAPTER X

GENERAL DISCUSSION AND CONCLUSIONS

A. Kakapo Diet.

The field data of Kakapo feeding sign obtained between November 1974 and March 1977 and the analysis of Kakapo faecal material have confirmed the reports of early New Zealand ornithologists that the Kakapo is a herbivor (Lyall, 1852; Haast, 1864; Potts, 1873; Reischek, 1884, 1930; Buller, 1888, 1905; Henry, 1903; Best, 1908; O'Donoghue, 1924).

The data presented herein reveals the diversity of vegetation sampled, both in the number of species eaten and in the particular portion of a plant's anatomy utilized by Kakapo. Many questions under the general subject of food selection still remain to be answered, particularly in the relationship between selection and nutrient content of plant parts. The data on nutritional values of foods reported here has served as a means of learning technique and should serve only as an introduction to, and understanding of, those factors influencing the distribution of Kakapo. Too few comparative figures are available in Chapter IX to explain the field observations of the apparently haphazard selection by Kakapo of plant species and individual plants within a species. Nevertheless, a similar pattern of the distribution of observed feeding sign occurred repeatedly in Kakapo feeding areas whether in Fiordland, Maud or Stewart Islands.

Firstly, in any one territory during a particular season or time interval a limited number of plant species (one plus), which may or may not have been abundant, had been found by field parties to have been eaten by Kakapo to the exclusion of other plant species in the locality.

Secondly, the individual plants of any one of these preferred species within any localized area were not all eaten to the same extent by Kakapo. Individual plants may have been extensively damaged through the bird's feeding methods, other individual plants may have had only one or two leaves sampled, while the remainder appeared to have been untouched.

The plant species eaten were not necessarily the same in each Kakapo territory. Although feeding sign on some species, notably the terminal buds of Dracophyllum species, Olearia colensoi leaves and the leaves of some Chionochloa species occurred widely in Fiordland and Stewart Island.

The selection of species is in part the result of plant distribution as affected by altitude and geographical location, but this does not explain why some species in two territories are taken by one Kakapo and not another. Such a situation has been observed in many of the territories containing a wide variety of plant species. For example, in territory 1 in the Sinbad Valley, Astelia was taken by one bird where in previous years it had not been utilized as a food.

Possibly the nutritional content of the plants may offer an explanation. A comparison between Olearia colensoi and O. ilicifolia Table XVa indicates a variation in nutrient content between leaf lamina and petiole. This suggestion finds support in the increasing amount of literature on variations in nutrient levels of plants. Four aspects are of interest in relation to Kakapo.

1.1. Variations in the nutrient components between species (inter-specific variations) Williams, et al., 1976; Connor, et al., 1960.

1.2. Variations in nutrient content within a species (intra-specific) related to location and site (substrate type) Wells and Saunders, 1960; Rogers and Davies, 1973.

1.3. Variations in nutrient content in different fractions of a plant's anatomy at any one time. Williams, et al., 1976b, Mills and Mark, in press.

1.4. Variations of the nutritional values and element concentrations within an individual plant according to its state of maturity and the time of year. Pritchard, et al., 1963; Burton, 1964; Raymond, 1969; Connor, et al., 1970; Mills and Mark, in press.

1.5. An additional explanation may be a behavioural one. The preference or avoidance of a particular species of plant may depend on previous experience with such plants and an individual's 'taste' preference.

The results from these findings, I consider, suggest possible explanations of the selective nature of the Kakapo's grazing and may well provide reasons for the selection of particular species of plants and parts of them. In a broader context availability of

nutrients may explain distribution patterns in Fiordland and Stewart Island. The relationships between plant nutrients and Kakapo feeding is an area for further investigation.

B. Kakapo and other New Zealand Parrots.

Unlike other parrots in New Zealand (Nestoridae and Platycercidae) the Kakapo has lost its capacity for flight. An area over which a Kakapo can forage is consequently restricted by water in particular. In many Fiordland territories feeding signs were stopped abruptly at one bank of a river, stream or even shallow riverlet, with no continuation of feeding sign on the opposite bank.

Parakeets (Cyanoramphus spp.), Kakas (Nestor meridionalis) and in particular Keas (N. notabilis) have all been reported in the vicinity of Kakapo territories. The Parakeets and Kakas tend to occupy lower altitude forest but Kea territories overlapped all 15 Kakapo territories. The Nestoridae are omnivorous (Jackson, 1960; Campbell, 1976), the Parakeets are seed and fruit eaters (Oliver, 1955), while the Kakapo are herbivorous.

It is interesting to observe that the Kakapo, restricted by its inability to fly, does not supplement its diet with the available insect fauna as do Keas in the same locality. The Kakapo appears to have specialized in the extraction of nutrients from a wide variety of plants by means of crushing

them, forming fibrous chews which it discards. The kernels of large seeds are quite capable of being crushed against the upper mandible by its powerful lower mandible. The lower mandible is strengthened by 5 longitudinal keratin ridges. Seeds such as the arils of Podocarpus nivalis and Coprosma species are crushed by Kakapo but Kea are unable to utilize these.

C. The Location of Kakapo Areas and Track and Bowl Systems in Relation to Vegetation and Food.

Kakapo in Fiordland occupy a variety of plant communities. Eight of the 15 Kakapo located between 1974 and 1977 were found on or near their track and bowl systems in proximity to the tree line 1000 and 1200 meters above sea level. Five Kakapo maintained track and bowl systems at lower altitudes (300-700m a.s.l.) where steep rocky terrain prevented the silver beech forest from extending to higher altitudes. One of the remaining 2 Kakapo occupied the valley floor in the head basin of the Esperance Valley and the other bird, in territory 2 in the Sinbad Valley, occupied a track and bowl system in low silver beech forest below a higher territory. The positions of these territories enabled them to graze through silver beech forest, detritus fans, alpine scrub and tussock grassland, all generally within close proximity to one another.

Feeding sign had been located in all these areas but the greatest altitudinal range of any one bird, as

far as can be judged, was some 525m in the Poseidon Valley (Buckingham, 1977; Gray, 1977b).

It is not clear what combination of factors influenced these birds in their choice of sites for their track and bowl systems: but altitude, directional aspect, acoustical properties of the site, the preference or need for audio or social contact, and food sources could all have influenced their decisions.

In the matter of food there appears to be two main advantages of track and bowl systems at such sites.

i) Food in relation to plant communities about track and bowl systems:

The diversity of plant communities about the tree line (silver beech forest, alpine scrub and tussock grassland) is the first advantage of siting a track and bowl system at such an altitude. Johnson, (pers.comm.) recorded over 200 species of plant in a similar area on the Tutoko High Bench. The leaves and seed heads of tussocks and small grasses are available along with herbs found in such grassland habitats. For example, Celmisia species, Astelia nivicola, A. nervosa, Gunnera monoica and Aporostylis bifolia have been found chewed or recovered in droppings. Generally common alpine scrub species regularly eaten by Kakapo include the Dracophyllum species, Olearia colensoi and of more restricted distribution Podocarpus nivalis. These

scrub species in the Kakapo territories are generally low growing, being usually less than 2m high. Since the Kakapo is a skilled climber it is capable of reaching the terminal buds and leaves.

The silver beech forest in these localities appears important in providing cover and protection during the winter months as snow can hinder movement of a flightless bird. Movement would be much easier under a beech canopy because of a discontinuous cover of snow. Thus Kakapo could move comparatively freely in the forest and make excursions into the scrub and tussock areas.

It was expected that berrying plants of the alpine scrub (P. nivalis, Coprosma spp., Gaultheria spp., and Pernettya spp.) and avalanche detritus fans (Myrsine spp., Aristotelia spp., Coriaria spp.) would provide a major fraction of the winter diet since Coprosma, Astelia and Podocarpus nivalis shrubs retain their berries through the winter. These three species had been found in quantity in a few fresh droppings (Morris and Russ, 1976) from the Tutoko High Bench.

On the other hand, examination of the bulk (500+) of the droppings revealed that in general seed numbers were low (Table X, p.141). Less than 50 of the 500 and more droppings contained seeds, whereas seeds were found in all the 23 Kea droppings. Faecal analysis did not reveal grass seeds taken by Kakapo as these were crushed and expelled as chews. The

results in Table X therefore under-estimate the importance of seeds.

Kakapo are better adapted to crushing seeds than Keas which prefer the fleshy mesophyll of the berries and excrete the whole seed. Kakapo have heavier mandibles, the palatine is broader and thicker and the lower mandible is strengthened by 5 longitudinal 'ribs' of keratin (McCann, 1963). A good example of what the Kakapo crushed and the Kea excretes unscathed is the arils of Podocarpus nivalis. Likewise Kakapo can crack and eat the kernal of the seeds of Coprosma species.

From Maud Island 15 species of seed have been found in Kakapo droppings, 12 of which were eaten over the summer and autumn months (January - May); but they contributed little to the winter diet of the bird which occupied the Ring Road. Hinau, tawa and kokekoke fruits may have contributed considerably to the winter diet of the Kakapo in the main bush stand but field data is not available.

Droppings from Maud Island contained a high proportion of sheeps sorrel and flax seeds; the former in December and January, and the flax in February.

ii) Food in relation to avalanche and alluvial fans near track and bowl systems:

The second possible advantage of track and bowl systems situated near the tree line was the presence of avalanche detritus and alluvial fans. These were

often at lower altitude sites (300-700m a.s.l.), and the tree line in the vicinity of such fans was at a lower altitude than expected as a result of rock, snow and water damage. Such territories were found in the Transit, Sinbad, Tutoko, Poseidon and Esperance Valleys.

In Fiordland rainfall is high and soils are rapidly leached but these fans may provide fresh substrate for early scrub communities such as grasses, herbs and shrubs. Since a site influences the nutrient content of vegetation such areas may be important. Furthermore, areas at the base of rock faces near track and bowl systems, may be enriched by nutrients leached from the faces above.

There is a lack of published data on the vegetation of alluvial fans in the Fiordland area, although the Hoheria, Aristolelia scrub canopy on avalanche detritus slopes are reported on by Cockayne, 1928, p.267; Poole, 1951, p.51; Holloway, 1954, p.399.

Detailed accounts of 2 detritus fans at Lake Thompson near Lake Te Anau are given by Mark et al., (1964) and Johnson (1976b). On the first of these 2 fans, 15 years old, Aristotelia serrata was the only canopy tree. On the second fan, 49 years of age, Fuchsia was predominant and Carpodetus serratus of secondary importance.

Johnson (1976a) describes the avalanche detritus fan in the Kakapo territory in the Sinbad Valley head

TABLE XVII

Fiordland Detritus Fan Vegetation

Vegetation	Esperance Valley	Sinbad Valley	Poseidon Valley	Lake Thompson
Trees/Shrubs	42	38	27	30
Ferns/ Lycopods	11	17	9	13
Grasses	6	7	6	0
Sedges/Rushes	4	7	3	1
Monocotyledon herbs	3	4	2	0
Dicotyledon herbs	36	25	13	3
Total	102	98	59	47

References : Esperance Valley : Atkinson, 1974
Sinbad Valley : Johnson, 1976a
Poseidon Valley : Gray, 1977b
Lake Thompson : Mark et al., 1964

* This is a slight under-estimate of species as in some instances several species have been grouped under one genus e.g. Hymenophyllum, Uncinia, Lachnagrostis spp.

and comments on the greater floristic complexity of this fan in comparison with those at Lake Thompson (Table XVII). Atkinson (1974) in his survey of the Esperance Valley vegetation describes the snow totara (Podocarpus nivalis) scrub and surrounding silver beech forest of a Kakapo territory (territory 1) on a river terrace of the Esperance River.

The vegetation in the Lake Thompson region and Sinbad Valley detritus fans, and of the Esperance Valley alluvial terrace, do not resemble the vegetation of the Poseidon Valley alluvial fan (territory 1).

The Olearia-Senecio scrub association on the Poseidon

fan is similar to the sub-alpine Olearia woodland-scrub classified by Given, 1971 as Class A_3. He describes the vegetation as 'typical of unconsolidated, unweathered substrata where soils have 'very thin upper horizons' and are 'underlain by blocky unweathered talus'. Such plant associations are generally situated near forest limit (c.900m) in the Lake Shirley area. The Poseidon fan was situated between 550-610m and is apparently of greater floristic diversity.

D. Kakapo Foods on Maud Island.

The first consideration of the vegetation on Maud Island is whether the feed available fulfils the Kakapo's feeding requirements. One of the Kakapo survived over three years on the Island until killed by a dog in July 1977 and another bird is still living after two years on the Island which suggests the food available is suitable. It appears, from the droppings collected and the occasional sightings of the birds, that one Kakapo grazed the roads and associated pasture and bracken while the second Kakapo apparently preferred the main bush stand. This is of interest when planning the future management of the species and the control of plant communities on the Island. Bracken, pasture grasses and typical pasture weeds (dandelion, catsear, yarrow, plantain and others; Table XIII, p.147) are all eaten by Kakapo and maybe easily grown although

difficult to limit in the absence of stock once regeneration is underway.

The roads on Maud Island have proved a fortuitous feature in supporting a variety of suitable food plants. The disturbed ground following excavation provided a habitat suitable for early seral plant species, a parallel to the Fiordland detritus fans. Early seral communities appear to provide adequate quantities of food for Kakapo, and on Maud Island the Ring Road, Jill's and Ridge Road were used regularly. Several grass species (canary grass, yorkshire fog and chewings fescue) established themselves rapidly on the disturbed ground and likewise the herb, sheeps sorrel, and the creeping Coprosma pumila. All 5 species occurred in the Kakapo diet and their distribution was generally restricted to the roads and disturbed ground around constructions for catching and holding water.

The excavations of the roads also exposed much bracken rhizome, and subsequent slips have continued to renew this food source which was utilized by one bird in particular (Fig.21, p.145).

Furthermore, the roads provided access for the birds and aided the collection of droppings. This was the principal reason why more information was obtained about the bird occupying this area than the one in the bush from which very few droppings were found.

In the bush, sign on plant species close to,

or on the ground - ferns, nikau seedlings and the fruits of tawa and possibly hinau - are important foods but Kakapo are quite capable of climbing into 7m high canopy, as observed by Morris (pers.comm.).

The second consideration on Maud Island is what modifications and controls of the vegetation would benefit Kakapo on the island.

There are two: the first is to maintain suitable plant species and plant communities from which the Kakapo derive benefit; and the second is the introduction of plants, as considered necessary, which would benefit the Kakapo.

As previously mentioned at least one Kakapo diet consisted largely of bracken, grasses and herbs (Fig.21 p.145). In the absence of grazing and burning on the island, which were the two methods used to maintain the pasture and bracken habitat in the past, regeneration of shrubs and forest will soon replace this community.

Merton (1976c) is of the opinion that sheep and Kakapo are not compatible. This is probably correct as sheep by their presence along track and bowl systems are likely to upset the males' booming behaviour on and about these when they are formed (N.B. booming was heard briefly in December 1975, Morris, 1975). Furthermore, sheep graze many of the grasses and herbs favoured by Kakapo. It is worthy of note that one Kakapo moved around into area 6 (Fig.17, p.97) following the removal of sheep from that side of the

island in July and August, 1976.

Grazing would therefore have to be strictly controlled by effective fences should sheep be permitted to assist in maintaining a pasture-bracken habitat.

Burning and the use of chemical herbicides are a possibility in controlling regeneration but both can be hazardous, especially on an island sanctuary.

The regular use of heavy machinery every 2 or 3 years would probably be the most suitable method of maintaining low canopy areas. The importance of the roads has already been stressed. The use of a bulldozer to clear these of vegetation, and old slips, and fill the often deep water-soured ditches would be beneficial both to Kakapo and to field parties. Additional tracks or roads, and gentle slopes where erosion would not be a problem. could also be cleared. Several plots of a quarter or half hectare of bracken covered ground could be bulldozed and sown with mixed grasses favoured by Kakapo (canary grass, chewings fescue). Much bracken rhizome would be exposed in these exercises and weeds would grow with the grass crop before bracken again became dominant after two or more years. Grass, weeds and bracken have all proved suitable foods. The clearing process could be repeated once bracken again dominated the pasture.

The vegetation when left to regenerate will result in a changed habitat. For a number of years

Coriaria, Pseudopanax, manuka and forest seedling species will develop into a dense scrub cover to replace the pasture and bracken community. From the reports of Henry (1895-1908) and others as well as observations in recent years in Fiordland and Stewart Island such a habitat would not be detrimental to Kakapo. The birds appear to be able to adapt to such a habitat and with grassland providing food requirements the birds should flourish.

Increasing the diversity of plants on the island with species potentially suitable for Kakapo has already commenced under the direction of D.V. Merton, (Merton, 1976c; Table I, p.67). Particular emphasis has been placed on berry and fruit producing trees, shrubs, and on grasses such as oats. It is hoped, that should a breeding population be established, such plants would provide a rich fruit crop at a time when Kakapo offspring are being fed by the female. Now that regeneration is underway many of the recently introduced species are finding it difficult to compete for space, especially some of the grasses. Hence the need, once a population of Kakapo is established, for small plots of cleared ground for the growth of early seral species. The regenerating Maud Island scrub with its Coprosma species, Pseudopanax, Coriaria, Fuchsia, flax and Blechnum ferns already contains a suitable food source which over the next 10 years should increase in abundance.

The need for additional plant species is, I consider, minimal.

Natural stands of forest appear to contain sufficient variety and abundance of species to support Kakapo as observed over the last 2 years.

As emphasised in Chapter IX, 'site' is important in affecting nutrient levels in plants and so the application of fertilizer and limiting minerals, particularly on cleared roads and plots could be as an effective way of ensuring a nutritious and abundant food source as the planting of many new species.

SUMMARY

Fifteen Kakapo were located in Fiordland between 1974 and 1977 by officers of the New Zealand Wild Life Service. Three of these Kakapo were moved to Maud Island. On Stewart Island a population of over forty Kakapo was located in January 1977.

The decline of Kakapo in Fiordland has been monitored by officers of the Wild Life Service over the last twenty years. The remaining Kakapo found were males and these birds were generally associated with a track and bowl system; the two exceptions being the Esperance Valley birds. Track and bowl systems were situated in areas which overlooked at least some of the surrounding terrain. They were frequently positioned on the crests of ridges or banks, some of gentle slope, others with steep precipitous flanks. Although feeding sign was rarely located on the track and bowl system feeding signs were generally found nearby at the same altitude or more typically at lower levels. In only a few territories (e.g. the Poseidon Valley) was feeding sign found at an altitude higher than the track and bowl systems.

Kakapo have been reported in a wide variety of plant communities. The 15 Fiordland Kakapo, their associated track and bowl systems, and feeding areas, were generally located in the vicinity of the tree line (circa 1050m) or at lower altitudes where the

tree line was prevented from extending to higher altitudes by steep rock faces and avalanches. About the timber line in the Kakapo area several principal plant communities were present. Track and bowl systems, and feeding sign were found in silver beech forest, amongst alpine scrub, and in tussock grassland communities.

It is suggested that one possible reason for track and bowl systems being located close to tree line is the rich diversity of plant species that are present, associated with the beech forest - alpine scrub - tussock grassland communities.

The influences of aspect on plant species were found to indirectly affect Kakapo feeding. Track and bowl systems and feeding sign tended to be located on ridge crests and well drained sunny slopes. The numerous alluvial and avalanche detritus fans supported a particularly diverse variety of species in relation to surrounding sites. Much feeding sign was found on such fans close to track and bowl systems. Kakapo feeding sign was generally found where the proportion of plant cover was high. Feeding sign and track and bowl systems were located under a range of canopy heights - from a low canopy in tussock grassland (less than 0.5m), up to 20 meters in silver beech forest.

On Maud Island 3 introduced Kakapo adapted to a new habitat. At least 2 of these 3 Kakapo were present during 1975-76 when the feeding study was

being undertaken. The birds wandered widely over an ever increasing feeding range and frequently used the roads from which over 500 droppings were collected for faecal analysis investigation. The Kakapo occupied pasture, bracken, regenerating scrub and podocarp-broadleaf communities on the island.

The Kakapo is a herbivor. In Fiordland over 79 species of plant have been a source of food for them. On Maud Island 28 species have been identified as Kakapo foods.

Kakapo are generally nocturnal feeders but during the breeding season birds have been seen foraging and booming during daylight hours. They are skilled climbers and have been reported climbing vertical tree trunks. Kakapo have been seen as high as 7m in the forest canopy. However, Kakapo are unable to sustain flight although they can glide down steep slopes.

Observations of Kakapo feeding in the wild are rare but it is apparent the birds are capable of covering several kilometers in a night at least in search of food.

On Maud Island the three Kakapo became accustomed to the new food species, although many of these belonged to the same genera as Fiordland food species (Coriaria, Pseudopanax, Asplenium, Coprosma, Acaena). Some of the new species taken as food confirmed reports from the early literature of plant species used by Kakapo in the latter half of last century.

These had not been reported in recent years as they were absent from the Kakapo areas in Fiordland but do occur in many parts of the Kakapo's previous range. Grasses, herbs (weeds) and bracken played an important seasonal role in the diet of at least one Kakapo on the island.

The range of foods eaten by Kakapo on Maud Island increased from 1974 to 1977. The individual birds appeared to have learned over this period where suitable foods, particularly seeds, could be found in season. Bracken rhizome was taken when available following the excavation of roads and subsequent slips. Grasses appeared in their highest concentrations in faeces in winter and early spring, herbs in spring and early summer. Leaf cuticles from over 23 genera and seeds from over 15 species of plant were found in Maud Island Kakapo faeces. Seeds of 4 plant species: sheeps sorrel, flax, Fuchsia and Coprosma occurred in large numbers between early summer and early winter.

In captivity in Fiordland and on Maud Island Kakapo have frequently fasted although over 15 species of plants have been sampled by Kakapo in the Esperance Valley aviary.

At Mt. Bruce, the longest surviving male included over 40 plant species in its diet: leaves, petioles, stems, roots, seeds, fruits and nectar (honey water) were included.

Kakapo faecal analysis results have supplemented

field observations. Meaningful quantative results from such a study would probably be misleading as close observation of Kakapo feeding habits and controlled feeding trials would first need to be done in captivity, and this has not been possible up to the present.

However, faecal analysis results have revealed the presence of 24 genera of plant being taken in 11 different localities in northern Fiordland. Fern species were the most regularly occurring group in the Kakapo diet. Several plant genera found in droppings, notably Anisotome, Gaultheria, Hebe and Nothofagus had been rarely reported if at all from field observations.

No insect or animal remains were found in fresh Kakapo droppings, but insects subsequently invaded droppings. Several very old faeces were found with insect remains which were identifiably those of secondary invaders. Kakapo foods in Fiordland included roots, rhizomes, bulbs, twigs, petioles, buds, leaves, flowers, flower stems, fruits and seeds. The collection of field data in Fiordland did not span a full yearly cycle but grass seeds and various berries and fruits contributed to the summer, autumn and winter diet. Evidence for spring feeding was obtained by examining field signs in summer that were obviously several months old. Leaves of grasses, shrubs and herbs were apparently eaten throughout

the year - particularly in the spring when buds were widely utilized. Ferns were probably taken throughout the year.

Twenty three Kea faeces collected in Kakapo territories contained large numbers of seeds, while opossum faeces included leaf cuticles of most species utilized by Kakapo in the same localities.

Kakapo manipulate and crush seeds and fruits in a manner typical of a great many parrot species. However, more unusual is their habit of forming chews. Leaves in particular are crushed in the bill, nutrients are extracted and the remaining plant material is expelled. Analysis of the chews and non chewed fractions indicate that an average of 26% of the crude protein, 56% of the ether extracts (fats) and 56% of the ash content (e.g. trace elements) of leaves may be removed by Kakapo before it expells the chew. Crude fibre and nitrogen free extracts form the bulk of the expelled chew. Nutritional analyses suggest that the Maud Island foods available to Kakapo contained higher nutritional values than the Fiordland species analysed.

APPENDIX I

Fiordland Plant Cuticle Reference Collection

Acaena aff. hirsutula	Aciphylla crenulata
Anisotome flexulosa	Anistotme haastii
Aporostylis bifolia	Archeria traversii
Aristotelia fruticosa	Aristotelia serrata
Asplenium bulbiferum	Asplenium flaccidum
Astelia linearis	Astelia nervosa
A. nivicola	A. petriei
Blechnum capense gp.	Blechnum penna-marina
B. procerum	Bulbinella gibbsii var. balanifera
Caltha novae-zelandiae	Cardamine debilis
Carmichaelia grandiflora	Carex sp. (Transit V.)
Carpha alpina	Cassinia vauvilliersii
Celmisia coriacea	Celmisia grandulosa
C. lanceolata	C. petriei
C. verbascifolia	Chionochloa conspicua
Chionochloa crassiuscula	C. flavescens
Coprosma astonii	Coprosma cheesemanii
C. ciliata	C. colensoi
C. crenulata	C. foetidissima
C. pseudocuneata	C. pumila
C. rugosa	C. serrulata
Coriaria plumosa	Coriaria sarmentosa
Cotula perpusilla	Craspedia uniflora
Cyathodes empetrifolia	Cyathodes juniperina
Dacrydium biforme	Drapetes sp. (Tutoko V.)
Dracophyllum fiordense	Dracophyllum longifolium
D. menziesii	D. uniflorum
Epilobium glabellum	Euphrasia zelandica
Fuchsia excorticata	Gaultheria crassa
Gaultheria depressa var. depressa	G. depressa var. novae-zelandiae
G. rupestris	Gentiana montana
Geum parviflorum	Gingidium montanum
Gnaphalium hookeri	Grammitis billardieri

Appendix I continued:

Griselinia littoralis	Gunnera monoica
Hebe cockayniana	Hebe macrantha
H. odora	H. salicifolia
H. subalpina	Helichrysum bellidioides
Hierochloe cuprea	Hoheria glabrata
Hydrocotyle novae-zelandiae	Hymenophyllum multifidum
Leptosperum scoparium	Liverwort
Lycopodium fastigiatum	Luzula rufa
Metrosideros umbellata	Microlaena colensoi
Montia fontana	Muehlenbeckia axillaris
Myrsine divaricata	Myrsine nummularia
Nertera dichondraefolia	Nothofagus menziesii
Notodanthonia nigricans	Notodanthonia nigricans
Olearia arborescens	Olearia colensoi
O. ilicifolia	O. moschata
Oreobolus strictum	Oreomyrrhis colensoi
Curisia macrocarpa	Oxalis sp. (Poseidon V.)
Pernettya macrostigma	Phormium cookianum
Phyllocladus alpinus	Phymatodes diversifolium
Plantago novae-zelandiae	Poa colensoi
Podocarpus nivalis	Polystichum vestitum
Prasophyllum colensoi	Pratia angulata
Pseudopanax colensoi var. ternatum	Pseudopanax lineare
P. simplex	Pterostylis australis
Ranunculus lyallii	Raoulia glabra
Raoulia tenuicaulis	Rubus cissoides
Schefflera digitata	Schizeilema sp.
Schoenus pauciflorus	Senecio bennettii
Senecio lyallii	S. scorzoneroides
Todea superba	Uncinia filiformis
Uncinia involuta	Viola filicaulis
Wahlenbergia setifolia	Weinmannia racemosa

APPENDIX 2

Maud Island Plant Cuticle Reference Collection

Acaena sp.
Achillea millifolium
Agrostis tenuis
Anthoxanthum odoratum
Aristotelia serrata
Asplenium bulbiferum
Asplenium flaccidum
Astelia sp.
Avena sativa
Bellis perennis
Blechnum capense type
Cassinea leptophylla
Cerastium vulgatum
Cirsium sp.
Coprosma pumila
Coprosma repens
C. rhamnoides
Coriaria arborea
Crepis capillaris
Digitalis purpurea
Dysoxylum spectabile
Elaeocarpus dentatus
Erigeron sp.
Fuchsia excorticata
Galium aparine
Geranium pusillum
Gnathalium luteo-album
Helichrysum bellidioides
Holcus lanatus
Hydrocotyle moschata
Hypochaeris radicata
Hypolepis tenuifolia
Leontodon taraxacoides
Leptospermum scoparium
Linum marginale
Melicytus ramiflorus
Metrosideros diffusa
Myrtus bullata
Olearia rani
Orchid sp.
Pernettya macrostigma
Pimelia prostrata var. *quadrifaria*
Plantago major
Phormium cookianum
Phymatodes scandens
Prunella vulgaris
Pseudopanax arboreum
Pteridium aquilinum
Rhopalostylis sapida
Rubus cissoides
Rumex acetosella
Schefflera digitata
Solanum aviculare
Taraxacum officinale
Trifolium pratense
Trifolium repens
Uncinia uncinata
Wahlenbergia sp.
Weinmannia racemosa

APPENDIX 3

Percentage Content of Faeces

All droppings found in a particular area or locality were grouped and sampled. Division was made between old and fresh droppings. Over 350 droppings from 42 localities were examined. Individual groups ranged from 1-20 droppings.

The localities or areas were as follows:
Caswell Sd. (1 area); Donne V. (2); Gulliver V. (6); Harrison V. (1); Poison Bay (1); Poseidon V. (1); Sinbad V. (4); Stirling V. (1); Surprise Ck. (2); Transit V. (3); Takahe V. (1); Lower Tutoko V. (1); Tutoko High Bench (T.H.B.), Dec.1975 (4); T.H.B., Jan.1976 (3); T.H.B., Feb.1976 (2), T.H.B., Mch.1976 (4); T.H.B., 1977 (5 areas).

Plant cuticles and other contents in faeces	Number of areas in which present (max. 42)	Average % cuticle content if present in faeces. Range in brackets
Plant cuticle (total)	42	32 (2-68)
Aciphylla crenulata	2	1 (1-2)
Anisotome haastii	20	12 (1-20)
Astelia spp.	5	2 (1-9)
Carex spp.	4	8 (1-24)
Celmisia spp.	3	2 (1-3)
Coprosma sp. (exocarp)	2	2 (1-3)
Dracophyllum spp.	8	6 (1-15)
Fern spp.	31	8 (1-32)
Gaultheria spp.	3	5 (1-9)
Grass spp.	15	3 (1-9)
Gunnera monoica	1	2 (2)
Hebe spp.	3	2 (1-4)
Hymenophyllum spp.	12	8 (1-41)
Moss	5	1 (1)
Nothofagus menziesii	6	14 (3-31)
Olearia colensoi	2	1 (1-2)
Phormium cookianum	1	1 (1)
Podocarpus nivalis	15	14 (1-48)
Pseudopanax colensoi	1	8 (8)
Unknown cuticles	36	8 (1-37)
Miscellaneous conducting tissue	42	62 (29-97)
Fern palea	20	4 (1-14)
Fern annulus rings	5	4 (1-11)
Astelia scales	6	2 (1-7)
Exocarp	3	2 (1-6)
Petiole	9	2 (1-7)
Tomentum	8	10 (1-22)
Trichomes	10	2 (1-7)
Seed fragments	1	3 (3)

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