

# FEEDING ECOLOGY OF HYBRIDIZING PARAKEETS ON MANGERE ISLAND, CHATHAM ISLANDS

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## ABSTRACT

The diet of Red-crowned Parakeets (*Cyanoramphus novaezelandiae chathamensis*) and hybrids (*C. n. chathamensis* x *C. auriceps forbesi*) was determined from crop contents and field observations. Crops were dissected from 220 Red-crowned and hybrid birds collected over four years on deforested Mangere Island in the Chatham group. Volume and prevalence of foods taken in winter, spring and summer were measured. No effect of sex or age was found on frequency of occurrence of food items, and low variation in diet attributable to species/hybrid status indicated that feeding strategies of the parent species had converged. Diet of all forms varied seasonally. The main winter food was grass seeds, with a small proportion of leaves. The spring diet was the most varied, consisting mostly of leaves, with seeds, flowers and invertebrates. Seeds were eaten in late summer, mostly from *Geranium traversii*. Field observations in winter emphasised the importance of leaf feeding. Some plant species seen to be eaten in summer were not found in crops. Habitat selection and perch height distribution was associated with breeding requirements as well as feeding.

## INTRODUCTION

Mangere Island (44°16' S, 176°17' W) in the Chatham group is inhabited by two species of platycercine parakeets. The Red-crowned Parakeet (*Cyanoramphus novaezelandiae chathamensis*) is more widely distributed in the Chatham Islands and closely resembles the Red-crowned Parakeet of mainland New Zealand. By contrast, Forbes' Parakeet (*C. auriceps forbesi*) is endemic to Mangere and Little Mangere Islands, and differs from the mainland Yellow-crowned Parakeet in body size and several features of plumage (Fleming 1939, Taylor 1976, Nixon 1982). Originally described by Rothchild (1893) as a separate species, Forbes' Parakeet was designated a subspecies of *C. auriceps* by Oliver (1930). Triggs and Daugherty (in press) have proposed the restoration of *forbesi* to full species level based on morphology and data on polymorphic allozymes.

The two species apparently coexisted on Mangere Island before the forest cover was cleared at about the turn of the century (Fleming 1939), after which the permanent population of Forbes' Parakeet became confined to the forested top of adjacent Little Mangere. Mangere Island was gradually recolonized by Forbes' Parakeets from Little Mangere and larger numbers of Red-crowned Parakeets, and in 1970, birds were noted bearing head plumage markings intermediate between those of the two species (Taylor 1975).

According to Taylor (1985), factors contributing to interbreeding were similar size of parent species, limited mate choice amongst the small number

of colonists, and removal of grazing mammals and cats (which supported rapid population growth but favoured neither parental genotype). Furthermore, ecological and social adaptations to different habitats no longer separated the two species when the habitat was disrupted. Taylor (1975) illustrated niche segregation with feeding observations of the locally allopatric populations of Forbes' Parakeet on Little Mangere Island and Red-crowned Parakeets on South East Island. In order of importance, Forbes' Parakeet took invertebrates, flowers, seeds and leaves. However, earlier records of foods included "numerous seeding plants", flowers, fruit (Fleming 1939), and carrion when the opportunity was presented (Travers 1868). Red-crowned Parakeets of the Chatham Islands have likewise been shown to use a broad range of foods. On South East Island, Taylor (1975) most often observed them taking leaves and shoots, with some flowers, and seeds. Fruit, invertebrates, nectar and berries were of lesser importance. Forbes' Parakeet was therefore characterized as a forest specialist, in relation to the more generalist habits of the Red-crowned Parakeet (Taylor 1975, 1985).

Operations to restore the habitat on Mangere were undertaken by the New Zealand Wildlife Service, and, beginning in 1976, an attempt was made to remove hybrids and lower the numbers of Red-crowned Parakeets to maintain species integrity, particularly of Forbes' Parakeet, during the regeneration period. The aim of the present study was to describe the diet of parakeets on Mangere Island, making use of birds collected during the removal operations. Following Taylor's observations from separate habitats, there was an opportunity to examine the relationship between species status and diet of the mixed population on Mangere (as far as possible given the bias towards one parental species). These data were compared with field observations to determine the extent to which feeding behaviours of parental species had been retained in the disturbed habitat.

## METHODS

Red-crowned and hybrid parakeets were shot with a .22 calibre rifle firing bird shot and placed in ethanol during the hybridization control operation on Mangere Island between September 1976 and December 1980. Crops and oesophagi from 220 birds were dissected out and washed in 70% ethanol. Crop content volume was measured using plastic syringes (1 ml, 3 ml and 6 ml) with nozzles removed at the zero mark. Crop contents were loosely compacted in the syringe to remove excess ethanol, and the volume read from the graduations. The material was then sorted in a Petri dish and proportions of each food type determined using a grid of 5 mm squares. Composition of diet was expressed as frequency of occurrence of all items (regardless of volume), and volume of major food classes. Samples of each new food item were retained for identification.

Each parakeet specimen was classified according to hybrid status, sex, age, season, habitat type, and year. Hybrid status was ascertained by an unweighted hybrid index, similar to those described by Hatheway (1962) and Short (1965). The hybrid index score used here was based on four head plumage characters: crown colour; frontal band width; lores marking width; and ear-covert marking size. Scores were grouped into five classes: the two

parental phenotypes; Forbes-like hybrids (hybrid 1); intermediate hybrids (hybrid 2); and Red-crowned-like hybrids (hybrid 3). Representative head plumage phenotypes are illustrated in Figure 1, and described in detail by Nixon (1982). Age categories - adult or juvenile - were determined from colour of bill and feet and general appearance of plumage. Seasons were winter (1 to 3 June), spring (22 September to 1 November), late summer (3 February to 5 March). Habitat types were divided into "bush" and "open" areas on the basis of the predominant vegetation type of the Mangere Island block in which the bird was collected. Effects of these variables on diet were examined separately using a chi-square test for association controlling for the other factors where possible. Higher order interactions were not examined.

Field observations were made during visits to Mangere island on 18 May to 3 June 1979 and 1 to 6 February 1980. For each parakeet sighted, notes

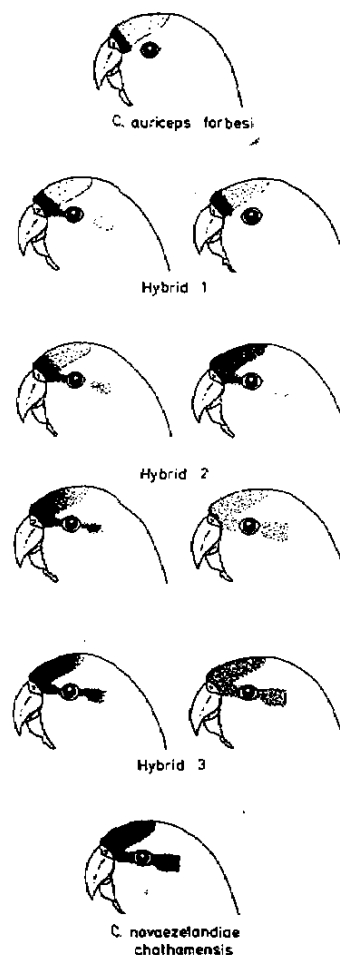


FIGURE 1 – Head plumage phenotypes of hybrid parakeets. Forbes (*Cyanoramphus auriceps forbesi*): Crown yellow, narrow frontal band does not extend to eye, no lores or ear-covert markings. Hybrid 1: crown yellow to orange, front narrow to wide usually extending to eye, ear-coverts green or with faint markings. Hybrid 2 (middle four figures): crown orange to red, wide or intergrading frontal band extending over lores, faint to prominent ear covert markings. Hybrid 3: crown orange or red with orange border, prominent lores and ear-covert markings. Red-crowned (*C. novaezelandiae chathamensis*): crown red, red band through lores to a large ear-covert patch.

were made of surrounding vegetation type, vertical height above ground of perch, species/hybrid status, and food taken after initial observation. A list of potential food plants available on Mangere Island in 1980 was compiled (Nixon 1982) with the aid of surveys by Ritchie (1970) and G. Kelly (unpublished). Reference plant material was collected for identification of crop contents.

## RESULTS

### *Condition of crops and food materials*

Of the 136 birds collected during spring, 5 (4 %) had empty crops, and 77 (57 %) had a crop content volume of between 0.01 and 0.90 ml. The maximum capacity observed was 9.8 ml. The large, distinct crops of parakeets were well suited to this form of analysis, as they generally contained whole and undigested food items. Materials found in the proventriculi and gizzards were less well preserved.

Seeds were usually ingested whole, with a notable exception of the larger *Dactylis glomeratus*. Some seeds were usually husked, e.g. *Sonchus grandifolius* and *Geranium traversii*. Bracts occurred commonly with *Geranium* seed. Remains of flowers in the crop were generally fragmented. Fruit pulp was not identified, and it is possible that some foods, such as *Pratia arenaria*, classed as seed were taken for their fruit flesh. Small quantities of "unidentified" material occurred in 13 % of crops. Some of this may have been fruit pulp, but this category also included sloughed epithelial lining of the crop.

The birds cut leaves into 3-4 mm long fragments, although clover leaves (*Trifolium* spp.) were taken whole and rolled into boli about 3 mm in diameter. Leaves of grasses were generally cut into about 4 mm lengths, with the edges rolled inwards. Thick leaf fragments that constituted the bulk of the "unidentified leaf" category appeared to be from the predominant *Olearia traversii*.

Invertebrates were invariably small, whole, and undigested. The most frequent types were hemipterans (mostly pseudococcids), and lepidopteran, dipteran, and coleopteran larvae. The largest of these invertebrates was 8 mm long.

### *Effects of age, sex, and habitat*

Thirty-five of the 220 birds were classed as juveniles, including some unlabeled specimens probably collected in late summer. The diet of the 35 was compared with that of 20 adults collected between 3 February and 25 April. During this period the main food of both age groups was seed, especially *Geranium traversii* which constituted 80 % and 64 % of crop volume for adults and juveniles respectively. Only crops of juveniles contained insects. Only adults ingested wood and leaf material (*Olearia* and grass). Despite these differences in minor foods, a comparison of frequency of occurrence of 25 items showed that variation in diet between age groups was not significant ( $p > 0.10$ ).

Diets of 87 male and 94 female parakeets were compared, irrespective of taxonomic status but excluding juveniles and those collected in winter.

The frequency of occurrence of 30 food items was very similar between sexes ( $p > 0.10$ ). The foods were mostly seeds, with some flowers, leaf, and insects.

Only 83 birds were labeled as to habitat. Of these, 24 were from blocks characterized by "open" grass or herbaceous vegetation or rocky areas, and 59 were from "bush" areas with *Olearia traversii* and *Plagianthus betulinus* var. *chathamicus*, the two dominant tree species. Most woody and fibrous material was found in crops of birds from open areas where, by definition, fewer woody plants grew. More *Cerastium* sp. seed, typical of open areas, was found in birds from bush areas. Parakeets on Mangere Island were observed to move widely over a range of habitats, and it seems likely that many birds were collected at a distance from previous feeding sites.

#### *Effects of hybrid status*

The frequency of occurrence of 25 items in the crops of 135 parakeets of four phenotypes ranging from Red-crowned to hybrid 1 is shown in Figure 2. The range of items taken was broadly similar, and variation was marginally non-significant (chi-square 15d.f. = 22.653,  $0.05 < p < 0.10$ ) among the four hybrid categories. Although the proportion of crops containing foliage of unidentified species (probably *Olearia traversii*) decreased slightly from Red-crowned to hybrid 1 phenotypes, the amount of grass leaves increased markedly. Similarly, higher proportions of insect food, especially caterpillars and beetle larvae, were taken by birds phenotypically closer to Forbes' Parakeet.

#### *Seasonal effects*

Hybrid categories were combined to provide a comparison of diet at three times of the year: late summer (32 birds), winter (6 birds), and spring (136 birds). Seed was important in the summer diet (Figure 3). The range of seed species eaten is shown by their frequency of occurrence in Figure 4, however one species, *Geranium traversii*, predominated above others. By volume, this comparatively large seed constituted 75 % of all summer food. The second most abundant seed was *Sonchus grandifolius* at 7 %. A small amount of unidentifiable flower, and minute quantities of insect and leaf material, were also eaten in summer.

In spring, mostly leaves were eaten along with some seeds and flowers (mainly *Disphyma australe*) (Figure 3). A wide range of seeds was present, but most were in small quantities, the predominant species being *Cerastium* (Figure 4). Most insects were consumed during this season.

The small winter sample contained mostly seeds, especially of the grass *Dactylis glomerata*. Leaves, mostly grass, made up much of the remainder. Small numbers of hemipterans were also eaten in winter.

#### *Habitat and feeding observations*

Observation of birds during winter 1979 and summer 1980 showed differences in feeding and social behaviour between the parental species. On both visits, mixed groups of both species and hybrids were seen feeding together, however Forbes' Parakeets were often encountered in pairs, whereas Red-crowned Parakeets more often formed larger flocks. During winter, the species differed markedly in habitat use (Figure 5). Red-crowned

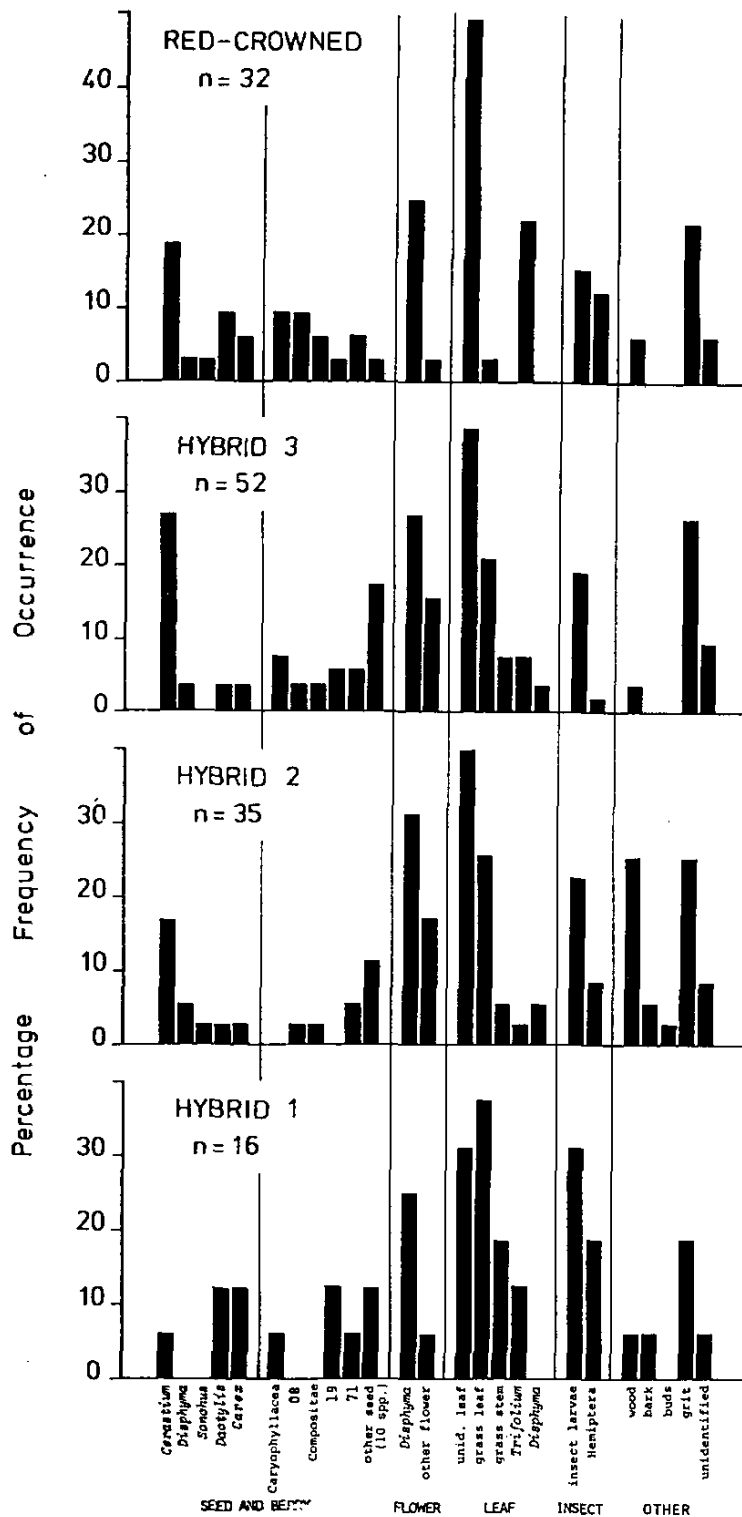


FIGURE 2 – Frequency of occurrence analysis of spring diet of parakeets according to hybrid status. Bars indicate the percentage of crops containing each food item. Items recorded as numbers are unidentified seeds.

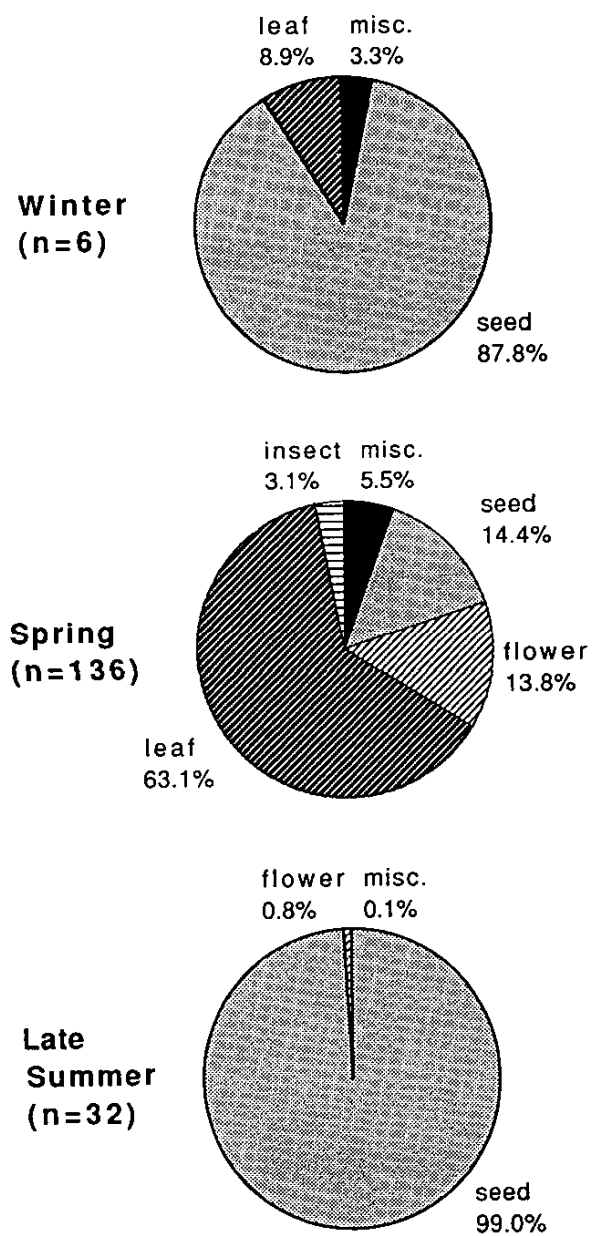


FIGURE 3 – Volumes of broad food types of Mangere Island parakeets

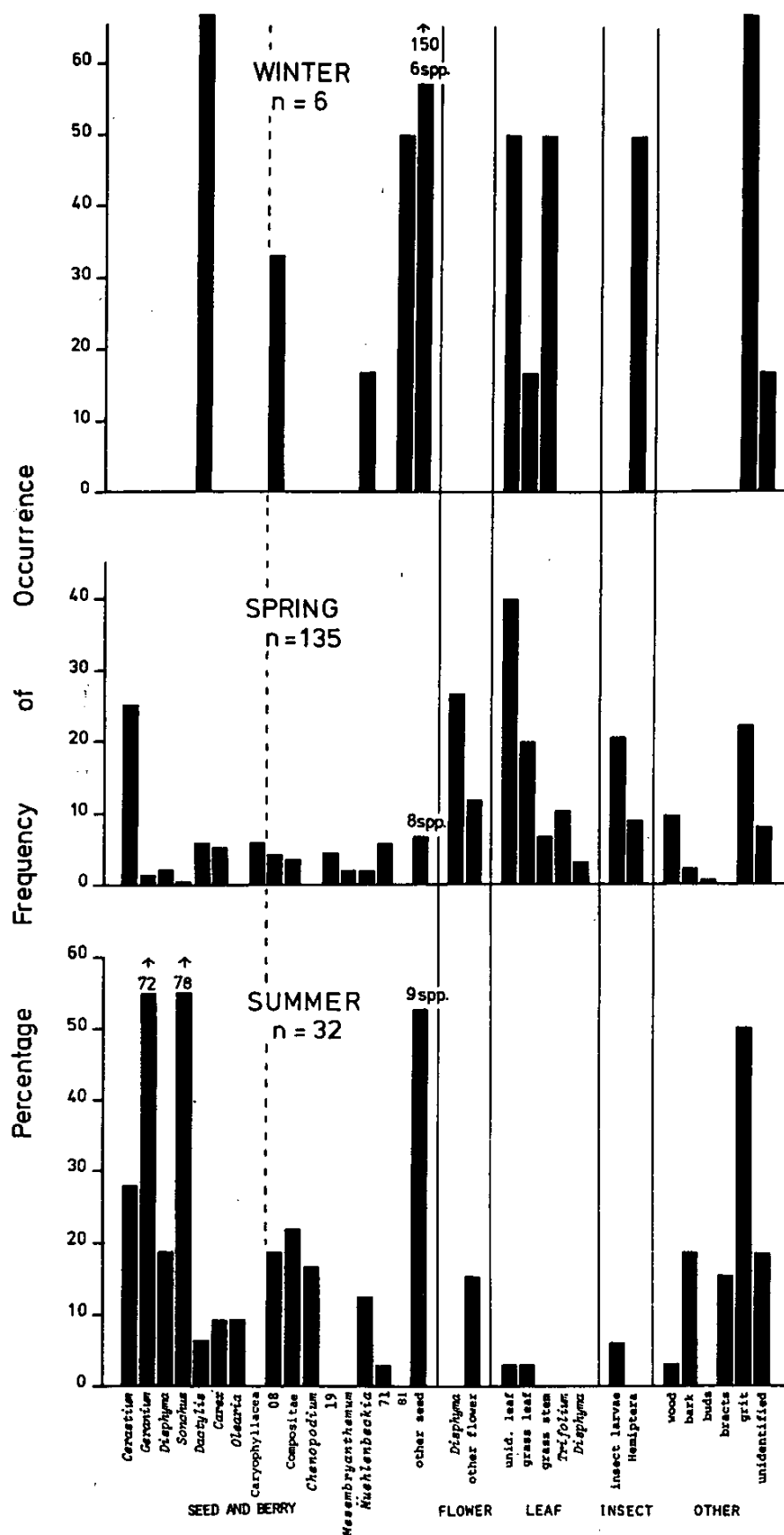


FIGURE 4 – Frequency of occurrence analysis of seasonal diet of Mangere Island parakeets. Bars indicate the percentage of crops containing each food item. Items recorded as numbers are unidentified seeds.



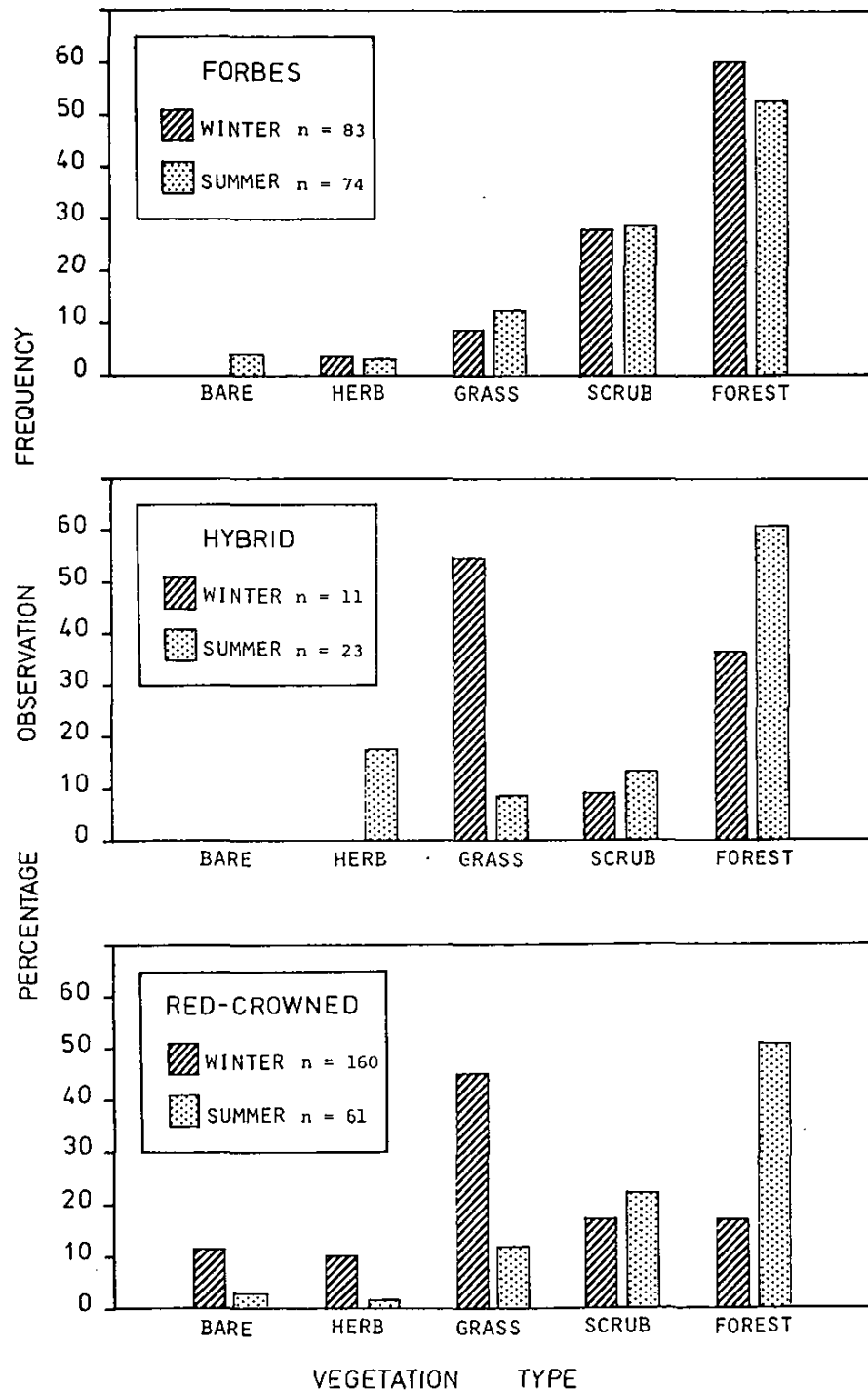


FIGURE 5 – Seasonal changes in habitat distribution of Mangere Island parakeets  
Vegetation types are described in the text.

Parakeets were present in all vegetation types, but were particularly common in grassland. Forbes' Parakeets were almost always found in or around the taller vegetation. However, during the summer breeding season, there was a shift in habitat use, mainly by Red-crowned Parakeets, so that the distribution of the two species became very similar ( $p > 0.10$ ). Another indication of behavioural difference was the comparative approachability of Forbes' Parakeets. This species was observed in flight less often than Red-crowned Parakeets – 20 % compared with 51 % of summer sightings respectively.

Perch heights reflected, in part, the general habitat preferences of the two species (Figure 6). In winter, when Red-crowned Parakeets occupied mostly open habitats, 61 % of these birds were observed on the ground, as against 21 % in summer. Forbes' Parakeet showed little seasonal variation in perch height. Those seen on the ground were invariably in close proximity to scrub or forest. The modal height of 4-5 m (Figure 6) was related to the vegetation structure on Mangere Island, as well as to the animals' preference. This was the canopy height of much of the Akeake and Ribbonwood on the eastern side of Mangere Island.

Incidences of first foods eaten after sighting in winter 1979, and in summer 1980 are given in Tables 1 and 2 respectively. Mixed groups of Red-crowned, Forbes, and hybrid parakeets were seen feeding together, but Forbes' Parakeets were often encountered as isolated pairs.

From 8 to 11 February 1980 Red-crowned Parakeets on South East Island were observed feeding on *Hebe* seeds, seed pods of *Phormium tenax*, *Sonchus* seeds, *Olearia chathamica* flowers, and a penguin carcass.

TABLE 1 – Observed foods of parakeets on Mangere Island, 18 May - 1 June 1979.

Food	Red-crowned	Forbes	Hybrid
Grass leaf	6	15	1
<i>Olearia traversii</i> leaf	7	6	1
pseudococcid insects	4	3	1
<i>Acaena</i> seed	3		2
<i>Plagianthus</i> twig	2	3	
<i>Hebe</i> leaf	3	1	
<i>Disphyma</i> leaf	3		
<i>Olearia traversii</i> bark		3	
Lichen	3		
<i>Olearia chathamica</i> leaf	2		
<i>Muehlenbeckia australis</i>	1	1	
<i>Disphyma</i> flower		1	
<i>Plagianthus</i> bark		1	

TABLE 2 – Observed foods of parakeets on Mangere Island, 1-6 February 1980.

Food	Red-crowned	Forbes	Hybrid
<i>Sonchus grandifolius</i> seed		6	1
<i>Olearia traversii</i> seed		5	1
<i>Olearia traversii</i> leaf	1	3	1
<i>Plagianthus</i> fruit/seed	2	3	
regurgatory feeding		3	
<i>Phormium tenax</i> fruit		1	2
<i>Plagianthus</i> leaves		2	
<i>Sonchus grandifolius</i> flower		1	1
<i>Olearia traversii</i> flower		1	1
<i>Plagianthus</i> flowers		1	
<i>Plagianthus</i> twig		1	
<i>Plagianthus</i> bark		1	
<i>Parietaria debilis</i> leaf		1	
<i>Muehlenbeckia australis</i> seed		1	
<i>Urtica australis</i> fruit/seed		1	

### Grit use

Particles of mineral grit were present in the crop contents in small quantities (usually several grains) and constituted most of the material present in the gizzards. The frequency of occurrence is shown with foods in Figure 4. The grit particles were almost always black, probably basaltic chips, and ranged in size from 0.5 to 2 mm in diameter.

## DISCUSSION

The parakeets of Mangere Island forage in open grassland and amongst low herbs interspersed with larger plants and trees. Many of these plants are endemic to the Chatham Islands at species or subspecies level. Ten of 74 potential food species from botanical lists were common in crop contents. In addition, several plants were eaten but not seen during botanical surveys. The proportions of these foods taken by Mangere Island parakeets varied markedly between seasons, probably reflecting availability and nutrient quality.

There was some disparity between crop contents and feeding observations in winter. The six crops available contained seed, mostly *Dactylis glomerata*, and small quantities of leaf, but birds were observed feeding mainly on leaves, especially of the more abundant and prominent species. Birds were not seen taking *Dactylis* seed but were often seen feeding on the ground before their food could be identified. Dawe (1979) found feeding on fallen seeds by Red-crowned Parakeets on Tiritiri Matangi Island to be important during winter, and it is possible that the Mangere birds were engaged in this activity.

The diets of all taxa were most diverse in spring, although this could be partly attributable to the large sample for this season. Leaves were the predominant food. Flowers and invertebrates were taken in larger quantities than at other times. Flowers were also the most frequently taken spring food

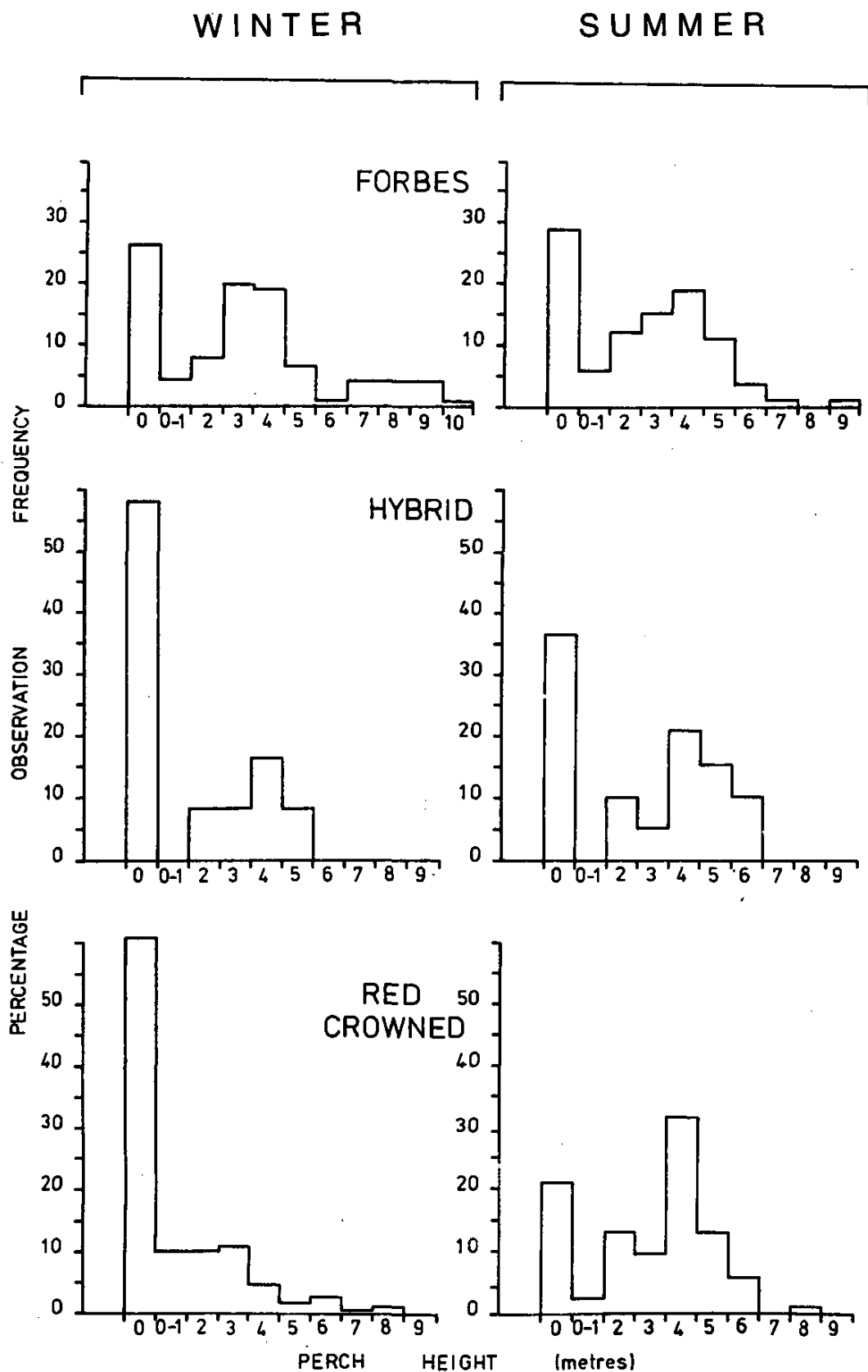


FIGURE 6 – Perch height distribution of Mangere Island parakeets.

observed by Dawe (1979). Volumes of food types (Figure 3) were very similar to percentages of foods of Red-crowned Parakeets observed on South East Island in spring (Taylor 1975).

During February, a wide range of plants on Mangere Island bore seeds, the most prominent being *Olearia traversii* and grasses. The bulk of the summer diet was seed, mostly the endemic *Geranium traversii*. Parakeets were not observed to feed on this plant, but its prostrate growth form makes it inconspicuous as a feeding station in the grassland community. On the other hand, the second most important crop item, seeds of the endemic sow-thistle, *Sonchus grandifolius*, were commonly seen to be eaten in the field. The seeds were easily identified by the white thistle down in the birds' bills. Mangere parakeets were, therefore, mainly graminivorous and frugivorous when seeds and berries were abundant in summer, which is in accord with observations of feeding of Red-crowned Parakeets on offshore Islands (Wilkinson 1957, Dawe 1979, Bellingham 1987) and other subspecies on outlying islands (Merton 1970, Warham & Bell 1979, Taylor 1985).

As well as varying their diet seasonally, Red-crowned Parakeets also selected different daytime habitats. These differences were illustrated by patterns of vegetation use and perch height. Their winter distribution appeared to be related to feeding. Red-crowned Parakeets ranged widely over open habitats and ate grass seed, leaves and insects found in the grass sward. The shift into taller vegetation during summer was probably associated with breeding, that is selection of nest sites, rather than feeding behaviour. Two nesting holes occupied by Red-crowned and hybrid birds were discovered in larger *Olearia traversii* trees, and fledgelings were common in and around the forest in summer. It appeared that such nest sites were limited to the remnant forest of approximately 500 m<sup>2</sup> on the eastern side of the Island. The need for the two species to share this small area for breeding may have been a significant factor in the advent of hybridization.

The absence of crop material from Forbes' Parakeets and the short duration and sampling biases inherent in field studies did not allow a full comparison of the two parakeet species. However, some general conclusions are possible. Trends in the occurrence of foods in crops amongst Red-crowned and hybrid parakeets suggest that the diets of all phenotypes on Mangere are similar, and varied according to seasonal availability. A greater frequency of insects in crops of Forbes-like hybrids followed the spring feeding differences described by Taylor (1975). But contrary to Taylor's observations on Little Mangere Island, Forbes' Parakeets and Forbes-like hybrids ate a larger quantity of grass leaf, as revealed by both field observations and crop analyses. In colonizing Mangere Island, Forbes' Parakeets were presented with sources of abundant food in the grass and scrub country adjacent to their favoured habitat – the now-remnant forest. They appear to have readily adopted non-forest foods, and taken more seeds and leaves, so that their diet has become more like that of Red-crowned Parakeets. Mixed species flocking, which occurred prior to widespread hybridization (Fleming 1939), may have allowed sharing of some feeding traditions.

In some birds, particularly island species, sexual dimorphism of the bill is associated with division of the feeding niche between males and females (Selander 1966, Lack 1971). Sexes of *Cyanoramphus* parakeets differ markedly in bill dimensions (Nixon 1982). However, results presented here demonstrate that the diets of the dimorphic sexes on Mangere were very similar. Dawe (1979) made a similar finding. The speculation that difference in bill size amongst Chatham Island parakeets is an adaptation to reduce competition (Smith 1975) is therefore not supported by these data.

In conclusion, the parakeets of Mangere Island displayed an ability to utilize a wide range of foods in a manner that is typical of their genus. Whereas some obvious behavioural characteristics have been retained by the parent species, it appears that both species and their hybrids have adapted their feeding to exploit common food resources.

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