

FOODS OF THE PARADISE SHELDUCK *Tadorna variegata* IN THE HIGH COUNTRY OF NORTH CANTERBURY, NEW ZEALAND

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ABSTRACT

The food of 204 Paradise Shelducks from the high-country of Canterbury was examined. Types of food and their percentage occurrence are listed. Plant material, particularly that obtained by grazing, made up most of the bulk of the food eaten throughout the year. Animal material, mainly of aquatic origin, was of only minor importance, with much of it apparently being ingested accidentally with plant material. Seasonal changes in the diet between 24 May 1972 and 5 May 1973 are discussed.

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INTRODUCTION

The Paradise Shelduck, *Tadorna variegata* (Gmelin), New Zealand's indigenous shelduck, is now distributed throughout most of the country. In pre-Polynesian times its distribution was probably limited by the availability of suitable grassland habitats (Williams 1971), but the reduction of forests and the development of pastoral land have apparently allowed the species to extend its range, particularly in the North Island (McAllum 1965). In Canterbury, Paradise Shelducks are found mainly throughout the river valleys of the Southern Alps, where they are relatively abundant. Elsewhere in the province smaller numbers occur, mainly near rivers in areas not intensively farmed.

Apart from anecdotal records, little has been published on the general biology of Paradise Shelducks. The present study formed part of a wider investigation of the range of helminth parasites which

infect the Paradise Shelduck in its natural habitat. Parasitic helminths of the alimentary tracts of waterfowl almost invariably enter their hosts via the mouth, so infection depends to a large extent on the feeding habits of the host. A detailed examination of the diet of the Paradise Shelduck was, therefore, considered essential. Although the Paradise Shelduck is known to be a grazing species — Travers (1871), Oliver (1955), McAllum (1965) and Williams (1971) — no-one has investigated the extent of this grazing habit. This paper presents data from 204 shelducks collected from the high-country of Canterbury.

MATERIAL AND METHODS

Collection of Samples

One hundred and eighty shelducks were collected from the main study area on the Canterbury side of the Lewis Pass, viz the valleys of the Hope, Kakapo, Doubtful and Boyle Rivers. These river valleys are representative of many of those favoured by Paradise Shelducks in Canterbury, possessing wide, open, shingle riverbeds bordered by grassed riverflats and terraces. Occasional areas of swamp occur on the riverflats. These are usually wet during the winter and spring, but are often dry during the summer and autumn.

Recent intensified farming activity has brought about an increase in the area sown in exotic grasses, clovers, lucerne and fodder crops such as turnips. Much of the terraceland, particularly above the Hope River, has been cultivated, but large areas of indigenous tussock grassland still remain. Most of the study area is grazed by cattle and sheep.

In May 1972, 70 birds were obtained from shooters in the study area (60 on 6-7 May and 10 on 27 May), and a further 10 in May 1973. These were mainly taken from large flocks grazing on sown pasture. From June 1972 to March 1973, 10 birds were collected by me each calendar month from the main study area. Most of these were taken on undeveloped riverflats or low terraces beside the rivers.

A further 24 shelducks were obtained from shooters during May 1972, from the upper reaches of the Selwyn River, Lake Coleridge and Porter's Pass. All three areas lie among the ranges east of the main divide in Canterbury and provide basically similar shelduck habitats to those in the main study area.

All birds shot by me were immediately labelled with a number, location and note as to whether they were solitary, or one of a pair or group. The alimentary tracts were removed and placed in plastic bags as soon as possible. Each monthly sample was kept refrigerated, without freezing, until all of the birds in it had been examined. The sample from the 1972 shooting season however, was too large to be dealt with in this way, making it necessary to freeze part of the sample. Although injection with formalin may have stopped post-mortem digestion more rapidly, this would have interfered with other aspects of the study.

Methods of Food Analysis

The gut contents were extracted by splitting sections of the gut longitudinally with scissors and washing the contents of each section into a fine mesh sieve (Mesh No. 72, aperture 210 micrometres) with flowing water. The sievings were then scanned under a stereoscopic microscope for identifiable food material. In general, identifiable food material was in, or anterior to, the gizzard. Those pieces which could not be identified immediately were stored in 10% formalin in labelled vials for later analysis. Where food material could be identified immediately, the species or category was simply recorded. Quantitative estimates of the foods eaten were not recorded. Instead proportions of the various foods eaten by the ducks were expressed simply as percentage occurrence throughout the sample. Healy (1970), Allan (1940) and Mason (1964) were consulted for identification of plant material, and Marples (1962) and Pendergrast & Cowley (1966) for animal material. Representative examples of a number of unidentified seeds and some leaf material were identified by Mrs M. Bulfin of Botany Division, DSIR, and Dr M. Winterbourn of the Zoology Department, University of Canterbury, identified many of the aquatic insects.

RESULTS

Overall Composition of Diet

Of the 204 shelducks examined, 202 contained identifiable foods. Of these 201 contained plant material, and 72 contained animal material (Table 1).

1. Plant Material — Both foliage and seeds were eaten.

For the purposes of this analysis it was convenient to group various species. For example, species of *Trifolium* and *Medicago* are referred to collectively as clovers; grasses are included as a single category as are the vegetative parts of rushes and sedges. For convenience the term "berries" is used to cover all fleshy fruits and those fruits surrounded by a fleshy layer, regardless of the origin of this layer.

The division between "terrestrial" and "aquatic" plants is difficult to define. Rushes, sedges and the herbs *Gunnera dentata*, *Lilaeopsis* sp. and *Pratia angulata*, for instance, are characteristically found in shallow water or near its edge. These are nevertheless included in Table 1 under the heading of "Terrestrial Plants."

Terrestrial Plants. Leaves of clover and grass predominated in the food. Mixtures of the two were often eaten though clover was usually present in greater quantities — in such cases 80% or more of the bulk was generally clover.

Leaves of members of the Juncaceae were the only category of terrestrial vegetative material, apart from grasses and clovers, that occurred in over 20% of the birds. A soft-leaved rush, *Juncus articulatis*, which is common in the study area, appeared to be the major species eaten. Leaves of two herbaceous plants, *Rumex acetosella*

TABLE 1. FOOD SPECIES IDENTIFIED FROM THE TRACTS OF 204 PARADISE
SHELDUCKS COLLECTED BETWEEN MAY 1972 AND MAY 1973.

		N*	g*
TERRESTRIAL PLANTS - VEGETATIVE			
MUSCI			
	<i>Breutelia affinis</i>	2	1.0
DICOTYLEDONES			
Caryophyllaceae	<i>Colobanthus</i> sp.	1	0.5
Polygonaceae	<i>Muehlenbeckia axillaris</i>	5	2.5
	<i>Rumex acetosella</i>	14	6.9
Haloragaceae	<i>Haloragis</i> (depressa?)	1	0.5
Rosaceae	<i>Acaena</i> sp.	3	1.5
Leguminosae	<i>Medicago sativa</i>	133	65.2
	<i>Trifolium dubium</i>		
	<i>T. repens</i>		
	<i>T. subterraneum</i>		
Umbelliferae	<i>Oreomyrrhis</i> sp.	5	2.5
	<i>Anisotome aromatica</i>	1	0.5
Epacridaceae	<i>Cyathodes fraseri</i>	2	1.0
Rubiaceae	<i>Nertera depressa</i>	1	0.5
Compositae	<i>Hypochaeris</i> sp. (flower buds)	14	6.9
	<i>Taraxacum officinale</i>	14	6.9
	<i>Cotula</i> sp.	1	0.5
	<i>Achillea millefolium</i>	3	1.5
Plantaginaceae	<i>Plantago lanceolata</i>	1	0.5
Salicaceae	<i>Salix fragilis</i>	1	0.5
MONOCOTYLEDONES			
Gramineae	including:	115	56.4
	<i>Lolium perenne</i>		
	<i>Poa pratensis</i>		
	<i>Anthoxanthum odoratum</i>		
Juncaceae	<i>Juncus</i> spp. (probably mainly <i>articulatus</i>)	42	20.1
TERRESTRIAL PLANTS - SEEDS AND FRUITS			
DICOTYLEDONES			
Polygonaceae	<i>Muehlenbeckia axillaris</i>	31	15.2
Haloragaceae	<i>Gunnera dentata</i>	8	3.9
Rosaceae	<i>Rubus cissoides</i>	1	0.5
Leguminosae	<i>Trifolium repens</i>	23	11.3
	<i>T. subterraneum</i>		
Rhamnaceae	<i>Discaria toumatou</i>	1	0.5
Araliaceae	<i>Pseudopanax crassifolium</i>	1	0.5
Cornaceae	<i>Corokia cotoneaster</i>	2	1.0
Umbelliferae	<i>Lilaeopsis</i> sp.	1	0.5
Ericaceae	<i>Gaultheria depressa</i>	1	0.5
Epacridaceae	<i>Cyathodes fraseri</i>	9	4.4
Rubiaceae	<i>Coprosma</i> spp.	4	2.0
Lobeliaceae	<i>Pratia angulata</i>	1	0.5
MONOCOTYLEDONES			
Gramineae	<i>Poa pratensis</i>	12	5.9
	indet. seeds		
	<i>Avena sativa</i>	11	5.4
Juncaceae	<i>Juncus</i> spp. (probably mainly <i>articulatus</i>)	12	5.9
Cyperaceae	<i>Scirpus</i> spp.	47	23.0
	indet. sedge seeds	9	4.4
	<i>Carex</i> spp.		

TABLE 1: continued

		N*	%*
AQUATIC PLANTS - VEGETATIVE			
CHLOROPHYTA			
	<i>Oedogonium</i> sp.	44	21.6
	<i>Mougetia</i> sp.		
	<i>Ulothrix</i> sp.		
MUSCI			
Amblystegiaceae	<i>Drepanocladus aduncus</i>	10	4.9
DICOTYLEDONES			
Ranunculaceae	<i>Ranunculus fluitans</i>	7	3.4
MONOCOTYLEDONES			
Hydrocharitaceae	<i>Elodea canadensis</i>	1	0.5
Lemnaceae	<i>Lemna</i> sp.	3	1.5
AQUATIC PLANTS - SEEDS			
DICOTYLEDONES			
Potamogetonaceae	<i>Potamogeton cheesemani</i>	9	4.4
AQUATIC PLANTS - "AQUATIC DETRITUS"		6	2.9
ANIMAL MATERIAL - TERRESTRIAL AND FREE-LIVING			
NEMATODA			
	<i>Dorylaimus</i> sp.	16	7.8
INSECTA			
O. Psocoptera	family indet.	1	0.5
O. Hymenoptera			
Formicidae	genus indet.	1	0.5
O. Diptera			
Simuliidae	<i>Austrosimulium</i> sp.	1	0.5
Blepharoceridae	genus indet.	1	0.5
Empididae	genus indet.	1	0.5
indet. family	genus 1 indet.	1	0.5
	genus 2 indet.	1	0.5
O. Hemiptera			
Saldidae	genus indet.	1	0.5
O. Coleoptera			
Elmidae	genus indet.	1	0.5
O. Ephemeroptera			
Leptophlebiidae	<i>Deleatidium</i> sp.	1	0.5
O. Odonata			
Coenagriidae	<i>Xanthocnemis zealandica</i>	1	0.5
ANIMAL MATERIAL - AQUATIC			
MOLLUSCA			
Hydrobiidae	<i>Potamopyrgus antipodarum</i>	8	3.9
Lymnaeidae	<i>Lymnaea tomentosa</i>	2	1.0
Planorbidae	<i>Gyraulus corinna</i>	3	1.5
Sphaeriidae	<i>Sphaerium novaezealandiae</i>	5	2.5
CRUSTACEA			
O. Cladocera	2 indet. genera	2	1.0
S.C. Ostracoda	<i>Herpetocypris pascheri</i>	10	4.9

TABLE 1: continued

		N*	%*
ARACHNIDA			
O. Acarina			
Halacaridae	genus indet.	2	1.0
INSECTA			
O. Ephemeroptera			
Leptophlebiidae	<i>Deleatidium</i> sp.	3	1.5
O. Plecoptera			
Gripopterygidae	<i>Megaloptoperla</i> sp.	1	0.5
	<i>Zelandobius</i> sp.	5	2.5
O. Trichoptera			
Rhyacophilidae	<i>Hydrobiosis</i> sp.	1	0.5
Sericostomatidae	<i>Pycnocentrodus aureola</i>	21	10.3
	<i>Olinga feredayi</i>	17	8.3
	<i>Oxythira albiceps</i>	36	17.6
O. Diptera			
Tipulidae	genus indet.	1	0.5
Chironomidae	genus indet.	7	3.4
Empididae	genus indet.	3	1.5
Ceratopogonidae	genus indet.	3	1.5
O. Coleoptera			
Elmidae	genus indet.	1	0.5

* N = number of birds in which food item was found

% = percentage occurrence

and *Taraxacum officinale*, both of which are common on permanent pasture and on riverflats in the study area, were each present in 14 of the shelducks. Immature flower buds of *Hypochaeris* sp., also common in the study area, were present amongst the food, although leaves of this species were not. Leaves of every other terrestrial plant ingested were recovered from less than 5% of the shelducks.

Seeds of several plants occurred frequently, although usually they did not contribute much to the bulk. Seeds often resist breakdown for much longer than other food items, and some pass out still viable with the faeces. It is recognised that their longer breakdown time may cause their occurrence in the diet to be overestimated. Interpretation of occurrence percentages must therefore be made with care. This is probably particularly true of *Scirpus* "nuts," which were present in 23% of the birds. These are particularly hard shelled, and as they are of very similar size to gizzard grit, may be retained in the gizzard as grinding agents some time after ingestion.

Apart from oats, *Avena sativa*, most terrestrial plant seeds appeared to have been taken either as seedheads or berries. Monocotyledonous seeds were probably ingested simply by plucking at the seedheads. Seedheads of grasses were found in several of the shelducks, and material which appeared to be the stalk portions of seedheads were nearly always found with *Juncus* seeds. Clover seeds, particularly

those of *T. repens*, were probably also eaten mainly as flowering heads. Those of *T. subterraneum* however, were the most common and unlike those of other species of clover eaten, the fruiting calyces of this species are anchored in the ground very close to the prostrate stems of the plant. Seeds were therefore more likely to have been eaten either with foliage, or separately when the calyces were forced to the surface during winter.

In the seasons when they were ripe berries appeared to be important in the diet of many of the shelducks. Those of *Muehlenbeckia axillaris* were found very frequently and indeed were the only item of food present in several of the birds collected during summer. Berries of *Gunnera dentata* and *Cyathodes fraseri* were also often present. Those of other species occurred only infrequently. Where shelducks have access to them, oats become important in the diet. Grain spread to supplement the winter diet of sheep was the usual source of this food, and little other food was present in birds which had been feeding on it.

Aquatic Plants. Filamentous algae were the most frequently eaten aquatic plants, and formed the only item in this category present in the tracts of over 20% of the ducks. *Drepanocladus* sp. (aquatic moss) was the next most common, occurring in 4.9% of the birds. *Ranunculus fluitans*, *Lemna minor* and *Elodea* sp. were also recorded. Seeds, but not leaves of *Potamogeton* sp. were found in several birds.

2. **Animal Material** — None of the invertebrates eaten by the shelducks occurred commonly as a food item (Table 1), and even when present animal material rarely contributed significantly to the bulk of the food.

Except for *Dorylaimus* sp., a free-living nematode, all invertebrates recovered on more than one occasion were of aquatic origin. Aquatic larvae of various insects (particularly those of caddis flies), were most commonly encountered, these being present in 28.4% of the shelducks examined. Larvae of a caddis fly, *Oxythira albiceps*, was the most commonly ingested animal, the only one which occurred in over 15% of the birds.

The presence of aquatic invertebrates in the food was generally associated with the presence of filamentous algae or other aquatic plant material. Eight of the 10 birds from Selwyn River (May 1972), proved unusual in this respect. These contained particularly large numbers of larvae of the caddis flies *Olinga feredayi* and *Pycnocentroides aureola*. These made up the bulk of the food in the oesophagus and gizzard of the ducks, and yet no aquatic plants had been ingested.

Six shelducks contained small amounts of "aquatic detritus" — a mixture of semi-decomposed root and stem material of aquatic plants. A number of ingested aquatic invertebrates, such as molluscs (*Spaerium novaezelandiae*, *Potamopyrgus antipadarum* and *Lymnaea*

tomentosa), crustaceans (cladocerans and ostracods) and insect larvae, were always present with this material.

Although 11 insect species not of aquatic origin were found, none was recovered from more than one bird. Most were adults of insects with aquatic larvae.

Differences Between Flocks and Paired Birds

Between June 1972 and May 1973, 41 shelducks known to have been taken from flocks and 53 known to have been members of pairs were collected. A flock was considered to be any group of three or more shelducks (birds in moulting flocks were not included in this definition).

A comparison of the occurrence of food items in members of flocks and members of pairs showed that although no significant difference existed between the occurrence of terrestrial foods, a significantly greater proportion of paired birds had ingested aquatic foods ($X^2 = 6.44$; $p = 0.01$).

Seasonal Variation in Diet in the Main Study Area

This section is based on the food found in the 10 shelducks shot each month in the Lewis Pass study area between May 27 1972 and May 5, 1974. Care must be taken when extrapolating from small samples such as these. Many of the fluctuations shown in Fig. 1 almost certainly do not represent similar changes in the population as a whole. Nevertheless, some seasonal changes in diet are revealed.

As indicated earlier, samples taken from the study area in May 1972 and May 1973 consisted largely of birds from flocks occupying an exotic pasture habitat, while those taken in the intervening period were mainly collected from riverbed habitat. This should be taken into account when comparing the graphs in Fig. 1.

Foliage — particularly clover, grass and rush — formed an important part of the diet of all birds throughout the year. Although no marked seasonal pattern stood out, there seemed to be a peak in utilisation of foliage during September and October which gradually declined again until February. The decline coincided with a general increase in utilisation of some alternative foods, particularly "berries" (Fig. 1e). Berries provided the most noticeable seasonal influence on the diet of the shelducks. When these became available they were particularly favoured. Those of *Muehlenbeckia axillaris* were most important, followed by *Cyathodes fraseri* and *Gunnera dentata*. *Muehlenbeckia* seeds and fruit first appeared in the shelducks in November, those of *Cyathodes* appeared in December and those of *Gunnera* in February.

Smaller seasonal peaks in the occurrence of food items such as clover and grass seeds (Fig. 1c & d), *Hypochaeris* flower buds (Fig. 1f), oat grain (Fig. 1g) and terrestrial and free-flying animal material (Fig. 1h), coincided with their availability throughout the year. Grass seedheads were usually eaten before they had ripened and

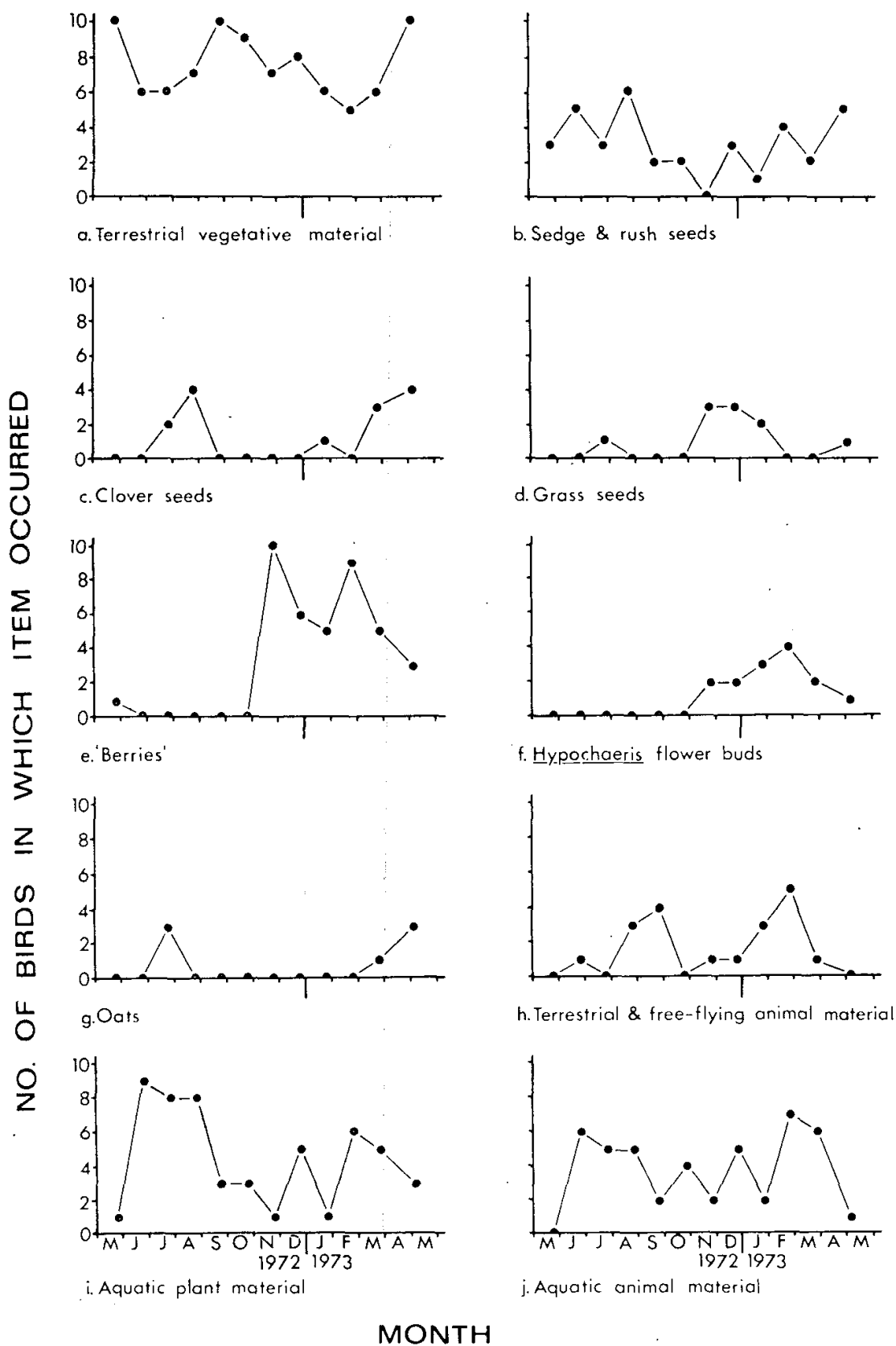


FIGURE 1 — Seasonal variation in food of Paradise Shelducks between 24 May 1972 and 5 May 1973. Graphs show number of ducks in each monthly sample of ten, which contained the above foods.

occurred most commonly between November and January. Most clover seeds found were mature. Calyces of subterranean clover (*Trifolium subterraneum*) containing ripe seeds are often forced to the surface during winter, accounting for a peak in occurrence of clover seeds in the ducks at this time. *Hypochaeris* flower buds are considered separately because they appeared to be selected independently of foliage of *Hypochaeris*. They were commonly eaten between November and April, a similar seasonal pattern to that of berries. Oats became an important source of food to some shelducks when available. The usual source was grain spread to supplement the diet of sheep during autumn and winter. A peak in ingested terrestrial and free-flying animal material during August and September was due entirely to the presence of *Dorylaimus* sp., while a second peak, in January and February, corresponded with the flying phase of many aquatic insects. Adult stages of these insects made up the bulk of the species which brought about this peak.

As with terrestrial vegetative material, aquatic plant material — mainly filamentous algae — was eaten throughout the year. It too probably grew less important as alternative foods became available during the spring and summer. A sharp rise in occurrence seen in December (Fig. 1i), was partly due to the inclusion in that month's sample of ducklings (near fledging) from a brood confined to an area of swamp.

The presence of aquatic animal material depended to a large extent on the presence of aquatic plant material. A comparison of Figs. 1i and 1j reveals the similarity of their monthly patterns.

In late summer most shelducks, apart from the young of the year, congregate on lakes to moult. During their moult shelducks are flightless for two weeks and are probably more restricted in their choice of food at this time than usual as they seldom move far from the water's edge. At this stage shelducks in the study area lost condition rapidly and before regaining their flight feathers they became quite emaciated.

The stomachs and gizzards of three birds collected in mid-moult in January 1973 contained very little food and the intestines also were virtually empty indicating that little had been eaten for some time prior to sampling. The stomach of each bird contained only a few blades of grass; in addition one contained several clover leaves and a willow leaf and another contained two small insects (an hemipteran and a psocopteran). The occurrence of berries in the January sample was unusually low because of the inclusion of birds from a moulting flock, which had no access to them.

DISCUSSION

Results showed that Paradise Shelducks in the main study area relied on grazing for the majority of their food. The foliage of several species of clover and grass introduced into New Zealand as

pasture plants were the most important foods. Leaves of a number of other terrestrial plants were also eaten but only in a few cases did they contribute a major portion of the food consumed.

Although it was evident that grazing provided most of the food, other types of feeding behaviour were regularly used. While only a minor part of the food eaten by the shelducks was of aquatic origin, filamentous algae (the most commonly eaten aquatic material) were obviously regularly included in the diet of many of the shelducks throughout the year.

The most important seasonal influence on the shelduck's diet was the appearance of fruit on low-growing shrubs and herbs during summer. Grazing became of only secondary importance at this time to many of the shelducks (during summer a number contained little or no food other than berries). Similarly, at times when grain was spread to supplement the diet of sheep in the study area some of the shelducks appeared to rely almost entirely on this as a source of food.

Little animal material was found amongst food eaten by shelducks in the study area. Once ingested, soft-bodied invertebrates are broken down much more rapidly than are species with hard parts or plant material. For this reason there is often a tendency in diet studies to underestimate the occurrence of soft-bodied food items. Nevertheless, it was clear that the shelducks relied very little on food material of animal origin. Undoubtedly, much of the animal material present was accidentally ingested with plant foods. Ingested aquatic invertebrates were generally present with filamentous algae or other aquatic plant material. Marples (1962) stated that *Oxythira* spp. (the commonest animal material ingested by the shelducks in the study area) are often found amongst filamentous algae. Many of the other species of aquatic invertebrates found in the shelducks also seek the shelter of aquatic vegetation (Pendergrast & Cowley, 1966). *Dorylaimus* sp., the second most frequently ingested invertebrate after the caddis fly larvae, lives amongst terrestrial vegetation (Dr W. C. Clark, pers. comm.). Their small size makes it most unlikely that they were eaten intentionally.

A few of the shelducks however, had clearly been seeking animal foods intentionally. Eight of the shelducks obtained from the headwaters of the Selwyn River in 1972 contained the caddis fly larvae *Olinga ferridayi* and *Pycnocentrodes aureola*. These species made a major contribution to the food consumed by five of these birds. None of the birds had eaten any aquatic vegetation. Both caddis fly species are quite large (10 mm) and are usually found clinging to rocks in moderately flowing streams. While some of the free-flying and terrestrial species (e.g. ant and booklice) were probably ingested accidentally, others found, such as the mayfly and damselfly adults and a moth, may well have been eaten intentionally.

The presence of "aquatic detritus" — always with a number of benthic invertebrates — in six of the shelducks from the study area, suggested that a "dabbling" type of feeding behaviour more characteristic of *Anas* spp. was occasionally used by the shelducks.

Oligochaetes were not found in the tracts of the shelducks. Once ingested these are broken down very quickly and their presence is often indicated only by their setae, which were not searched for. Nevertheless, it is quite likely that aquatic oligochaetes were ingested occasionally with other food material, and earthworms may have been eaten when conditions forced them to the surface.

While the results give a general idea of the food and feeding habits of shelducks in the study area, the situation may be somewhat more complex. In the first place no birds under one month old were examined in this study. Thus the extent to which animal material is utilised by very young shelducks is unknown. The two youngest examined, approximately one month old, contained mainly fruit of *Muehlenbeckia axillaris*. Foliage of grass and clover, and immature flower buds of *Hypochaeris* sp. made up most of the remainder of the bulk. Although one contained several *Dorylaimus* sp. neither had animal material of nutritional importance. This was also true of four other young shelducks examined of between two and four months old. Because they probably require a fairly protein rich diet at first, it is possible that ducklings of less than one month include more animal material in their diets than older ducklings do.

In addition, there is a possible difference in habitat utilisation by flocks and paired birds. Zander (1967) postulated that the ecological niche occupied by the Paradise Shelduck can be divided into two separate "subniches," one for the breeding population and one for the non-breeding population. He based his hypothesis on differences in behaviour and habitat utilisation between flocks and pairs. My observations also suggest a difference in habitat utilisation for much of the year, although their habitats are by no means discrete. Large flocks of shelducks in the study area were usually found grazing on developed pasture. In May 1971 and 1972 these flocks appeared to consist mainly of young of the year — 79% ($n = 45$) and 73% ($n = 60$) respectively of birds shot from these flocks possessed a large bursa of Fabricius (Bisset 1974). It is thought likely that many of the remaining birds in these flocks were 18 months old, unpaired birds. On the other hand few paired birds were seen on developed pasture. Most inhabited riverbeds or small swampy areas on tussock-clad terraces. It is believed that many of these birds remained on or near their breeding territories throughout most of the year, as pairs were usually seen in the same localities month after month during the study. Flocks present in the riverbed habitat in the study area were usually much smaller than those on developed pasture and tended to form groups on the greener, more closely grazed areas of riverflats where exotic grasses and clovers were the dominant ground cover.

Because nearly all of the birds collected from June 1972 onwards came from riverbed habitats, only a small section of those in flocks in the study area was sampled. Thus it was difficult to show the extent of any differences in feeding habits between the flocks and pairs from the results of stomach analyses. However, while no significant difference was shown for the occurrence of terrestrial material, the results showed that birds known to have been members of pairs contained aquatic material significantly more frequently than did those from flocks.

While many of the plants present in developed pasture in the study area have spread onto the undeveloped land, most riverbed and swamp plants are not found growing in developed pasture. One could therefore reasonably expect further differences in diet to become apparent if a more truly representative sample of birds from flocks was obtained. Judging from habitat utilisation alone it seems likely that as an overall trend, flocks may have a somewhat narrower feeding ecology than the paired birds of the breeding population.

From the rather limited amount of published information available it appears that the Paradise Shelduck's diet resembles that of the Australian Shelduck (*T. tadornoides*), the South African Shelduck (*T. cana*) and the Ruddy Shelduck (*T. ferruginea*) of Europe and Asia, more closely than that of the other species in the genus, *T. tadorna* and *T. radjah*, which tend to rely more heavily on worms, crustaceans and molluscs for much of the year (Delacour 1963). Frith (1969) stated that the diet of *T. tadornoides* consists mainly of the seeds and leaves of clover, green algae, some duckweed and pondweed, and small amounts of herbs characteristic of the water's edge. He added that insects are found in 40% of the birds but that these contribute little to the bulk of food. Similarly, *T. cana* and *T. ferruginea* are birds of inland freshwaters and are omnivorous, but eat mainly plant material (Delacour 1963).

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SHORT NOTE

WILSON'S STORM PETREL AT KAIKOURA

At midnight on 5 April 1975 I found a live Wilson's Storm Petrel (*Oceanites oceanicus*) sitting in the lighted hallway at the Edward Percival Marine Laboratory, Kaikoura. When the bird was picked up it regurgitated ten drops of a red clear oily substance. The bird was shown to Dr M. B. Jones and some marine biology students and I noted several characters. It was readily identified from Falla, Sibson & Turbott (1970, *Field Guide to the Birds of New Zealand*, 2nd ed.) by the white rump patch, long legs, and black feet with yellow webs. The bird was stressed and I quickly released it. It flew northwest toward Kaikoura township.

From the literature (see *Annotated Checklist*, OSNZ 1970: 29) and Mr A. T. Edgar (pers. comm.) there appear to be only six records of this species in New Zealand with no pattern of distribution or season. Two of these were made in April and one in November in the South Island. There are three records from the North Island, one each in January, March and May.

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