FOOD HABITS OF PUKEKO
(Porphyrio melanotus Temminck)

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SUMMARY

An examination was made of the contents of 298 Pukeko gizzards collected between February 1963 and August 1964. Specimens were from Rotorua, Canterbury and Nelson-West Coast. Food consisted almost exclusively of plant material, most important in all three districts being grasses and sedges. Predominant grasses were *Poa* spp., *Glyceria* spp. and *Anthoxanthum odoratum;* sedges, *Scirpus* spp., *Eleocharis* spp. and *Carex* spp. All parts of these plants were eaten. Leaves of clover (*Trifolium* spp.), seeds of dock and sorrel (*Rumex* spp.), seeds of willow-weed (*Polygonum* spp.) and seed-heads of rush (*Juncus* spp.) were also frequently taken. Animal material was sparse. Spiders (*Arachnida*), beetles (*Coleoptera*), flies (*Diptera*) and other insects predominated. Earthworms (*Annelida*), peripatus (*Peripatus novae-zealandiae*), wood-lice (*Isopoda*) and fragments of lizard and bird bones were occasionally found. Although grit occurred at all times, a greater weight was taken in winter and early spring.

INTRODUCTION

The Swamp-hen or Pukeko (*Porphyrio melanotus* Temminck) is indigenous to New Zealand. Primarily a swamp-dweller, it can adapt itself to a variety of conditions; thus, where its habitat has been modified by drainage and cultivation of wetlands it may be found foraging on pasture-land or in scrub, though rarely far from water.

Buller (1873) referred to its feeding habits thus:— "It subsists principally on soft vegetable substances, but it also feeds on insects and grain. By the aid of its powerful bill it pulls up the inner succulent stems of the raupo, or swamp-reed, and nips off the soft parts near the root, holding the object in the toes of one foot while feeding, something after the manner of a Parrot." Oliver (1955) reported that its diet also included such items as fish, frogs, lizards, birds and birds' eggs. These observations have been supported by many others. There have frequently been lively conflicts of opinion about the amount of damage caused by Pukekos. Acclimatization societies advocate protection of the birds, whereas many farmers claim that their depredations in pasture, crops and chicken runs warrant their destruction in areas where they are numerous. As a result of this conflict the Department of Internal Affairs in 1931 arranged for an investigation into their food habits (Muggeridge and Cottier 1931). Gizzard contents of 63 birds collected from Auckland, North Canterbury, Southland and Otago were analysed and the results tabulated. This study indicated that Pukekos were primarily vegetarians, although the authors pointed out that soft-bodied insect material might remain for less time than plant material in gizzards, thus giving a somewhat distorted result.

The study was inconclusive as samples were small and their distribution wide. Thus, with the problem not fully resolved, arguments continued and in 1962 the Department decided that a fuller investigation was required.

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MATERIAL

Birds were collected by Mr. G. Tunnicliffe of Canterbury University and by field staff of the Rotorua District office of the Department of Internal Affairs.

Mr. Tunnicliffe supplied gizzard contents preserved in 70 per cent. alcohol. These were subsequently washed, dried, sorted, weighed and organic material identified. A total of 171 gizzards, collected between February 1963 and January 1964, were from the following localities:— Ellesmere area (59), Bennetts (21), Kaituna Lagoon (12), Belfast (5), Waimo Lagoon (3), Hurunui River (2), miscellaneous (7), Waimea County (6), Hokitika area (23), Whataroa (3), Ahaura (4), West Coast unspecified (26).

Whole birds, frozen as soon as possible after death, were sent from Rotorua. Approximately twelve a month were obtained between May 1963 and August 1964. The gizzards of 127 of these were examined, the others being either damaged or empty. Rotorua specimens came from:— Matata (35), Opotiki (32), Tokoroa (11), Galatea (11), Kawerau (10), L. Rotorua environs (9), Gisborne (4), L. Rerewhakaitu (4), Reporoa (4), miscellaneous (7).

Whenever possible Rotorua birds were taken in approximately equal numbers from indigenous habitat and cultivated farmland. Over the whole year they were collected as follows:— Swamp (42), Pasture and Swamp (59), Pasture (12). The remainder were from unspecified habitats.

Table I

PUKEKOS — ALL BIRDS 1963-64

Mean and percentage weights of grit and dried plant material in gizzards

Month	No. of Specimens	Grit		Dried Plant Material	
		mean wgt. in gms	percentage wgt.	mean wgt. in gms	percentage wgt.
May	43	7.2	88	1.0	12
June	34	8.5	91	0.9	9
July	38	7.8	91	0.8	9
Aug.	31	8.0	92	0.7	8
Sept.	35	6.9	91	0.7	9
Oct.	19	5.1	91	0.5	9
Nov.	16	6.5	91	0.5	9
Dec.	20	5.7	83	1.0	17
Jan.	23	4.1	72	1.6	28
Feb.	11	5.7	86	0.9	14
Mar.	20	5.3	80	1.4	20
Apr.	6	5.0	83	1.0	17

Tables were prepared to show the frequency of occurrence of all foods in all gizzards on a monthly basis, these being subsequently condensed into seasonal occurrences of main food groups in all birds, expressed as a percentage (Tables II, III, IV, V). Grit is expressed as a percentage of the total weight of gizzard contents of all birds (Table I). Identification of animals was based on Parker and Haswell (1940), Powell (1947) and Imms (1947 and 1951) and that of plants on Martin and Uhler (1939), Allan (1940), Hubbard (1954), Hamlin (1955), Hyde (1957), Caldwell (1960), Martin and Barkley (1961), Mason (1964) and on information supplied by G. Tunnicliffe.

GRIT

Grit occurred in all gizzards and usually comprised the greater part by weight of the contents (Table I). Particles varied in size from fine sand to stones 5 mm. in diameter. As a percentage of total dry weight of gizzard contents grit increased in winter and early spring, attaining a maximum of 92 per cent in August and a minimum of 72 per cent in January. Only Rotorua figures were available for a study of wet weights. These showed a maximum of 58 per cent in August and a minimum of 34 per cent in March. The maximum mean monthly weight per gizzard was 8.5 gm. in June and the minimum 4.1 gm. in January. The mean weight of grit ingested during winter and early spring (May-October) was 33 per cent greater than in November-April. It appears that extra grit may have been needed for grinding fibrous vegetative material eaten in winter, whereas hard seeds, such as those of sedges and members of the Polygonaceae taken predominantly in summer and autumn, would act in part as their own grinders.

ANIMAL MATERIAL

Seventy-five (25 per cent) stomachs contained animal material, but, with the exception of four, only in minute amounts. Probably some was ingested accidentally, e.g. spiders among grass stalks and beetles at the roots of plants. Notwithstanding that soft parts of animals bodies would soon disintegrate in the gizzard, it was clear that the significant portion of Pukeko diet was not of animal origin.

Insect fragments were found in 64 specimens, spiders in 36, earthworms in five and bone in four. In three gizzards the bone fragments came from lizards, in the fourth from a bird.

Insects. Most frequently occurring were ground-dwelling beetles in adult and larval forms, flies adult and larval, grasshoppers and crickets, water-boatmen and insect eggs.

Spiders. Two kinds occurred, by far the more common being harvestmen (*Phalangidae*). A few nursery spiders (*Dolomedes minor*) and their nests were found.

Earthworms. These rapidly disintegrated in the gizzards but were identifiable by the presence of setae.

Other animal material was from various sources. *Peripatus novaezealandiae* occurred twice, wood-lice twice, fragments of a gastropod shell once and lepidopterous larvae three times.

Table II
ROTORUA PUKEKOS 1963 - 64
Number of occasions of eating of plant foods

Season	May June July	Aug.Sept. Oct.	Nov.Dec. Jan.	Feb.Mar. April	Total	Total occurrences as percentages
No. of gizzards	52	37	15	23	127	100
Seeds						
Sedge	30	12	7	17	66	52
Rush	2	7	6	14	29	23
Grass	5	6	14	12	37	29
Polygonaceae	23	9	2	15	49	38
Other dicotyledons.	12	7	3	9	31	24
Vegetative						
Sedge and rush	41	25	5	10	81	64
Clover	12	15	4	9	40	31
Grass	30	33	15	16	94	74
Other Plants	4	3	-	3	10	8

Table III
CANTERBURY PUKEKOS 1963 - 64
Number of occasions of eating of plant foods

Season	May June July	Aug.Sept. Oct.	Nov.Dec. Jan.	Feb.Mar. April	Total	Total occurrences as percentages
No. of gizzards	40	24	32	14	110	100
Seeds						
Sedge	5	7	16	2	30	27
Rush	-	2	2	1	5	45
Grass	8	3	9	3	23	21
Dicotyledons	6	6	9	2	23	21
Vegetative						
Sedge and rush	20	16	23	11	70	65
Clover	15	12	1	1	29	26
Grass	26	15	15	6	62	56
Other plants	4	1	3	-	8	7

PLANT MATERIAL

Plant material comprised the bulk of Pukeko food at all times. The monthly mean dry weight reached a minimum of 0.5 gm. in October-November and a maximum of 1.6 gm. in January (Table I). The temporary drop in February was not significant as the sample size was small. Rotorua data showed no related change in body weight, state of moult or feeding pattern.

A study of 64 Rotorua birds, for which time of shooting was recorded showed the greatest mean dry weight of food was taken in early morning (sunrise + 3 hours), less at mid-day and least in late afternoon (sunset — 3 hours) see Table VI.

Table IV

NELSON-WEST COAST PUKEKOS 1963-64

Number of occasions of eating of plant foods

Season	May June July	Aug. Sept. Oct.	Nov. Dec. Jan.	Feb. Mar. April	Total	Total occurrences as percentages
No. of gizzards	23	24	14	-	61	100
Seeds						
Sedge	1	1	7	-	9	15
Rush	-	6	4	-	10	16
Grass	2	13	11	-	26	43
Dicotyledons	7	3	4	-	14	23
Vegetative						
Sedge and rush	8	11	5	-	24	39
Clover	11	14	6	-	36	51
Grass	20	19	13	-	52	85
Other plants	1	1	1	-	3	5

Eight of the eleven morning specimens were shot in summer when seeds were most frequently eaten; 25 of 29 afternoon specimens in winter and spring when vegetative material predominated; mid-day specimens were collected throughout the year. Allowing for possible distortion of results by unequal sampling, it appears that Pukekos forage at all times of the day although perhaps less in afternoon and evening.

Seeds and vegetative parts of plants have been listed separately as it was found that often only one portion of a plant was eaten; e.g. clover leaves were present in 105 stomachs but clover seeds occurred in only five. (Tables II, III, IV and V.)

Grasses. These were the most abundant material and many species occurred in samples from all three districts. *Poa* spp. occurred most

frequently: *P. annua* and *P. trivialis* in all districts, *P. pratensis* in Canterbury. Second in importance were *Glyceria fluitans* and *G. maxima* in Rotorua, *Holcus lanatus* in Canterbury and *Anthoxanthum odoratum* in Nelson-West Coast. Grass occurred in 207 (70 per cent) of the 298 gizzards. There appeared to be no preferential selection of grass seeds as items of food; instead they were always associated with other parts of the plant. Most favoured portions were the tender stalk-bases, although often the whole plant was eaten, being snipped by the sharp beak of the Pukeko into approximately quarter-inch sections as if by a pair of scissors. Usually only fibrous roots and occasional leaves were found entire.

Sedges. Vegetative parts of sedges appeared in 168 (56 per cent) of gizzards. Not only were stalks, leaves and rootstocks eaten, but the fleshy tubers, whole or fragmented, were often found to form the bulk of a meal. Sedge seeds frequently occurred in considerable quantities. *Eleocharis sphaecelata* predominated in Rotorua gizzards and *E. gracilis* and *E. neo-zelandica* in Canterbury. *Scirpus* spp. seeds also occurred in many gizzards from these two districts:— *S. caldwellii, S. medianus, S. lacustris* and *S. americanus* from Canterbury. *Carex* spp. seeds were infrequent in Rotorua and Canterbury specimens but predominated among Nelson - West Coast sedges. They belonged to three species: *C. testacea, C. virgata* and *C. leporina.* Other sedge seeds were from *Cladium junceum,* found in eleven Rotorua gizzards and *Mariscus ustulatus* in four.

Rushes. Seeds occurred in 44 (15 per cent) of all stomachs, five from Canterbury, 29 from Rotorua and ten from Nelson - West Coast. In all three districts *Juncus bufonius* and *J. maritimus* predominated. Usually seed heads containing the seeds were taken although vegetative material was sometimes present.

Clover. Dicotyledonous leafy material found in gizzards was almost exclusively clover. It occurred in 105 specimens (34 per cent) and was particularly important in the diet of Nelson - West Coast birds, appearing in 36 (51 per cent) of the 61 specimens compared with 29 (26 per cent) in 110 from Canterbury and 40 (31 per cent) in 127 from Rotorua.

Willow-weeds, docks and sorrel. In all three districts seeds of *Polygonum* spp. and *Rumex* spp. were frequently taken. Usually these occurred without vegetative parts of the plants and thus appeared to have been specifically selected. Vegetative fragments of *Rumex* spp. were found twice in Canterbury and twice in Nelson - West Coast specimens. Rotorua species were *Polygonum hydropiper* and *P. persicaria* in 25 specimens, *Rumex acetosella* and *R. crispus* in 24. Canterbury species were *Polygonum persicaria, P. aviculare* and *P. hydropiper* found in 12 specimens and *Rumex crispus, R. acetosa* and *R. acetosella* in four specimens. Nelson - West Coast species were *Polygonum hydropiper,* taken once, and *Rumex acetosella* and *R. crispus* seven times.

Seeds of many other plants were found but their occurrence was infrequent and usually sparse. *Bidens tripartitus* seeds were numerous in six Rotorua gizzards; *Stellaria media* occurred in four from Rotorua and one from Canterbury. *Ranunculus* spp. were found in three Rotorua gizzards, four from Nelson - West Coast and one from Canterbury. *R. sardous* came from Rotorua, *R. sceleratus* from all three districts and *R. bulbosa* from Canterbury.

Miscellaneous seeds occurring more than once were *Taraxacum officinale* (4), *Trifolium* spp. (5), *Portulaca oleracea* (2) and *Coprosma* sp. (3).

Aquatic Plants. These were found infrequently. Rotorua gizzards contained *Salvinia natans* (5), *Lemna minor* (1) and *Zannichellia palustris* (1). Canterbury gizzards contained *Potamogeton pectinatus* (3), *Zannichellia palustris* and *Elodea canadensis.*

SEASONAL CHANGES IN DIET

These were confined mainly to the frequency with which seeds were eaten. At all times vegetative parts of grass and sedge were taken more often than other foods. The incidence of clover leaves showed a marked variation, being highest during the August - October period (Table V). As would be expected, seeds were eaten more in summer and early autumn, with grass seeds predominating in November - January and seeds of all kinds in the February - April period.

Table V

PUKEKOS — ALL BIRDS 1963 - 64

Number and percentages of occasions of eating of plant foods*

Season	May June July	Aug. Sept. Oct.	Nov. Dec. Jan.	Feb. Mar. April	Total
No. of specimens	115	85	61	37	298
Seeds					
Sedge	36(31)	20(24)	30(50)	19(51)	105(35)
Rush	2(2)	15(18)	12(20)	15(41)	44(15)
Grass	15(13)	22(26)	34(56)	15(41)	86(29)
Polygonaceae	32(28)	16(19)	9(15)	16(48)	73(25)
Other dicotyledons	16(14)	9(11)	16(26)	10(27)	51(17)
Vegetative					
Sedge and rush	69(60)	52(61)	33(54)	21(57)	175(59)
Clover	38(33)	41(48)	11(18)	10(27)	100(34)
Grass	76(67)	67(79)	43(70)	22(60)	208(70)
Other plants	9(8)	5(6)	4(7)	3(9)	21(7)

* Numbers in brackets are percentages.

FOOD SELECTION OF ROTORUA PUKEKOS

As most Pukekos from Rotorua were from specified habitats an attempt was made to determine how selective they were when taking food. Habitat designation was swamp, swamp and pasture and pasture. Table VII shows the number of birds from each habitat containing swamp plants only, pasture plants only or both.

TABLE VI

Mean dry weight of plant food taken at different times of day

Time	Sunrise + 3	Mid-day	Sunset − 3
No. of specimens	11	34	29
Mean weight dried plant	1.3 gm.	1.0 gm.	0.8 gm.

TABLE VII

Number of Gizzards containing	Habitat			
	Swamp	Swamp & Pasture	Pasture	Total
Swamp plants	18	18	2	38
Swamp & pasture plants	8	37	15	60
Pasture plants	3	6	2	11
Total	29	61	19	109

Three birds of 29 from swamp habitat contained pasture plants exclusively and two of 19 from pasture contained swamp plants exclusively, indicating that they may have recently moved into the locality where they were shot. Of 61 from mixed swamp and pasture, 18 contained swamp plants only and 6 pasture plants only. Without further information about movements before death it was impossible to define the limits of their feeding range. Considering gizzard contents in relation to habitat, 82 per cent of 109 birds studied had clearly had recent access to both swamp and pasture. Of these, 22 per cent had taken swamp plants only and 19 per cent pasture plants only and the rest contained both.

It would be possible to infer from these figures that Pukekos feed more often in swamp than pasture when both are available. However, the inference could well be invalid as two vital factors are missing — the relative amount of different kinds of food consumed and the comparative availability of these foods in the collection area.

As there were no trained staff carrying out field investigations to complement laboratory work, labels accompanying specimens provided the only information about habitat. Thus a community designated as pure swamp may have included some pasture plants, conversely sedges and rushes might occur in pasture. In mixed communities the proportion of swamp- to pasture-plants was unknown, and would certainly have varied with the locality.

Most plant material found in gizzards was macerated, making a quantitative analysis impracticable, thus results were necessarily limited to qualitative analyses and frequency of occurrence of foods.

From a study of available data it appears that Pukekos forage as they move about in a habitat which normally includes swamp, damp pasture and grassland. Seeds, predominantly those of sedge, rush, grass, sorrel and dock, are eaten in season. Grasses, clover leaves and the more tender portions of swamp plants form their staple diet throughout the year.

CONCLUSION

The result of this investigation substantiates findings of previous workers, namely that Pukekos are primarily vegetarian. Animal material occurred in small amounts and appeared to be of little significance.

It was not possible in this study to determine whether Pukekos preferred swamp- to pasture-plants although some foods were clearly more acceptable than others.

Plants eaten were limited to those growing in swampland or pasture, with sedge, clover and grass predominating. All parts of sedge and grass plants were taken, including their seeds, but usually only leaves and leaf stalks of clover were found. Seeds of willow-weeds and docks and seed heads of rushes occurred with moderate frequency. A variety of other plants appeared in gizzards but their occurrences were infrequent, usually sparse and clearly had little effect on the basic constitution of Pukeko diet.

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