# FOOD OF THE KINGFISHER (Halcyon sancta) DURING NESTING

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ABSTRACT

Food of Kingfishers in forest in the Orongorongo Valley, near Wellington, was identified from remains in pellets ejected by nestlings at four nests and from pellets and droppings of birds caught in mist-nets. Food items included a wide variety of invertebrates, with cicadas, dragonflies and chafers especially important. Lizards, small birds and mice were also important. The lizards identified were the forest gecko and common skink, and the small birds were the Rifleman, Grey Warbler and Silvereye.

Kingfishers were absent from the study area from June to September; it is suggested that the seasonal movements of Kingfishers are related to changes in the availability of food.

## INTRODUCTION

The Sacred Kingfisher (*Halcyon sancta*) belongs to the subfamily Daceloninae, whose members are mostly generalised predators of small animals, taking a wide range of generally slow-moving or stationary invertebrates and small vertebrates from land or water (Fry 1980). *H. sancta* breeds in New Zealand and Australia, Norfolk Island, Lord Howe Island, New Caledonia, and the Loyalty Islands (Falla *et al.* 1979). Southern Australian birds (*H. s. sancta*) are migratory, wintering in northern Australia and islands to the north, in an area from the Solomon Islands in the east and Sumatra in the west to the southern Philippines in the north (Peters 1945). There is no clear evidence that birds of the New Zealand subspecies (*H. s. vagans*) migrate, but seasonal changes in the numbers of Kingfishers in some parts of New Zealand indicate that birds move from higher altitudes to winter in lowland and coastal habitats (Taylor 1966). The concentration of Kingfishers in the northern North Island in winter has been interpreted by Ralph & Ralph (1977) as evidence that some birds also move northward to winter there.

Taylor (1966) suggested that the seasonal movements of Kingfishers were responses to changes in the availability of food rather than directly to changes in temperature. However, until recently our knowledge of the food habits of New Zealand Kingfishers has been largely restricted to general descriptions or brief anecdotes. Oliver (1955) listed mice, small birds, lizards, fish, larger insects (crickets, grasshoppers, dragonflies and cicadas), freshwater crayfish, and crabs; Falla *et al.* (1979) noted "worms, insects and spiders, crabs and other crustaceans, shellfish, small fish, tadpoles, lizards, mice and occasionally small birds, even ducklings". Photographic studies (e.g. Moon 1979) well illustrate the range of foods taken. O'Donnell's (1981) observations on the food of Kingfishers include prey he identified from 14 pellets ejected by nestlings.

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We have identified prey remains from pellets collected below four Kingfisher nests and from pellets and droppings of birds caught in mist-nets in forest of the Orongorongo Valley near Wellington. We were also able to relate food habits to seasonal changes in availability of prey and the seasonal movements of Kingfishers.

## STUDY AREA

The Orongorongo Valley (41°21'S, 174°58'E) is a steep-sided forested valley on the western slope of the Rimutaka Range, 18 km east of Wellington. The lower slopes in the vicinity of the DSIR field station (120 m a.s.l.) have hard beech (*Nothofagus truncata*) forest on the ridges and rata-podocarp-broadleaf forest on the terraces (Campbell 1984). The climate is temperate; average annual rainfall for 18 years was 2420 mm, the wettest month (July) receiving about 2½ times as much rain as the driest (November) (Moeed & Fitzgerald 1982). Mean monthly temperatures at Kelburn in Wellington vary from 16.4 °C in February to 8.1 °C in July (NZ Meteorological Service 1973).

The Orongorongo River flows over an unstable shingle bed and frequently changes its course; its larger pools and backwaters contain eels (*Anguilla* spp.) and brown trout (*Salmo trutta*). Side streams, often with the forest canopy closed over them, are more stable and have eleotrid and galaxiid fish and freshwater crayfish (*Paranephrops planifrons*) present.

Two species of gecko, the forest gecko (*Hoplodactylus granulatus*) and the green gecko (*Naultinus elegans*) are recorded in the research area and another species, the common gecko (*H. maculatus*), a few kilometres to the south. Of ten shed gecko skins collected in the research area since 1968 eight were from forest geckos and two from green geckos. Two species of skink have been recorded in the research area — the common skink (*Leiolopisma nigriplantare*) is a diurnal species found in open places, and the copper skink (*Cyclodina aenea*) is a nocturnal bush dweller.

Common small birds (less than 20 g in weight) that might be preyed on by Kingfishers in the Orongorongo Valley are the Rifleman (*Acanthisitta chloris*), Whitehead (*Mohoua albicilla*), Grey Warbler (*Gerygone igata*), Fantail (*Rhipidura fuliginosa*), Tomtit (*Petroica macrocephala*) and Silvereye (*Zosterops lateralis*) (Robertson *et al.* 1983).

House mice (*Mus musculus*) are present in numbers that vary greatly from year to year (Fitzgerald 1978). Although mainly nocturnal, they are sometimes seen during the day.

## METHODS

Pellets and prey remains were collected from beneath Kingfisher nest-holes in dead trees. A few pellets were intact but most were in pieces. At one nest used in two successive years we attached scrim around the base of the tree to catch the pellets, but at the other two nests we collected material from the ground after the chicks had fledged.

We identified prey by comparing the fragments from the pellets with specimens in the reference collections of Ecology Division, DSIR. Individuals were counted from the numbers of the most common distinctive fragments, e.g. head capsules, elytra, bones, or teeth. Numbers and species of lizards were identified from frontal, maxilla and dentary bones.

Information on seasonal changes in the abundance of prey species was taken from several sources. During intensive studies of invertebrates by A. Moeed and MJM, some prey species have been recorded from tree-trunk traps (Moeed & Meads 1983) and pitfall traps (Moeed & Meads 1985). A file of casual observations by staff and visitors at the DSIR Orongorongo field station yielded additional information for some species.

The file also provided some records of when Kingfishers were present in the area, but most information on the seasonal abundance of Kingfishers came from regular monthly mist-netting and banding of birds from 1969 to 1976 at seven mist-net rigs by AHW and BMF. Each rig consisted of six nets one above another that formed a continuous curtain of net from 1.5 m above the ground to 13.5 m in the forest canopy (Whitaker 1972, Robertson *et al.* 1983). From 1974 to 1976, faeces and pellets were collected from mist-netted birds and then treated as described by Moeed & Fitzgerald (1982).

## RESULTS

A nest with young calling loudly was found about 15 m up a dead beech tree in hard beech forest on 26 January 1972; a Kingfisher was seen carrying a lizard to the nest. When the nest was visited again on 22 February the young had gone but pellets and remains of prey were collected on the ground below the nest-hole.

In December 1973, Kingfishers were active around a dead rimu (*Dacrydium cupressinum*) near the Field Station. Three fresh Kingfisher eggshells found on the ground below the nest-hole in the rimu on 22, 23 and 24 January 1974 indicated that the chicks had just hatched. An adult was seen carrying food to the nest on 23 January 1974. We attached scrim to the base of the tree on 26 January and collected pellets until 19 February 1974.

In October 1974, Kingfishers were again active around the dead rimu, and on 6 November a Kingfisher was observed at the previous year's nest-hole. On 16 December, a broken eggshell (not from a hatched egg) was found beneath the nest. Although this nesting attempt apparently failed the birds must have relaid because on 19 February 1975 pellets were found on the scrim and further material was collected until 24 February.

On 23 January 1982, a Kingfisher was observed feeding young at a nest in the dead top of a hard beech tree on the bank of the Orongorongo River. Pellets, mainly in fragments, were collected below this nest on 11 February, after the young had fledged.

A wide variety of prey was identified in the pellets from these four nests (Table 1). Large insects were particularly common, especially chorus cicadas (*Amphipsalta zelandica*), giant dragonflies (*Uropetala carovei*) and mumu chafers (*Stethaspis longicornis*). Beetles were well represented by at least 20 species from seven families. Vertebrates (lizards, small birds and mice) were mainly recorded in the 1972 nest; eight of the nine geckos were confirmed as forest geckos and two of the three skinks as *Leiolopisma* sp.. In the 1974 nest material, one of the four skinks was confirmed as *Leiolopisma* sp.; the other lizards could not be identified beyond family. The birds recorded were five Riflemen, two Grey Warblers and a Silvereye.

TABLE 1 — Prey identified from pellets ejected by nestling Kingfishers at four nests

| | Approx. length (mm) | 1972 | 1974 | 1975 | 1982 | Total |
|---|---|---|---|---|---|---|
| Insecta | | | | | | |
| Odonata | | | | | | |
| *Procordulia smithii* | 50 | | | 1 | | 1 |
| *Uropetala carovei* | 88 | 28 | 11 | 27 | 11 | 77 |
| *Blattodea* | | | | | | |
| *Parellipsidion* sp. | 14 | | 1 | | | 1 |
| Orthoptera | | | | | | |
| Stenopelmatidae | | | | | | |
| *Hemideina crassidens* | 45 | 2 | 1 | 2 | | 5 |
| Phasmatodea | | | | | | |
| Phasmatidae | | | | | | |
| *Acanthoxyla* sp. | 98 | | 2 | 7 | 1 | 10 |
| Hemiptera | | | | | | |
| Cicadidae | | | | | | |
| *Amphipsalta zelandica* | 27 | 6 | 133 | 142 | 32 | 313 |
| *Kikihia scutellaris* | 18 | | 5 | | | 5 |
| *Kikihia* sp. | | 1 | 8 | | | 9 |
| Coleoptera | | | | | | |
| Carabidae | | | | | | |
| *Holcaspis vagepunctata* | 17 | | 1 | | | 1 |
| *Mecodema simplex* | 28 | 6 | | | | 6 |
| *Megadromus vigil* | 20 | 13 | | 2 | | 15 |
| *Plocamostethus planiusculus* | 26 | 22 | | 2 | | 24 |
| indet. spp. | | | 8 | 2 | | 10 |
| Lucanidae | | | | | | |
| *Dorcus novaezealandiae* | 18 | 2 | | | | 2 |
| *Lissotes reticulatus* | 17 | 21 | 2 | | 3 | 26 |
| Scarabaeidae | | | | | | |
| *Odontria magnum* | 17 | 5 | 1 | | | 6 |
| *Odontria piciceps* | 14 | | | | 1 | 1 |
| *Pyronota festive* | 10 | | 1 | | | 1 |
| *Stethaspis longicornis* | 21 | 2 | 7 | 28 | 8 | 45 |
| Elateridae | | | | | | |
| *Corymbites megops* | 21 | 1 | | | | 1 |
| *Geranus lineicollis* | 15 | 1 | | | | 1 |
| *Ochrosternus zealandicus* | 18 | 2 | | | | 2 |
| *Thoramus foveolatus* | 20 | 3 | | | | 3 |
| *Thoramus wakefieldi* | 30 | 1 | | | | 1 |
| Tenebrionidae | | | | | | |
| *Artystona erichsoni* | 12 | 1 | | | | 1 |
| *Uloma tenebrionoides* | 13 | 1 | | | | 1 |
| Cerambycidae | | | | | | |
| *Hexatricha pulverulenta* | 17 | 7 | | | | 7 |
| Curculionidae | | | | | | |
| *Platyomida hochstetteri* | 13 | | | | 1 | 1 |
| *Psepholax barbifrons* | 8 | 1 | | | | 1 |

TABLE 1 — continued

| | Approx. length (mm) | 1972 | 1974 | 1975 | 1982 | Total |
|---|---|---|---|---|---|---|
| Diptera | | | | | | |
| Tabanidae | | | | | | |
| Dasybasis opla | 14 | | 1 | | | 1 |
| Dasybasis transversa | 11 | | 1 | | | 1 |
| Scaptia adrel | 15 | | 1 | | | 1 |
| Lepidoptera | | | | | | |
| Hepialidae | | | | | | |
| Trioxycanus enysii | 38 | | 1 | | | 1 |
| indet. sp. | | | | 1 | | 1 |
| Hymenoptera | | | | | | |
| Ichneumonidae | | | | | | |
| Certonotus fractinervis | 31 | 2 | | | | 2 |
| Pompilidae | | | | | | |
| Salius monachus | 22 | | 1 | | | 1 |
| Salius wakefieldi | 20 | | 1 | | | 1 |
| Colletidae | | | | | | |
| Apis mellifera | 15 | | 7 | | | 7 |
| Arachnida | | | | | | |
| Araneida | | | | | | |
| Dipluridae | | | | | | |
| Porrhothele antipodiana | 37 | 3 | 1 | | | 4 |
| Araneidae | | | | | | |
| indet. spp. | | | 1 | 7 | | 8 |
| Agelenidae | | | | | | |
| Cambridgea foliata | 30 | 1 | 4 | | 3 | 8 |
| Crustacea | | | | | | |
| Decapoda | | | | | | |
| Cambaridae | | | | | | |
| Paranephrops planifrons | >40 | 4 | 1 | | | 5 |
| Oligochaeta | | | | | | |
| Terricolae | | | | | | |
| indet. sp. | | | 1+ | | | 1+ |
| Vertebrata | | | | | | |
| Reptilia | | | | | | |
| Gekkonidae | | | | | | |
| Hoplodactylus granulatus | | 8 | | | | 8 |
| indet. sp. | | 1 | 1 | 1 | | 3 |
| Scincidae | | | | | | |
| Leiolopisma sp. | | 2 | 1 | | | 3 |
| indet. sp. | | 1 | 3 | | | 4 |
| Aves | | | | | | |
| Acanthisitta chloris | | 5 | | | | 5 |
| Gerygone igata | | 2 | | | | 2 |
| Zosterops lateralis | | 1 | | | | 1 |
| Mammalia | | | | | | |
| Mus musculus | | 7 | | 1 | | 8 |

The invertebrates varied greatly in length, from some species of less than 10 mm to others of 90 mm (Table 1, Fig. 1), the modal size category of species being 10-20 mm. However, most individuals taken were of species somewhat longer than 20 mm, their modal size category being 20-30 mm.

Although invertebrates formed a high percentage of the individual prey identified, if biomass of prey is considered the few vertebrates taken were important as they represented 46% of the weight of prey consumed (Table 2).

A pellet regurgitated by a bird mist-netted on 21 November 1974 contained remains of four beetles: one *Hexatricha pulverulenta* (Cerambycidae), one *Metablax acutipennis* (Elateridae) and two *Lissotes reticulatus* (Lucanidae).

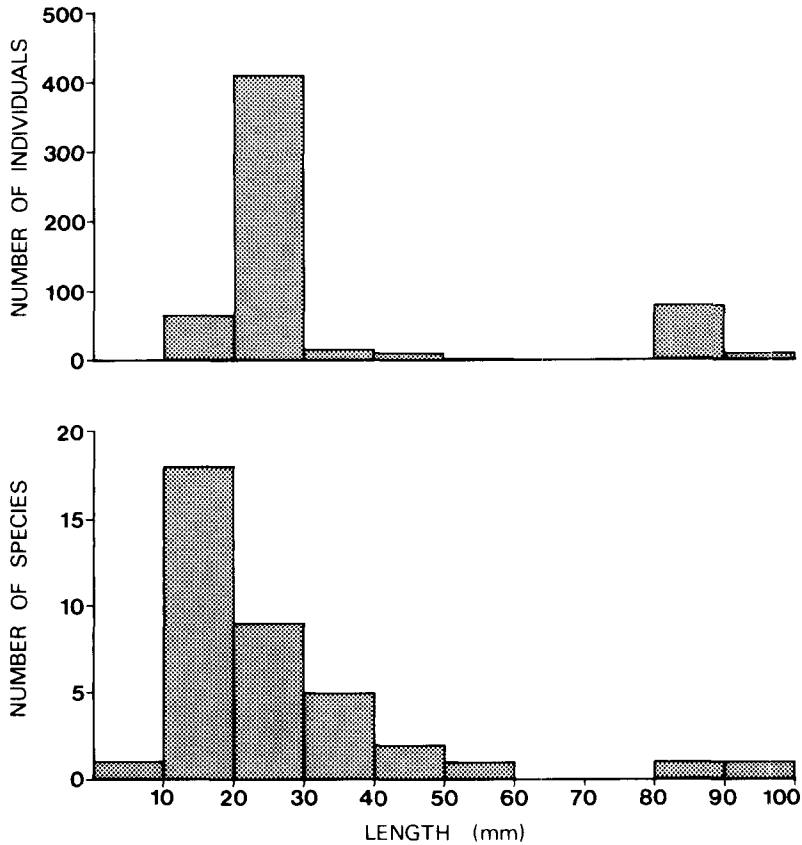


FIGURE 1 — Size distribution of prey by species and number of individuals for all nests combined

TABLE 2 — Numbers and weights of the main groups of prey and the biomass of each. Estimates of the weights of prey species are taken from Fitzgerald & Karl (1979) and Robertson *et al.* (1983). The weight for Silvereye is the average January-February weight (BMF, H. A. Robertson & AHW, unpubl. data).

| | No. | Wt (g) | Biomass (g) |
|---|---|---|---|
| *A. zelandica* | 313 | 0.68 | 212.8 |
| *Uropetala* | 77 | 1.00 | 77.0 |
| *Stethaspis* | 45 | 0.65 | 29.2 |
| Weta | 5 | 1.67 | 8.3 |
| Other insects | 153 | 0.25 | 38.2 |
| Spider | 20 | 0.50 | 10.0 |
| Freshwater crayfish | 5 | 10.00 | 50.0 |
| Lizard | 18 | 10.0 | 180.0 |
| Rifleman | 5 | 7.0 | 35.0 |
| Grey Warbler | 2 | 6.4 | 12.8 |
| Silvereye | 1 | 12.0 | 12.0 |
| *Mouse* | 8 | 15.5 | 124.0 |
| Total invertebrate | | | 425.7 |
| Total vertebrate | | | 363.8 |
| Overall total | | | 789.5 |

A pellet from a bird caught on 19 February 1975 contained remains of at least three cicadas. Most of these species were also recorded from material at nests.

Seven droppings from Kingfishers caught in mist-nets contained finely fragmented material which was more difficult to identify than remains in pellets. All four droppings collected in October and November contained scales from Lepidoptera, whereas single droppings collected in December, February and March did not. Those in February and March contained fragments of cicada.

The large insects that are important in the diet are all seasonal species recorded from late spring to autumn. Chorus cicadas are recorded in the Orongorongo Valley from the end of November to May; Moeed & Meads (1983) collected them in trunk traps from January to April with peak numbers

in February. The smaller cicada *Kikihia scutellaris* has a slightly later peak. Giant dragonflies are recorded from late October to mid-April. The giant dragonfly and chorus cicada are frequently eaten by feral cats in the Orongorongo Valley, and they were found in cat droppings from December to April and November to April respectively with peak numbers in February and March (Fitzgerald & Karl 1979). Mumu chafers have been recorded from December to March but were caught in mist-nets only in December, January and February, with highest numbers in January.

## DISCUSSION

Large invertebrates were important foods for nestling Kingfishers in the Orongorongo Valley, and some of the same species or genera were recorded by O'Donnell (1981) in pellets from a nest near Taumarunui. This indicates that our results are probably representative of the diet of Kingfishers in forest. Vertebrates, although comprising only a small proportion of the number of animals caught, were so much larger than the invertebrates that they too were important prey.

The predominance of geckos rather than skinks in the diet is noteworthy. References to Kingfishers preying on lizards have been compiled by AHW as part of a bibliography of New Zealand lizards (AHW, unpublished); of 20 records that identified the prey to family, 19 were of skinks and one of a gecko. This contrasts with 7 skinks and 11 geckos from the Kingfisher nests in the Orongorongo Valley.

The foods from the 1972 nest differed somewhat from those from the other nests, having more vertebrates, many more species of beetles, but far fewer cicadas. These differences may reflect differences in the availability of prey between years, differences between habitats (only the 1972 nest was in extensive hard beech forest), or different hunting techniques or preferences by individual birds. Remains of mice were most frequent in the 1972 nest, and mice were more common in the forest then than in 1974, 1975 or 1982 (Fitzgerald 1978, BMF and B.J. Karl, unpubl. data).

The high proportion of droppings containing Lepidoptera compared with only two moths among the insects in the pellets may indicate seasonal differences in diet rather than a bias in the method, as droppings with Lepidoptera were collected in October and November — earlier than any of the pellets. Seasonal changes in the diet of Kingfishers were also noted by Guthrie-Smith (1927 p.63) at Lake Tutira; the first broods in December were fed lizards and the second broods in February, dragonflies.

In forest, Kingfishers probably capture much of their food in the forest canopy. In our mist-netting, Kingfishers were caught mainly in the two uppermost nets of the rigs, in or near the canopy; 79% of 56 birds were caught there and only 4% in the bottom two nets (AHW & BMF, unpubl. data). Stead (1932) described Kingfishers catching insects from flowering shrubs by taking the insect in passing or by diving straight on to the foliage, "stopping themselves from penetrating too far by keeping their wings spread".

Kingfishers are absent from the research area in winter and return in September. The earliest bird of the season was recorded on 15 September, although birds were not caught in the mist-nests until October, and no birds

were caught in the mist-nets after June. The only direct evidence that Kingfishers move away from the Orongorongo Valley is a bird mist-netted there on 19 December 1975 that was recovered dead on 25 April 1976 at Seatoun, Wellington Harbour, 11 km away. Of 27 Kingfishers banded in the Orongorongo Valley, five were recaptured in the following breeding season, presumably having moved out of the area for the winter and returned. Birds probably move out of the Orongorongo Valley for winter because large invertebrate prey that are active by day are scarce in the forest then and geckos and skinks are likely to be torpid.

Taylor (1966) interpreted his counts of Kingfishers as showing movement of birds from higher altitudes to lower altitudes and coastal habitats for the winter. Ralph & Ralph (1977) recorded the numbers of Kingfishers in winter through parts of New Zealand from the Bay of Plenty and East Coast to Canterbury and found them to be most common in the northern half of the North Island, at low altitudes, and in open habitats. They suggested that Kingfishers may be partially migratory, many birds moving to northern parts of New Zealand for the winter, but their results need to be compared with ones in other seasons. Records of Kingfishers in the *Atlas of Bird Distribution* (Bull *et al.* 1985), made throughout the year but especially in spring, show that Kingfishers are common in the North Island and scarce in the South Island. This pattern would be less clear if many birds wintering in the north returned to southern parts of the South Island in spring.

Our findings support the suggestion by Taylor (1966) that the seasonal movements of Kingfishers are largely determined by changes in their food supplies. Over the area in which Taylor made his counts most Kingfishers moving out of forest into other habitats where food is more plentiful in winter are also likely to be moving to lower altitudes. As the DSIR field station in the Orongorongo Valley is only 120 m above sea level, the Kingfishers moving out of the valley for the winter are shifting to other habitats rather than to substantially lower altitudes. This indicates that seasonal movements are primarily between habitats and only secondarily between altitudes.

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## SHORT NOTE

### Emendation of the name of the fossil rail *Rallus hodgeni* Scarlett

An extinct species of flightless rail now known to have been widely distributed in the North and South Islands of New Zealand was originally described from postcranial elements from Pyramid Valley Swamp as *Rallus hodgeni* by Scarlett (1955). It was placed in various genera (see synonymy in Olson 1977) until specimens of skulls and mandibles showed that it belonged with the "*Tribonyx*" group of gallinules in the genus *Gallinula* (Olson 1975).

In the original description, Scarlett (1955:266) named the species "after Messrs J. and R. Hodgen, owners of Pyramid Valley swamp." Species-group names formed from personal names are to be formed in accordance with the rules of Latin grammar (ICZN 1985: Article 31a). Hence, because the species was clearly dedicated to more than one person, the genitive ending must be plural and *hodgeni* must be regarded as an incorrect original spelling (see the example given with ICZN Article 31c, which deals with a nearly identical case). Therefore, Scarlett's name should be emended to *Rallus hodgenorum* and the species should henceforth be known as: *Gallinula hodgenorum* (Scarlett).

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