

# The ageing of Weka (*Gallirallus australis*) using measurements, soft parts, plumage and wing spurs

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## ABSTRACT

Weka (*Gallirallus australis*) can be aged accurately up until 50 days old using leg and bill measurements, and then less accurately up to 180 days old using plumage development, wing spur shape and iris colour. Weka less than one year old can be distinguished by their remex tip and wing spur shape. Beyond one year, Weka can only be placed into age groups, using wing spur shape.

KEYWORDS: Weka, Rallidae, moult, juvenile development

## INTRODUCTION

The Weka (*Gallirallus australis*) is a New Zealand endemic flightless forest dwelling rail. The North Island Weka (*G. a. greyi*) is considered endangered, the Fiordland population of the Western Weka is potentially endangered, and the northern South Island populations of Western Weka (*G. a. australis*), the Eastern (Buff) Weka (*G. a. hectori*) and the Stewart Island Weka (*G. a. scotti*) are considered vulnerable (IUCN 1994).

There are no published accounts of methods of ageing Weka, and little published information on growth and plumages of closely related rails. The tips of primary feathers are used to distinguish sub-adult and adult Lord Howe Woodhen (*Gallirallus sylvestris*, Fullagar *et al.* 1982), and there are wing and bill measurement and non-definitive pre-basic moult data for captive Buff-banded Rails (*G. p. philippensis*) (G. Elliott & A. Beauchamp, unpubl. data).

Juvenile Weka banded on the North Island (Beauchamp 1997a, unpubl. data), South Island (Beauchamp 1987a), Chatham Island (Beauchamp, unpubl. data), Kapiti Island (Beauchamp 1987a), Rakitu Island (Beauchamp, unpubl. data), and Kawau Island (Beauchamp, 1997b, unpubl. data) between 1979 and 1997, provided an opportunity to assess the usefulness of measurements, soft part and iris colour changes, plumage development and wing spur shape in age determination.

## METHODS

Between 1979 and 1997 known age juvenile and sub-adult Weka were caught on Kapiti Island (n = 136), at Double Cove (n = 18) in the Marlborough Sounds, and on Kawau Island (n = 128), to gain information on demography (Beauchamp 1987a, 1987b, 1997b). Records of bill and leg dimensions and colour, iris colour, plumage development and wing spur growth and abrasion were assessed to determine if they could be used to age Weka. In addition, information from juvenile and sub-

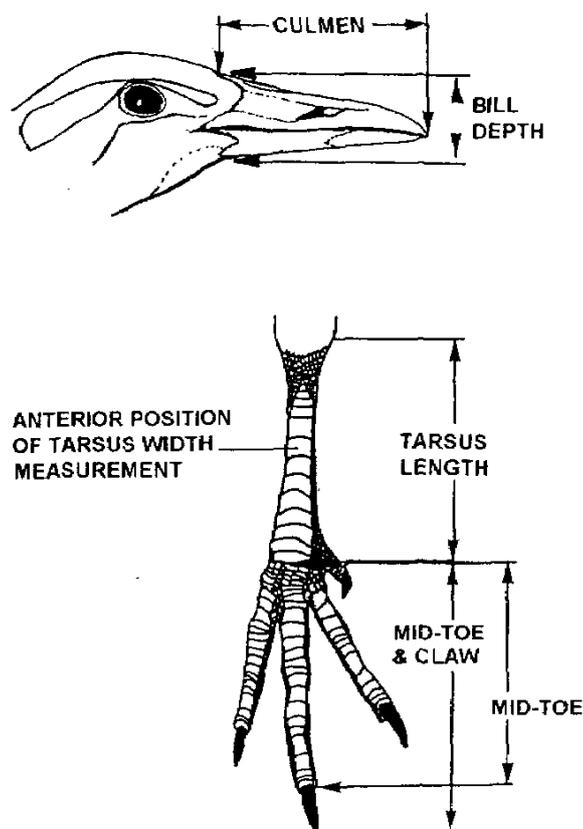


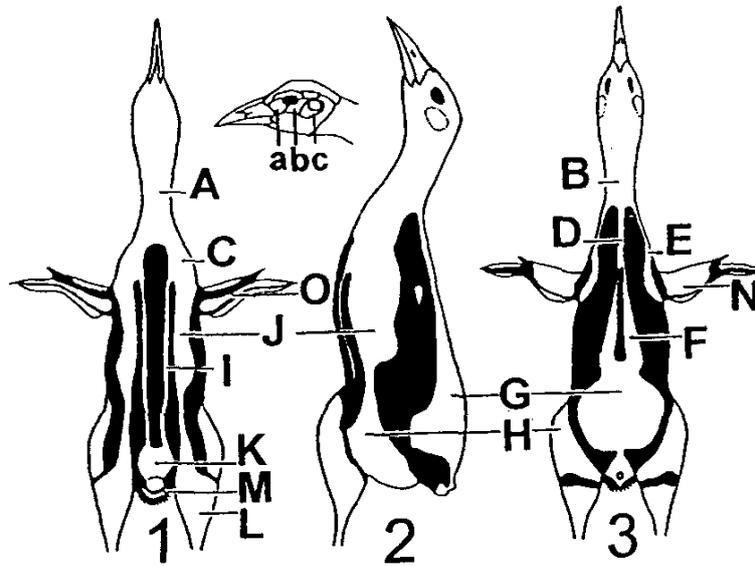
FIGURE 1 - Positions of Weka bill and leg measurements. The tarsus measurement is from the lower notch at the back of the leg to the distal edge of the last tarsal scale. The tarsus width is taken in the Weka's anterior-posterior plane. All leg measurements are taken with the leg straight.

adult North Island Weka from Rakitu Island (Beauchamp, unpubl.), Rakauroa (Beauchamp 1997a) and the North Island Weka breeding programme (Beauchamp, unpubl.); Buff Weka from Chatham Island (Beauchamp, unpubl.); and Stewart Island Weka from Codfish Island and Ulva Island, were used to verify that the patterns found applied to all Weka populations.

Weka plumage and soft parts colour were recorded at each recapture (Kapiti Island  $n = \sim 1200$ , Double Cove  $n = 6$ , Kawau Island  $n = 189$ ), and the culmen, bill depth, tarsus length, tarsus width, mid-toe and mid-toe and claw, and maximum wing cord were measured (Fig. 1). Sex was assigned using discriminant functions (Beauchamp 1987a) and was confirmed using positions during copulation, and the pitch of distress and spacing calls (Beauchamp 1987a, 1997b).

Bill colour was recorded at the proximal base, upper ridge and tip of the mandible, and leg colour at the major anterior scales of the tarsometatarsus, using the Methuen name and code system (Kornerup & Wanscher 1978).

Assessment of bill and leg growth, and juvenile plumage development was confined to Weka where the age was known to within three days of hatching.



**Plumage tract**

**HEAD**

- Pt. ioralis (a)
- Pt. buccalis (b)
- Pt. auricularis (c)

**BODY**

- Pt. cervicalis (A & B)
- Pt. pectoralis (C)
- Pt. interscapularis (D)
- Pt. humeralis (E)
- Pt. dorsalis (F)
- Pt. pelvica (G)
- Pt. femoralis (H)
- Pt. sternalis (I)
- Pt. cruralis (L)

**WING COVERTS**

- Primary major overcoverts
- Minor overcoverts
- Secondary major overcoverts
- Secondary major undercoverts
- Pt. antebranchialis (N)
- Pt. subhumeralis (O)

**MAJOR WING**

**FEATHERS**

- Remiges primaries
- Remiges secondaries
- Alula

**TAIL**

- Pt. dorsalis caudale (M)
- Retrices

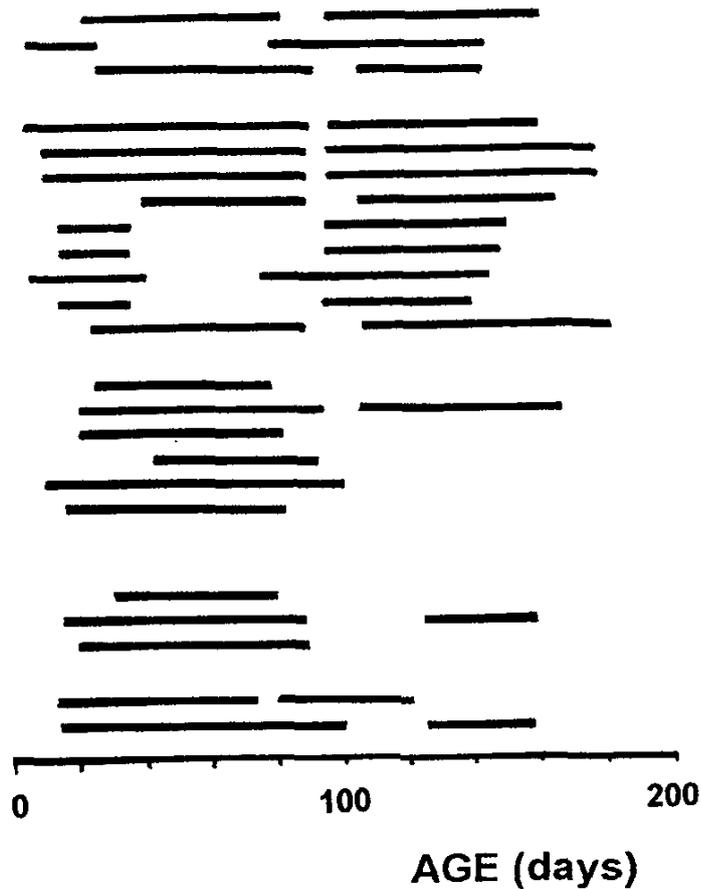


FIGURE 2 - Position of feather Pterylae (Pt) tracts (Baumel *et al.* 1979) of Weka, and the sequence of feather tract development and moult on Kapiti and Kawau Islands. Apterylae are black regions. 1 = Ventral view, 2 = Side view, 3 = Dorsal view.

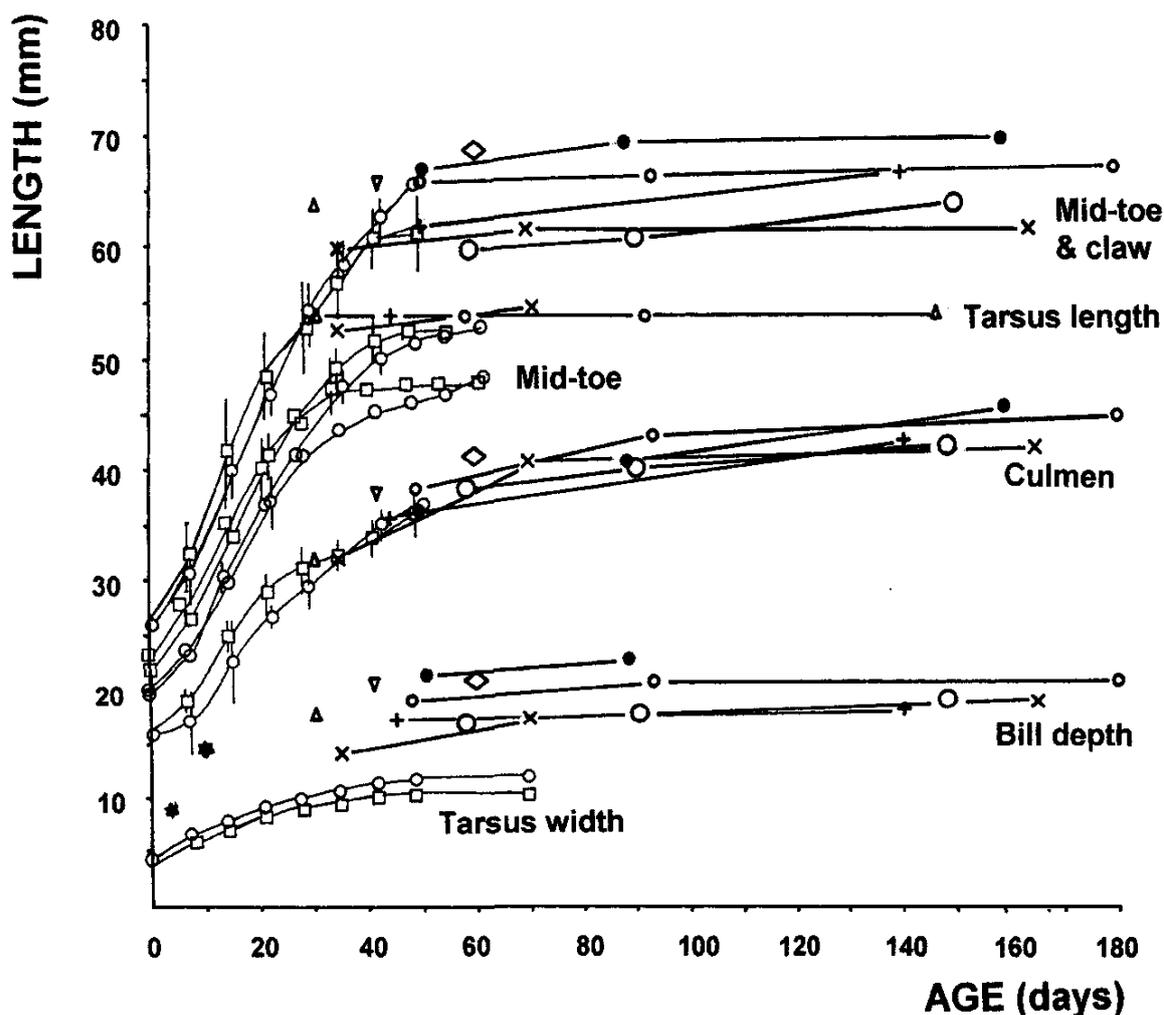


FIGURE 3 - Development of some Weka bill and legs dimensions. Kapiti Island and Kawau Island data. Growth curves are from one-chick clutches on Kapiti Island, mean  $\pm$  1 S.E. ( $\square$  males,  $\circ$  females,  $n = 3$  for each sex). Kawau Island data are for individual Weka  $\bullet$ ,  $\circ$ ,  $\diamond$ ,  $\nabla$ ,  $\triangle$  = male.  $\ast$ ,  $\times$ ,  $+$ ,  $\circ$ ,  $D$  = female.

Older known-age Weka were used for soft-part colour, plumage development and wing spur analyses. Plumage tracts (Fig. 2) were analysed to define the extent and length of plumage development and moult (Beauchamp 1987a), using the method of Humphrey and Parkes (1959). The plumages assessed were the juvenile plumage, non-definitive basic plumage (sub-adult) and definitive basic plumage (adult).

The wing spurs of known-age Weka were assessed at each recapture on Kawau Island between 1992 and 1997, and on Kapiti Island in May 1993.

## RESULTS

### Bill and leg measurements

On Kawau Island, few young Weka were caught when less than 30 days old, but the few measurements suggest that the timing of leg and bill development was similar to that found on Kapiti Island, despite significantly different end point dimensions for culmen, bill depth, mid-toe, mid-toe and claw in each sex (Table 1).

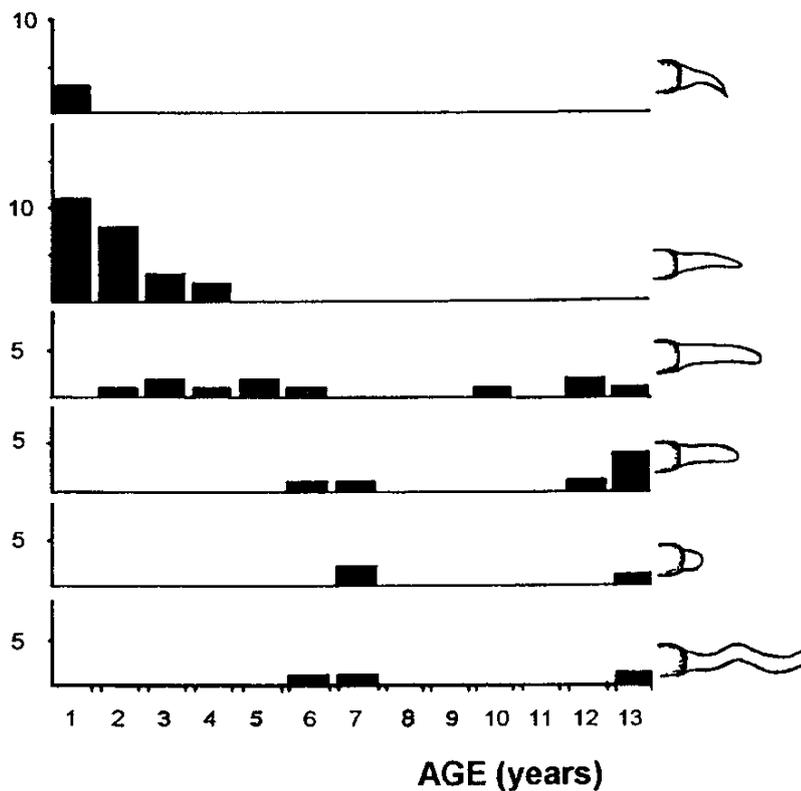


FIGURE 4 - Wing spurs of Weka of known age on Kapiti and Kawau Islands.

If we regard the measurements of young Weka to be indistinguishable from those of adults when measurements reach the lower 95% confidence limits of adult measurements (Table 1), then juvenile Weka can be aged to week of hatching using tarsus length, tarsus width and mid-toe length until 21 days old, mid-toe and claw until 28 days, and culmen length until 50 days (Fig. 3).

### Bill colour change

The timing and degree of changes in bill colour varied between subspecies and the sexes in each subspecies and cannot be used to reliably age Weka. The bills of the North Island Weka were darker and duller than other sub-species. In all populations, the upper mandible of males lightened from a totally dark greyish-brown, to a dark greyish-brown upper margin and tip, and a grey-red (8C2) proximal base. Bill colour of females changed to a greater extent. Compared to males, the margin was frequently a lighter grey, the tip was cream-grey, and the proximal regions were a deeper pink or red (8C4) with less grey.

### Metatarsus colour change

The colour changes of anterior scales on the metatarsus also varied between subspecies and sexes. In all populations, chicks had greyish-magenta (14E3) metatarsi. The large posterior scales changed to brown (7E5), and the anterior scales to

TABLE 1 - Comparison of adult Weka bill and leg measurements (mm), Kapiti Island and Kawau Island. Data are: mean, *s.e.*, 95 percent confidence limits.

Male	Kapiti Island (n=71)	Kawau Island (n=42)	t-value	<i>p</i> value
culmen	47.2, 1.7, 43.8 - 50.6	47.8, 1.8, 44.2 - 51.4	- 1.799	0.076
bill depth	22.9, 0.9, 21.1 - 24.7	21.7, 1.1, 19.5 - 23.9	6.017	<0.001
tarsus length	58.3, 2.3, 53.7 - 62.9	61.1, 3.0, 55.0 - 67.2	- 5.243	<0.001
tarsus width	11.7, 0.5, 10.7 - 12.7	11.7, 0.7, 10.3 - 13.1	0.731	0.467
mid toe	55.4, 2.2, 51.0 - 59.8	58.0, 1.7, 54.6 - 61.4	- 6.893	<0.001
mid toe & claw	68.7, 2.6, 63.5 - 73.9	71.0, 2.2, 66.6 - 75.4	- 5.054	<0.001
max. wing length	196.8, 8.3, 180.2 - 213.4	191.2, 9.4, 172.2 - 210.2	3.178	0.002

Female	Kapiti Island (n=87)	Kawau Island (n=32)	t-value	<i>p</i> value
culmen	43.9, 1.5, 40.9 - 46.9	44.5, 1.8, 40.8 - 48.2	- 1.690	0.097
bill depth	19.8, 0.9, 18.0 - 21.6	18.5, 0.8, 16.9 - 20.1	8.329	<0.001
tarsus length*	51.9, 4.9, 42.1 - 61.7	55.3, 2.7, 49.8 - 60.8	- 4.993	<0.001
tarsus width	10.3, 0.4, 9.7 - 11.1	10.2, 0.3, 9.6 - 10.8	- 0.600	0.551
mid toe	50.4, 2.0, 46.4 - 54.4	53.6, 2.1, 49.3 - 57.9	- 7.411	<0.001
mid toe & claw	62.6, 2.4, 57.8 - 67.4	65.8, 2.5, 60.7 - 70.9	- 6.056	<0.001
max. wing length	176.8, 7.1, 162.6 - 191.0	172.6, 7.3, 157.7 - 187.5	2.800	0.007

\* = t-test based on unequal variance

brownish-orange (7C4), between 40 and 100 days. In the Western Weka and Buff Weka, scales changed from brownish-orange to greyish-pink between 100 and 200 days old, and then to the greyish-pink, dull-pink or dull red (8C4) of adults, between 200 and 365 days old. The metatarsi of the Weka on Kapiti Island became redder and reached adult colours between 225 - 300 days. Anterior scales of most North Island Weka darkened from brownish-orange to a reddish-brown (8D6) and then dark brown (8F6). The anterior scales of a few female North Island Weka changed to dull red.

### Iris colour change

Iris colour was less variable between populations, and may be useful in ageing younger Weka. All irises were dark yellow-brown (7A2) between hatching and 45 - 90 days, depending on the population (Table 3). Iris colour then changed from greyish-yellow (4C3) to reddish-brown (9D7) between 70 and 450 days, and reddish-brown or deep red (10C8).

### Juvenile plumage development

Plumage development can be used to age juvenile and sub-adult Weka to within weeks of age, but requires caution in the absence of information on the length of juvenile dependence, the weight at independence and in the next 3 - 5 months. In food deficient periods, and when young were independent before 70 days, plumage development was slower, and skeletal development took precedence. Juvenile

TABLE 2 - Weight (g) changes of Weka from Kapiti Island and Kawau during the period of non-definitive pre-basic moult. Data are: mean, *s.e.*, range, (n).

	Independence	3 - 5 months after independence	paired t-value	<i>p</i> value
Females				
Kapiti Island	514, 59.7, 430-590 (10)	564, 50.8, 480-610 (10)	- 2.017	0.059
Kawau Island	628, 95.6, 480-750 (20)	893, 121.5, 690-1110 (20)	- 6.639	<0.001
Males				
Kapiti Island	645, 96.3, 460-780 (10)	730, 110.6, 500-820 (10)	- 1.834	0.084
Kawau Island	708, 98.0, 560-900 (19)	1112, 173, 920-1600 (19)	- 8.859	<0.001

NOTE: The same individuals were used in each paired sample t-test comparison.

plumage development followed the same sequence in all populations (Fig. 2). The first plumage to develop were the ear coverts, at 8 - 25 days, and the nape, at 12 - 26 days. Most pterylae started growing before 10 days, and the down remained attached to the tip of the juvenile plumage until 50 - 70 days. Secondary and primary remex papillae activated at six days and 14 days respectively, and the tips of all remiges were visible at 20 days. Wing undercoverts pterylae started to develop at 40 - 50 days. By 90 days most contour feathers were fully developed and the remiges were losing their basal sheets. The apterylae region immediately below the wing, started to develop downy feathers over its entire area at 70 - 100 days.

Some plumage changes were visible at a distance, and could be used to age Weka approximately. The ear patch developed at 8 - 25 days, and was a light grey patch behind the eye, against a blackish-brown downy head. Wing coverts started to develop at 25 days, and the wings appeared as brown patches surrounded by black-brown downy plumage at 30 - 40 days old. Weka showed the first signs of tail development, a downy stump, at 22 - 35 days. Young were three quarters the size of adults, with a visible tail and grey-brown dorsal and ventral plumage, at 35 - 50 days old. Young were adult-size, but with sleek greyer plumage, at 70 - 90 days.

### Sub-adult plumage and development rates

There were considerable differences in the extent and duration of non-definitive pre-basic moult between the Kapiti Island and Kawau Island populations. These appeared to be due to the differences in condition (weight for size, Beauchamp 1987a) during the 3 - 5 months after independence, with Kapiti Island and Kawau Island Weka representing opposite ends of a weight continuum (Table 2). However, the primary and most secondary remiges of juveniles were always retained until the definitive pre-basic moult when Weka were 330 - 445 days old. Consequently, all Weka less than a year old had remiges with pointed tips.

TABLE 3 - Changes in the iris colour of Weka from three populations. Figures are the range (days), with extreme limits in brackets. Adult = indicates that this eye colour was seen in Weka over a year old.

Iris Colour	Kawau Island ( <i>G. a. greyi</i> )	Kapiti Island (mixed origin)	Double Cove, Marlborough Sounds ( <i>G. a. australis</i> )
Dark yellow-brown	0 - 40 (50)	0 - 70 (90)	0 - 70 (80)
Greyish-yellow	45 - 60	70 - 240	80 - 100
Reddish-brown	45 - 160 (295)	240 - 365 & Adult	80 - 365 & Adult
Deep red	Adult	Adult	Adult

On Kapiti Island non-definitive pre-basic moult started at 74 - 76 days in the femoral and ear regions, and by 95 days the entire body was in moult. Minor wing coverts and upper tail coverts started moult at 100 - 110 days old. The major wing coverts, remiges, and rectrices did not moult.

This moult sequence was similar in those young Weka on Kawau Island which were independent at 30 and 70 days. However, the sequence and timing of moult differed in Weka that fledged after 70 days, and when there was adequate food during the 3 - 5 months after fledging (Fig. 2). During this time young Weka increased in weight significantly (Table 2) to between 30 - 100% heavier than adult paired Weka. Nine Weka (8%) moulted the rectrices and tertiary remiges, and 11 others moulted the rectrices alone.

All remiges and rectrices were replaced in the definitive pre-basic moult during the November - January after fledging (330 - 455 days of age) to form the adult plumage. At this time, all remiges had rounded tips.

### Spur development and abrasion

All Weka hatched with a 4 - 5 mm spur with an inward-pointing curved needle-sharp tip (Fig. 4). The tip was lost during the first year, and the spur grew and was abraded throughout life. It was sharp, pointed and 5 - 8 mm long, when all Weka were 1 - 2 years, and until some were four years old. Some Weka older than two years had long blunt spurs (8 - 12 mm), and those over seven years old had shorter very blunt spurs (2 - 4 mm). Long curved spurs 10 - 20 mm, sometimes corkscrew shaped, occurred on Weka of six years and older.

## DISCUSSION

Weka less than 50 days old can be aged to within a week of hatching using bill and leg measurements, and plumage. They can be aged less accurately using plumage development up to 180 days. First year Weka have remiges with pointed tips. Older Weka can only be aged using spur shape. Weka between one and five years old can

be assigned to a probable age category, and older birds placed in the greater than five years group.

These ageing techniques have been used to assess the impact of targeted Weka eradication activities on the surrounding population in the Tuku-a-tamatea Valley, Chatham Island (Imber *et al.* 1994, Beauchamp, unpubl. data), to record the age structure of the Weka groups released after poison operations on Kapiti and Mokoia Islands, to assess the age structure of the Weka population on Ulva Island before rat poisoning operations (Beauchamp, unpubl. data), and to assess the age structure of Western Weka killed on Westland roads (B. Stuart-Menteth, pers. comm.). The techniques were also used to age birds taken into the North Island Weka breeding programme, and to find which mixes of age and sex resulted in the fastest bonding and breeding (Beauchamp unpubl. data).

Further analysis of known age Weka on Kawau Island may lead to more refined wing spur ageing categorisation. However, the use of more refined categorisation requires caution since Weka from different populations may use spurs for different purposes. Weka on Kawau Island and Kapiti Islands used spurs when climbing or squeezing through narrow openings (Beauchamp, unpubl. data), and generally fought with only their feet and bills (Beauchamp 1987a). In other populations, the wing spur was used during fights (Harper 1946).

The characteristics that are useful for ageing Weka may be useful for ageing other rail species (Olson 1973). First-year and adult Lord Howe Woodhen are aged using the pointed and rounded remex tips, respectively (Fullagar *et al.* 1982, Marchant & Higgins 1993). The remiges of juvenile Buff-banded Rail are not pointed, and it is difficult to distinguish between first year and older rails using this character (Beauchamp, unpubl. data). Wing spur shape may also be a useful additional ageing tool for Lord Howe Woodhen and Buff-banded Rails.

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