Corella, 1991, 15(1): 19–23

CONSUMPTION OF SEEDS BY RED-BROWED FIRETAILS *Neochmia temporalis* AT FEEDERS: DEHUSKING RATES AND SEED CHOICE

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Received 12 June 1989

Red-browed Firetails *Neochmia temporalis* dehusked seeds before swallowing them. Smaller seeds were dehusked at a faster speed than larger seeds, but despite this, intermediate-sized seeds, between 1.5 mm and 2.0 mm in width, provided the best energy returns. When given a choice at feeders, Red-browed Firetails consumed seeds of intermediate dimensions more frequently than larger or smaller seeds. This suggests these finches prefer seeds that offer higher energy returns.

INTRODUCTION

Australian finches feed predominantly on seeds from grasses and other plants (Immelmann 1982). The husk, or test, is usually removed from the seed prior to swallowing, probably because the husk contains little nutritive value, may impede digestion, or occupy space in the crop.

External beak dimensions have been shown to control the size and shape of seeds that finches are able to eat (Hespenheide 1966; Pulliam and Enders 1971; Abbott *et al.* 1975, 1977; Grant and Grant 1980), and the morphology of the upper mandible may also determine which seeds can be dehusked by finches or influence the rate at which different-sized seeds are dehusked. For Red-browed Firetails the blade-like lower mandible peels the husk from the kernel while the seed is held in grooves in the upper mandible and rotated with the tongue (Read 1987).

In this study I measured the speeds with which Red-browed Firetails dehusked and consumed a range of seeds that differed in size and shape. I then used these speeds and the masses of the various seed kernels to predict which seeds would be preferred, assuming that firetails attempted to maximize food intake while feeding (e.g. Pulliam 1974). These predictions were tested using choice experiments where Red-browed Firetails were presented with a suite of seeds, and the relative consumption of each used as a measure of selection or preference (e.g. Eggers 1977).

METHODS

The speed with which Red-browed Firetails processed seeds of different shapes was investigated in an aviary using three individually marked birds. These three finches were taken from a wild population near Currency Creek, South Australia, and returned to this population at the conclusion of the work.

Seven seed types were offered to the finches: Barley *Avena* sp., Barley kernels, Japanese Millet *Panicum* sp., White Millet *P. milaceum*, Panicum *Panicum* sp., Canary seed *Phalaris canariensis* and Maw *Papaver* sp. Details of the dimensions and masses of the kernels of these seeds are provided in Table 1. Masses of the seed kernels were determined by weighing 100 intact seeds on a

TABLE 1

Dimensions and masses of seed kernels for seeds presented to Red-browed Firetails. The length and width of 20 kernels from each type of seed were measured with vernier calipers, while the average mass of a kernel was determined from 100 seeds (see Methods for details).

Seed type	Length* (mm)	Width* (mm)	Mass (mg)
Barley (with husks)	10.5±1.60	3.0±0.15	26.0
Barley	8.6±0.77	2.8±0.36	26.0
Canary Seed	4.8±0.24	1.8±0.18	6.1
Japanese Millet	3.3±0.38	2.0±0.11	2.5
White Millet	2.7±0.11	2.0±0.11	4.4
Panicum	2.3±0.10	1.6±0.04	1.9
Maw	1.2±0.05	0.9±0.08	0.3

*mean±S.D.

Mettler balance to an accuracy of 0.1 mg, and then subtracting the mass of the husks. The mass of husks was determined by presenting the three captive birds with 10 g of each seed type on separate days. The 10 g of intact seeds were placed in a large box, with sides 15 cm tall to prevent spillage of husks and seeds. The following day the husks and uneaten seeds were collected from the box and separated in a vertical separation column. The mass of the uneaten seeds was subtracted from the initial 10 g, then the husks were weighed and the mass of the kernels relative to the husks calculated. Intact Barley seeds were not taken by Red-browed Firetails and so Barley seeds were dehusked by hand. Only Barley kernels (dehusked seeds) were used in other experiments (see Results).

Daily rates of consumption of seeds and choices of seeds were measured in the aviary by providing the three captive birds with 5 g of each of six seed types at dawn, and then measuring the mass of leftover seed at the end of the day. Seeds were placed on a cardboard tray that had been divided into six compartments, each 64 sq. cm. The tray was approximately 5 mm deep, which was sufficient to prevent spillage of seeds but allowed husks to be blown off by the wing beats of the birds. One seed type was placed into each compartment, and the relative positions of the different seed types on the tray was changed daily throughout the experiment. The amounts of each seed type consumed by the birds were used as a measure of preference. No other food was available to the birds in the aviary.

In addition to measuring seed choice in captive birds, a wild population of Red-browed Firetails from Upper Sturt, South Australia, was offered Barley kernels, Japanese Millet, White Millet, Canary Seed, Panicum and Maw seeds. Two hundred grams of each of these seeds were placed daily in large trays within a wire mesh enclosure which excluded all other granivorous birds. Seed preference was measured by calculating the mass of each seed type consumed over two consecutive 24 hour periods.

The rates at which Red-browed Firetails handled and dehusked the various seeds were determined from video films of the captive birds. A National CCD video camera with superimposed stopwatch was used, and the videos replayed at one-sixth normal speed. The time taken for the finches to pick up and dehusk individual seeds was then recorded to the nearest 0.1 seconds. Handling times (time to find, pick up and dehusk a seed) and handling rates (seeds/minute) were also calculated from these films.

RESULTS

Red-browed Firetails were able to eat the six seeds, but Barley seeds that had husks were not taken. If the husks were removed from the Barley seeds before being presented to the birds then firetails would occasionally take them. Even then the Barley kernels were not swallowed whole, but were bitten into small pieces, which were then picked up and macerated before swallowing. All the other seeds, once dehusked, were swallowed whole.

All three finches averaged between 0.35 and 0.40 seconds to locate and pick up each of the seed types. There were no significant differences between the procuring rates for the different seeds (ANOVA's, p's >0.05). However, individual Red-browed Firetails dehusked seeds at different rates (Table 2). Although there were no differences for the three captive birds for White Millet, Panicum or Barley, they differed significantly when dehusking Japanese Millet, Canary Seed and Maw (ANOVA's, Table 2). The main cause of this variation was that Bird 3 processed Canary Seed faster than Japanese Millet, whereas the other two birds processed Japanese Millet faster than Canary Seed (Table 2). Although there were differences in the rates at which the birds processed the different seeds (ANOVA, Table 2), processing rates for all birds tended to increase with an increase in seed size. The mass of seed consumed per minute varied between seed types (Table 2). Captive firetails had higher rates of intake when feeding on White Millet, Canary Seed and Panicum than when they fed on other seeds. The lowest rate of food intake (mg/min) occurred for Maw. Given these differences, Red-browed Firetails should feed primarily on White Millet, Canary Seed and Panicum rather than on the other seeds, if they are to maximize their rate of food intake while feeding.

TABLE 2

Processing times for six seed types by three captive Red-browed Firetails. Number of seeds timed for each bird given in parantheses. Values and means±standard deviation.

Seed type	Dehusking Time (secs)				Differences between birds*	Average total handling time per seed (secs)	Seed consumption per minute (mg)
	Bird 1	Bird 2	Bird 3	Average			
Maw	1.0±0.09 (35)	0.7±0.07 (29)	1.2±0.18 (24)	1.0	**	1.4	13
Panicum	1.0±0.08 (24)	1.3±0.11 (28)	1.4±0.14 (24)	1.2	NS	1.6	71
White Millet	1.6±0.10 (68)	2.2±0.34 (22)	1.9±0.23 (21)	1.9	NS	2.3	115
Japanese Millet	2.6±0.37 (22)	2.8±0.37 (20)	5.0±0.53 (20)	3.5	**	3.9	39
Canary Seed	5.3±0.49 (20)	3.4±0.37 (39)	3.0±0.29 (35)	3.9	***	4.3	85
Barley	25.3±5.39 (3)	29.7 (1)	23.6 (1)	26.2	NS	26.6	60†
Differences between seeds in dehusking times	***	***	***	—			

*ANOVAs. NS, not significant; ** $p<0.01$; *** $p<0.001$.
†Kernels were cracked into smaller pieces before being swallowed. Calculation assumes that all pieces were consumed and so may overestimate intake.

Daily consumption of the different seed types from feeding trays by the three captive birds and wild birds is presented in Table 3. Larger amounts of intermediate sized seeds (Canary Seed, White and Japanese Millet and Panicum) were eaten by both the captive and wild birds instead of the tiny Maw seed or large Barley kernel. The aviary birds consumed an average of 3.8 g of seed kernels daily.

TABLE 3

Seed consumption for three captive Red-browed Firetails over 12 days and for a flock of wild Red-browed Firetails over two days. Standard deviations not calculated for the wild population owing to changes in the population size (100–250 birds) using the feeder. Seeds are ranked in descending order of size.

	Amount consumed (g) per day	
	Aviary Birds	Wild Birds
Barley	0.78±0.30	4.0
Canary Seed	2.68±0.27	74.3
Japanese Millet	2.64±0.74	128.2
White Millet	2.06±0.33	139.3
Panicum	2.31±1.23	108.9
Maw	1.31±1.52	5.3
TOTAL	11.28±3.20	460.0

DISCUSSION

All of the seeds consumed from feeding trays by Red-browed Firetails were dehusked by the birds before they were swallowed. Dehusking occupied 75–91 per cent of the foraging time of birds at feeders (Table 2), and, therefore, the ability to remove husks efficiently may be an important criterion in determining which seeds should be eaten by the firetails.

The maximum width of seeds dehusked by Red-browed Firetails under experimental conditions was 2.0 mm. Seeds 2.0 mm or smaller are supported reasonably well by the groove in the upper mandible, which has a maximum width of approximately 1.95 mm (Read 1987). The Barley seeds with husks were considerably wider than this groove, and such large seeds could not be held by the bill for dehusking. Thus, the ability of Red-browed Firetails to dehusk seeds appears to be determined by the morphology of the beak and groove in the upper mandible, and by the size and shape of the seed. Seeds greater than 1.95 mm would be difficult for the birds to dehusk, and therefore should not be taken by Red-browed Firetails.

The results show that small seeds were processed faster than large seeds, which is consistent with other studies (e.g. Abbott *et al.* 1975). All seed types were handled by each of the three captive birds at similar rates, the only exception was that one bird was slow in handling Japanese

Millet. Individual variation such as this has also been noted in Clark's Nutcrackers *Nucifraga columbiana* when handling the seeds of the Pinyon Pine (Johnson *et al.* 1987).

Red-browed Firetails did not feed on very small or large seeds as often as seeds of intermediate size. With the exception of Japanese Millet, which has a bulky husk, the intermediate seeds were processed more efficiently than the very large or small seeds. When given a choice, the firetails fed predominantly on the most efficiently processed seeds, as predicted. However, they did not feed solely on the most profitable seeds, consuming smaller amounts of the less profitable varieties.

When foraging at feeding trays, Red-browed Firetails occasionally investigated a series of seed types, but tended to stay with the first seed type visited until the feeding bout was finished or they were disturbed. However, birds which first encountered a seed type that would be inefficiently processed moved until they found a suitable seed (pers. obs.), which suggests a deliberate selection by the finches. By selecting the seeds which maximized their rate of food intake, firetails should minimize their feeding time. This may be beneficial, allowing them more time for other activities (e.g. breeding, preening) and minimizing exposure to predators. Finches are often prone to predation while feeding (Barnard 1980). Thus, people providing seeds for finches at feeding trays should provide White Millet, Canary Seed and Panicum. These seeds are the most efficiently processed and so minimize the time that Red-browed Firetails will be exposed to predators (goshawks and cats) while at feeders.

Although Red-browed Firetails concentrated on the most efficiently processed seeds, they also sampled Maw seeds regularly and Barley kernels to a lesser extent, despite the reduced rates of food intake when feeding on these. There are many factors that might account for this use of less preferred seed types. For example, some of these less preferred seed types based on energy or mass may rank higher than other seeds to finches if they contain high levels of valuable nutrients or proteins. Alternatively, owing to the high degree of variation in seed handling ability between individuals (Table 2), certain individuals may efficiently consume a seed type which is inefficiently handled by other individuals.

Interactions between individuals within a flock are also likely to influence which seeds are consumed at feeding trays. Wild Red-browed Firetails feed in flocks, and hence a bird successfully feeding at one compartment of a tray may influence the feeding behaviour and preferences of other birds in the area. A similar phenomenon has been reported for Great Blue Herons *Ardea herodias* (Krebs 1974) and House Sparrows *Passer domesticus* (Barnard 1980), which preferentially land in areas occupied by conspecifics, rather than vacant regions. Alternatively, some birds may choose to feed uninterrupted on a less favourable seed, if a compartment of the tray containing a favoured seed is crowded with finches which are interfering with each other. Goss-Custard (1976) found that interference from neighbouring birds resulted in a reduced feeding efficiency for waders feeding in large compact flocks compared with smaller, more open flocks.

Several other factors which were not investigated in this study may also influence which seeds are taken in the wild by Red-browed Firetails. The time spent searching and procuring seeds in the wild is likely to occupy a significantly larger amount of the finches' foraging time than occurs at feeders where ample quantities of seeds are provided. Thus, in the wild, both dehusking and searching times may influence seed selection, with seeds that are clustered or otherwise easy to locate being preferred over widely scattered or cryptic seeds, even if the latter provide higher returns during dehusking.

In addition, the varying risk of predation from feeding on seeds in different locations may affect the value of a particular seed type to the finches. Barnard (1980) has shown that the risk of predation for House Sparrows increases with increasing distance from cover. Therefore, wild Red-browed Firetails may choose to feed on less favourable seeds which grow in a sheltered position, instead of more efficiently processed seeds in exposed areas.

ACKNOWLEDGMENTS

The majority of the experimental work documented in this paper was conducted as part of an Honours Zoology Thesis at the University of Adelaide. I should like to thank my supervisor Dr David Paton for his assistance with this study and comments on earlier drafts of this paper. I

also thank Tony Robinson and Julia Haska for allowing me access to their feeding tray at Upper Sturt. This work was supported in part by a Wildlife Conservation Fund grant to D. C. Paton and J. L. Read. The South Australian National Parks and Wildlife Service provided permits to trap and keep Red-browed Firetails for the aviary experiments.

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NEST BUILDING BY LOGRUNNER

Contradictory statements appear in current field guides as to the building of the nest of the Logrunner *Orthonyx temminckii*. Beruldsen (1980) suggests dual building by saying 'when building the nests, the birds first lay down a platform', but Reader's Digest (1986) and Simpson and Day (1984) state that only the female builds.

I watched a pair adding to a half-completed nest at Binna Burra in the Lamington National Park, Queensland, on 18 April, 1990, for one hour in midafternoon. At approximately half-minute intervals, each bird carried twigs to the nest in its bill. Often the visits overlapped; sometimes both were in the nest together. They always followed the same route to the nest irrespective of where the twigs were gathered, and they always built from the front. Both birds worked in silence.

Some unknown interruption caused the male to move (I did not observe whether he ran or flew) to a more open area about 20 m distant, where he uttered a series of rapid staccato chattering calls while running round in an obvious distraction display. The female froze beside the nest for about a minute, then entered and sat facing outwards, but shortly after continued building. The male continued the distraction display for about five minutes, then rejoined the female and proceeded as previously.

Twice the female tried to affix a leaf the same size as herself to the nest entrance before discarding it. Two leaves placed on top of the nest stayed in place.

The nest was situated along the line of a shallow valley in the damp, dark rainforest. The symmetrical nest was about 15 cm deep, constructed of twigs latticed almost vertically and placed on the ground beside a small sloping rock with a single stemmed plant behind it. The dome was unfinished and there was a step at the front, with the entrance facing downhill.

The pair ignored people passing along the track and talking quietly. The times of incidents quoted are approximate only, as I did not wish to distract the birds by any movements. Similarly, close examination of the nest was brief.

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Received 1 June 1990