

INFLUENCE OF COLOUR AND SUGAR CONCENTRATION ON THE FORAGING BEHAVIOUR OF RED WATTLEBIRDS *Anthochaera carunculata*

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The foraging behaviour of a group of semi-wild Red Wattlebirds *Anthochaera carunculata* was examined using a series of experiments. It was found that the birds (a) had no colour preference for those colours offered; (b) could discriminate between different sugar concentrations, and (c) rapidly modified their feeding techniques to exploit new food sources. It could not be determined whether the birds used visual cues or cross sampling to locate higher concentration solutions. Weaker solutions were still consumed, partly because some birds were excluded from the richer solutions.

INTRODUCTION

The process of food selection in hummingbirds has been extensively investigated, particularly the roles of flower colour, position and sugar concentration (Amadon 1966, Grant 1966; Collias and Collias 1968, Miller and Miller 1971, Hainsworth and Wolf 1976, Stiles 1976, Wolf 1976, Wheeler 1980). Despite many behavioural, ecological and physiological studies of Australian nectar-feeding birds (e.g. Recher 1971, Dow 1975, Ford and Paton 1976, Collins *et al.* 1980) no-one has examined experimentally, the cues these birds use to determine which flowers to visit.

The following paper reports experiments which examine food selection and flexibility in foraging skills of the Red Wattlebird *Anthochaera carunculata*, a large honeyeater belonging to the Family Meliphagidae. Three questions were asked:

- (1) Do wattlebirds prefer foods associated with certain colours?
- (2) Can wattlebirds recognise differences in sugar concentration?

(3) Are wattlebirds capable of modifying their feeding actions when confronted with a structurally different feeder where nectar is less accessible?

During the experiments I noted that the wattlebirds often consumed large amounts of the weaker solutions even when stronger solutions were available. So, in addition to the above questions, two further questions were investigated. Firstly, do wattlebirds merely choose to feed at the first food source they encounter? Secondly, does intraspecific aggression sometimes force birds to use the weaker solutions present?

METHODS

The experiments were carried out between 10 February and 5 June, 1980, in a suburban woodland in Beverly Hills, N.S.W. A resident population of four to six Red Wattlebirds was present. A feeding station was located on a horizontal limb of a Blue Gum *Eucalyptus saligna* approximately three metres above the ground. Wattlebirds, being highly nectarivorous, readily visited it.

The station usually consisted of four identical jars spaced 10 cm apart, each holding 74 ml of a honey and water mixture. Before the experiments and in most trials the honeywater concentration was 11% sucrose equivalents (wt/wt). This weak solution was used to prevent the birds becoming too dependent on the artificial nectar. By using a fifth jar covered with wire gauze, which excluded birds, I found that losses to insects and through evaporation were negligible during the experiments. In some experiments unmodified water dispensers, used for rodents, were provided as different feeder types.

During experiments the position of each feeder was rotated one place in the station each day, to correct for biases resulting from their position. Each day the jars were filled at 0800 hours and measurements of the amounts taken were recorded at 17:00 hours. The feeders were then covered with plastic bags until 08:00 hours the following day.

EXPERIMENTAL PROCEDURES

Colour preference (Experiment A)

To determine if wattlebirds preferred certain colours the artificial nectar was coloured using vegetable dyes (Miller and Miller 1971). Three drops of dye were added to each jar to colour the solutions green, blue, yellow and red respectively. Whenever the jars were refilled, more dye was added to maintain a strong colour. The sugar concentration for all jars was 11% (wt/wt) and the experiment was conducted over an eight-day period.

Taste preference (Experiment B)

Originally these experiments were meant to determine to what extent visual cues are used by the birds in selecting food. However the lack of a control meant that this question could not be answered and so these experiments were examined in respect to the birds' taste preferences.

Jars with coloured solutions were used to see if the honeyeaters could detect differences in sugar concentration. Since green had the lowest rate of consumption in Experiment A, and it is a rare flower colour (Keighery 1982), it was chosen as the reward colour and its sugar concentration increased to 21% (wt/wt). All other

solutions remained at 11% and the experiment was carried out over six days.

Further testing of the birds' abilities to discriminate between concentrations involved the use of jar and bottle feeders. Instead of colouring the food, red and blue discs were arranged alternately on the feeders. Those with red discs had 11% solutions and those with blue discs had 21% solutions. The experiment using the jars ran for four days while that using the bottles lasted three days. The latter was performed after Experiment C.

Flexibility of feeding behaviour (Experiment C)

By replacing the jars with bottle feeders the ability of the wattlebirds to modify their feeding actions was examined. The change required of the bird was from bending and licking at an open jar, to using the beak to move a ball bearing in a bottle's tube and then begin licking. The amounts consumed over the following four days were noted and corrected for losses through leakage which were determined prior to the experiment (0.5 ml/hr). An 11% solution was used throughout this trial.

To compare efficiencies in the use of jars and bottles, results from a four-day period of jar usage prior to experimentation was randomly chosen. Results for the jars immediately preceding the changeover to bottles could not be used because Pied Currawongs *Strepera graculina* invaded the station, began feeding from the jars and hindered the feeding of the wattlebirds. The currawongs did not feed from the bottles.

Behavioural interactions (Experiment D)

Interactions between conspecifics and other species were investigated by observing the feeding station from 0800 to 1000 hours on each of five consecutive days (1-5 June). On each day two jars with 11% solutions and two with 21% solutions were present. Records were kept of all aggressive behaviour, numbers of birds at the station and the number of sips made by each bird at each food concentration.

RESULTS

Colour preference.

A heterogeneity test revealed that the data from successive days could not be pooled (X^2_{11}

= 65.6, $df = 11$) Therefore, to determine whether there was any consistent ranking of the colours, a Kendall's coefficient of concordance was used (Siegel 1956). The null hypothesis of no consistency was accepted ($S = 52.3$, $n = 4$, $k = 8$; $p > 0.05$). The mean volumes of nectar removed (ml/day) were similar for all colours (green = 18.1, blue = 22.5, yellow = 26.5 and red = 19.9). Thus the wattlebirds appeared to show no preference for any of the four colours when feeding from the jars.

Taste preference.

As with the colour preference experiment, variability in the amounts of nectar consumed from day to day meant that the data could not be pooled ($X^2_{df=5} = 21.7$, $df = 5$). However, a Kendall's coefficient of concordance revealed that there was a consistent ranking of the colours ($S = 108.5$, $n = 9$, $k = 6$; $p < 0.05$). The higher concentration solution (green) had the most liquid removed ($\bar{x} = 42.3$ ml/day), while the amounts consumed from the lower concentration solutions (all other colours) were markedly less (mean values: blue = 24.2, yellow = 24.5, red = 27.8 ml/day).

In the experiments using the coloured discs on the jars and bottles, the birds consumed more of the stronger solution in both situations. This preference increased during the following days. The ratio of high/low concentration over the days were: jars — 1.6 (151 ml), 2.1 (132 ml), 2.5 (128 ml), 2.8 (151 ml); bottles — 1.4 (121 ml), 2.4 (82 ml), 10.9 (83 ml) respectively. The numbers in brackets are the total volumes of all solutions removed by the birds on the day.

Flexibility in feeding behaviour

From the second day onwards the Red Wattlebirds consumed as much nectar from the bottle feeders as they had from the jars (ratio of volumes removed from bottles/jars over the days: 0.32 (231 ml), 1.5 (325 ml), 0.98 (249 ml), 0.98 (398 ml) respectively). This was despite the fact that the presence of currawongs may have deterred the wattlebirds from feeding from the bottles.

Behavioural interactions

When alone, wattlebirds showed a preference for the more concentrated solutions. On 82 out

of 85 visits the birds either went directly to the higher concentration or, after sampling both concentrations, settled at the higher one. However, significant amounts of the weaker solution were still consumed. One possible reason for this is that when feeding as a group, individuals are displaced from the stronger solutions to the weaker ones.

A number of different types of intraspecific interactions were observed when more than one wattlebird was present at the feeding station. Three behaviours were noted: (a) fighting and chasing (often involving physical contact), (b) displacement (where a smaller bird was supplanted by a larger bird), and (c) appeasement (a display used by a smaller bird to gain or retain access to a feeder despite the presence of a larger bird; see McFarland 1983). The relative sizes of the birds at the station were easily assessed by eye, since the birds were often side by side on the branch at some stage during the interaction. In all three cases of fighting the loser left the vicinity of the feeding station. However, in 16 out of 23 displacements and four of the 12 appeasement displays, the loser moved and began feeding from a weaker solution.

DISCUSSION

In this study Red Wattlebirds exhibited no preference for consuming red, yellow, blue or green nectar. This is perhaps not surprising since honeyeaters may visit flowers of a wide range of colours (Sargent 1928, Keighery 1982). Since nectar producing flowers may appear in a variety of colours, birds with an innate preference for only one colour would be at a disadvantage in such an environment. In those cases where colour preferences have been shown in nectarivorous birds, the preferences have been found to be learnt rather than innate (Grant 1966, Stiles 1976).

Red Wattlebirds are capable of discriminating between nectar of different concentrations and tend to show a preference for the stronger one. Hummingbirds exhibit similar preferences (Hainsworth and Wolf 1976) and wherever the foraging costs and risks of feeding at the two concentrations are the same one would expect such discrimination.

While the wattlebirds took more of the stronger solutions, they still consumed appreciable amounts of the weaker ones. This may have been expected initially since the birds visiting the weaker solution would not have known that a stronger one was available. On later days after some cross sampling, the amounts of weaker solution taken should have declined, but I found that the weaker solution was still being utilised. Either the birds continue to cross sample throughout the entire time that a food is available or, the birds either through aggression or appeasement, were being displaced from the stronger solution and often began using the weaker one.

Cross sampling of the available nectar sources was evident during the observations of the feeding station. The advantage of such 'exploratory shifting' (Collias and Collias 1968) is that it enables the birds to readily identify and switch sources should a previously unprofitable one become richer than all others. The flexibility in foraging skills required in such a strategy was shown by the wattlebirds in their ready acceptance and use of the bottle feeders when they were presented. Plasticity in feeding behaviour appears to be common in Australian meliphagids with many species reported to use a wide variety of exotic flowers (Sargent 1928), including some where the nectar was difficult to obtain (McCulloch 1977).

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