SHORT COMMUNICATIONS

THE VALUE OF INSECTS AND NECTAR TO HONEYEATERS

Recher and Abbott (1970) suggest that honeyeaters hawk for insects as a source of protein rather than as a means of gaining energy. They are able to fulfil their demands for energy from nectar alone. Our observations over the past two years on honeyeaters in the Mount Lofty Ranges and elsewhere in South Australia lead us to agree with their conclusion. To test this conclusion we have estimated the energy that the birds expend and gain from capturing insects by hawking and from feeding from flowers. The most numerous honeyeater in this area is the New Holland Honeyeater *Phylidonyris novaehollandiae,* which takes most of its insects by hawking and spends nearly equal time feeding on insects and nectar. (We have made a total of 3,611 feeding observations on New Holland Honeyeaters throughout the year by following individual birds and noting their first feeding action. Fifty-nine per cent of these were feeding on flowers, thirty-three per cent hawking and the remaining eight per cent capturing insects in other ways.)

The energy gained from any feeding activity per unit time can be determined by measuring the feeding rate (number of items per minute) and the calorific value of each individual item. The energy expended is a function of the metabolic rate of the bird and the level of activity, i.e. sitting, hopping or flying.

New Holland Honeyeaters make an average of about ten flights per minute when hawking (281 flights in 1,720 seconds or 9.8 flights per minute) and we have assumed that they take one insect per flight; occasionally they may take two or more; sometimes they may miss. The insects they take are usually tiny Diptera or Hymenoptera ranging in weight from about 0.5 milligrams (tiny midges and wasps) to about 5 milligrams (large midges and ants) or occasionally larger. Insects of this type are about seventy per cent water (range fifty-three per cent to eighty-nine per cent in thirty-eight insects) so that their dry weights are 0.15−1.5 milligrams. The calorific value of insects is about 5.5 calories per milligram dry weight (Golley 1961) and if birds assimilate seventy-five per cent of this energy they would gain 0.60−6.0 calories per insect or 6−60 calories per minute. (This is probably a generous estimate judging from the amount of undigested exoskeleton in the faeces of honeyeaters.)

The basal metabolic rate of a New Holland Honeyeater at 15 °C, an average afternoon temperature in winter in Adelaide, would be approximately 0.15 calories per second or nine calories per minute. (This was calculated from the formulae of Lasiewski and Dawson (1967) and from the preliminary unpublished results of Dr Baudinette of Flinders University.) This would be the rate of energy expended by a completely relaxed bird so that the amount expended by a bird in the process of hawking would be considerably higher. Wolf (1975) calculated that a sitting but alert bird uses energy at about twice the basal metabolic rate and a flying bird at about eight times this rate. If we assume that a hawking honeyeater spends half of its time sitting and half of its time flying (vertical flying, hovering and snapping is probably even more expensive than direct flight) then this value of nine calories per minute should be multiplied by five (½ x 2 + ½ x 8), which is forty-five calories per minute. Thus even when feeding on insects weighing five milligrams at a rate of one every six seconds a honeyeater would gain sixty calories, barely replacing the energy it expends. That the insects taken are usually much smaller than five milligrams suggests that insects are not taken as a source of energy but as Recher and Abbott suggest as a source of protein and probably other essential substances.

We have also estimated the reward from nectar to show that this can frequently provide a substantial surplus of energy. This study has been reported more fully elsewhere (D. C. Paton, Honours thesis, University of Adelaide, 1974) and a summary of the calorific rewards that birds obtain from some of the more important flowers they visit is given here. Feeding rates vary from about thirteen flowers per minute in the case of the large tubular flowers of *Correa* to an estimated eighty flowers per minute for the small cup-shaped flowers of *Eucalyptus fasciculosa* (the rate was too fast to count accurately but a clump of ten to fifteen flowers was visited for five to six seconds). The volume of nectar ranges from an average of two microlitres in *Epacris* to nearly twenty microlitres in *Correa.* The calorific value of each flower depends on the volume of nectar and also on the concentration, which is usually in the range of fifteen to forty per cent sucrose (or equivalent sugars) in the flowers visited by honeyeaters.

Table I gives the feeding rates, average value per flower in calories and the total energy that could be gained by a honeyeater in one minute as well as summarizing the rewards from feeding on insects. The energy gained by the birds feeding on these seven species at average volumes and concentrations of nectar ranges from 72 to 400 calories per minute. These values were calculated for the amounts of nectar available in early morning. There is considerable variation both during the day and seasonally in the volume of nectar found in flowers. To give an idea of the wide seasonal range of reward from

TABLE I

The feeding rate in items per minute (number of items timed in brackets), value per item in calories (number of items measured and numbers of days on which measured in brackets), and energy gained per minute by New Holland Honeyeaters feeding on flowers and insects.

	Season	Feeding rate per min.	Value per item cal.	Energy per min. cal.
Eucalyptus cosmophylla	Winter	35 (940)	11.6 (141–4)	400
E. leucoxylon	Win–Spr	43 (430)	8.3 (195–3)	360
Astroloma	Aut–Spr	34 (310)	10 (720–10)	340
conostephioides	April		(min) 2.1 (68)	70
	August		(max) 20.7 (80)	700
Grevillea lavandulacea	Win–Spr	35 (350)	6 (250–5)	210
E. fasciculosa	Aut–Win	80 (estd)	2.3 (330–5)	180
Correa schlechtendalii	Autumn	13.3 (81)	10.3 (254–4)	140
Epacris impressa	Winter	40 (240)	1.8 (364–4)	72
'small' insect		10 } (281)	0.6	6
'large' insect		10 }	6.0	60

one species of plant, we have given values for the minimum and maximum volumes found on any one morning for *Astroloma*. Flowering of *Astroloma* had only begun in April and was at its peak in August.

The energy expended by birds when they are collecting nectar would be about twenty-seven calories per minute in winter (3 x basal metabolic rate for foraging according to Wolf 1975) or rather less in autumn or spring. Even if we assume that only ninety per cent of the nectar is taken and assimilated, birds must almost always replace the energy they are expending and often show feeding efficiencies (energy gained divided by energy expended) of between five and ten for a range of flowers. Occasionally when the amount of nectar is initially low the birds may deplete this and it will be unprofitable to feed from flowers later in the day (Ford in preparation). It is interesting that the poorest flower, *Epacris*, is not often visited by New Holland Honeyeaters; the only honeyeater frequently seen feeding on this flower is the Eastern Spinebill *Acanthorhynchus tenuirostris*, which is both smaller and quicker at feeding (60 flowers per minute, 470 flowers timed).

Thus from these simplified calculations it would appear that a New Holland Honeyeater hawking for insects is at best barely replacing the energy it is using up whereas when it is feeding on nectar it may be gaining energy at up to ten times the rate at which it is expending it. Therefore the long-beaked honeyeaters of the genus *Phylidonyris* and very likely the larger wattlebirds (*Anthochaera*) probably gain most of their energy from nectar and their protein, perhaps at some cost, from insects. Many of the other honeyeaters especially of the genera *Meliphaga* and *Melithreptus* take most of their insects in a less expensive way from the leaves and bark of trees and are perhaps also more efficient. The feeding efficiency in a range of honeyeaters that feed on insects and nectar is now being studied more intensively. The energetics of feeding in birds that feed entirely on insects such as flycatchers should also be studied.

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