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SHORT NOTE

Retention time of beads in captive Torres imperial pigeons, *Ducula spilorrhoa spilorrhoa*

HAYLEY J MEEHAN[1]
School of Biological Sciences, Victoria University of Wellington, PO Box 600, Wellington, New Zealand
Present address: 133 Hill Road Belmont, Lower Hutt, Wellington, New Zealand
hayley_j_meehan@hotmail.com

KARL HILLYARD
Adelaide University, LSA Building, Roseworthy Campus, Adelaide, South Australia, Australia

MURRAY GUY
Adelaide Zoo, Frome Road, Adelaide, South Australia, Australia

The retention time of ingested seeds through the gut of frugivores can have important implications for seed dispersal. Theoretically, the longer the retention time, the more likely a seed is to be widely dispersed (Murray *et al.* 1994). *Ducula* pigeons are considered to be "true" frugivores and excellent seed dispersers in tropical rain forests where they occur in Asia, Australia and the Pacific (Leighton & Leighton 1983; Lambert 1989; Healey 1992; Whittaker & Turner 1994; Corlett 1998; Steadman & Freifeld 1999; McConkey & Drake 2002), although nothing is known about the retention time of the seeds they have ingested. Retention time is defined as the time from the eating of a fruit to the depositing of its seed(s) (Fukui 1996). The aim of this research was to measure the retention time of beads, as surrogate seeds, in the digestive tract of the Torres imperial pigeon *Ducula spilorrhoa spilorrhoa*.

Torres imperial pigeons migrate each year from New Guinea to northeastern and eastern Australia to breed (Goodwin 1970). In Queensland, large breeding roosts are established typically in mangroves on small offshore islands where they are relatively free from human influences (Crome 1975a,b). Pigeons breeding on these islands make daily flights to the Australian mainland to feed exclusively on fruits and berries in lowland rainforests (Crome 1975a; Frith *et al.* 1976; Frith 1982; Healy 1992). Pigeons have thin-walled gizzards and short wide guts that allow large seeds to pass intact (Cadow 1933; Lambert 1989).

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Feeding trials were conducted consecutively on 4 mature Torres imperial pigeons (weight before: pigeon 1, 423 g; pigeon 2, 451 g; pigeon 3, 443 g; pigeon 4, 463 g). Birds were transferred to a 3 m^3 cage the afternoon before their trial. There was no food in the cage from the time of transfer to when the trial started, but water was available ad libitum. At 0800 h on the morning following the transfer, each bird was presented with 10 pieces (1 cm^3) of apple, each containing a single plastic bead (4 × 3 mm), in its feeding bowl. Beads were used to simulate the retention time of seeds. The bird was allowed to feed freely for 10 min, after which the remaining experimental fruits were removed. Experimental fruits closely matched the regular diet of the captive birds, which consists of chopped apple and pear, and sultanas, peas, and banana. A closed-circuit camera system allowed the observer to view and record the time of 1st and subsequent ingestions, and the time of each defaecation or regurgitation. The cage floor was covered with white plastic to make beads in defaecations and regurgitations easy to see and count. The bird was observed continuously until all ingested beads were expelled. Retention time was calculated as the time period between ingestion and defaecation or regurgitation (Fukui 1996).

Four beads were regurgitated (each 15 min after ingestion), and 11 beads passed through the entire gut and were voided by defaecation (Fig. 1). Beads appeared in the faeces between 45 and 260 min after being ingested (median retention time 85 min; mean ± SD = 94.5 ± 59.6). Sample sizes were insufficient to compare retention times between individual pigeons.

The use of beads to simulate seeds, and testing their retention time on captive birds is a common

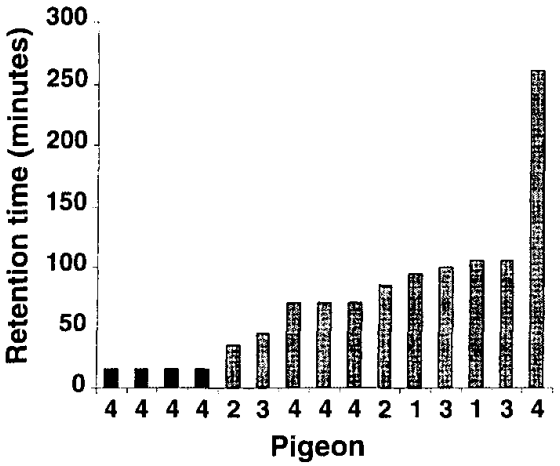

Fig. 1 Retention time of regurgitated (solid bar) and defaecated beads (shaded bars) in 4 Torres imperial pigeons (*Ducula spilorrhoa spilorrhoa*).

method (Murray *et al.* 1993; Nogales *et al.* 2001), however it may not accurately reflect true retention times of seeds in the wild, for 2 reasons. Firstly, seeds are more likely to be firmly encased in their pericarp than beads were in their experimental fruit; secondly, confinement of these pigeons may have restricted their food consumption and digestion rate relative to their wild counterparts.

The dispersal distance of a seed is a function of its retention time within its disperser and the disperser's range and rate of travel (Hoppes 1987; Fukui 1996; Westcott & Graham 2000). Wide-ranging daily disperser movement patterns from breeding islands to feeding sites on the mainland, involving return flights of up to 30 km (Crome 1975a,b; Frith *et al.* 1976; Frith 1982; Healy 1992) and the reasonably long seed retention times presented here, suggest that Torres imperial pigeons may frequently disperse seeds some distance from their sources.

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