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The effectiveness of stomach–flushing in assessing wader diets

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INTRODUCTION

Pumps that displace food by introducing water into the stomach (water–offloading) have been shown to be efficient as a non–destructive means of sampling gut contents. They have been used very successfully on fish (Meehan & Miller 1978), reptiles and amphibians (Legler & Sullivan 1979), passerine birds (Ford *et al.* 1982) and seabirds (Wilson *et al.* 1982; Ryan & Jackson 1986). This technique has apparently not been used on waders, despite the large numbers that are caught for ringing and the numerous studies that have been made of wader diets using other, often destructive, techniques.

As part of a study of the diets of waders at the Swartkops estuary (33° 52' S, 25° 38'E), South Africa (Martin 1991), a simple water–offloading technique was used to complement direct feeding observations, and the efficency of the stomach pump was evaluated.

METHODS

Birds caught in mist nets on their low tide foraging areas at night were stomach–pumped using a technique devised for passerines and described in detail by Ford *et al.* (1982). To summarize, a length of plastic tubing, 4 mm in external diameter, was passed down the oesophagus and into the stomach. The end of the tube was partially heat–sealed and rounded to prevent abrasion. Several small holes were made in the distal 15 mm of the tube. The other end of the tube was attached to a 60 ml syringe. Sufficient water was forced from the syringe to fill the bird's stomach and the bird was then smartly turned upside down and the regurgitate collected in a large beaker. It seemed to make no difference whether sea or fresh water was used. All samples were stored in 5% buffered formalin until analysed. To test the efficiency of the device, nine birds were stomach–pumped and then killed. Their oesophaguses and stomachs were removed, cut open and preserved immediately.

When analysing stomach regurgitates it is important to use a method that assesses diet independently of sample volume.

Table 1. Efficiency of the stomach flushing technique.

Species	Total food volume index	% extracted by pump
Grey Plover	50	24
	4	0
Turnstone	13	62
	12	58
	6	50
	23	35
	5	0
Curlew Sandpiper	7	71
	16	69

Table 2. Percent volumes of each prey type in the stomach-pump samples compared to the proportions remaining in the guts.

Species	Sample type	Prey type (% volume) 1	2	3	4	5
Grey) Plover (n=1)	Pump	70	25	5		
	Gut	95	5	0		
Turnstone (n=4)	Pump	10–88	0–85	5–30	0–2	0–1
	Gut	40–80	0–45	2–28	0–15	0–5
Curlew Sandpiper (n=2)	Pump	25–90	5–35	5–10	0–35	
	Gut	70–98	2–30	0	0	

Frequency of occurrence (the proportion of samples in which each prey type is found) and aggregate volume (the relative contribution, by volume, of each prey type when all samples are pooled) are suitable methods (Duffy & Jackson 1986).

Prey remains recovered using the pump were sorted into five categories. The remains in each category were placed in a petri dish and the area they covered (mm^2) was measured using 1 mm squared paper placed under the dish. Prey items remaining in the stomachs were removed, sorted and measured in the same way and the two samples were combined as an index of total food volume.

RESULTS AND DISCUSSION

The technique was used on 14 wader species up to the size of Eurasian Curlew *Numenius arquata* and African Black Oystercatcher *Haematopus moquini*. A 3 mm diameter tube would have been better for birds as small as Little Stint *Calidris minuta*. Of the 214 individuals handled, samples were obtained from 172 (80%); there was one casualty (a Curlew Sandpiper *Calidris ferruginea*).

With the exception of two birds, whose stomachs proved to be almost empty, between 24% and 71% (median = 58%) of the gut contents were recovered with a single application of the pump (Table 1). Duffy & Jackson (1986) found that repeated applications often ensured the total clearance of seabird stomachs. Except for the two samples mentioned above, no additional prey species were found in the guts that had not been collected by the pump. The range in the proportions of each of five prey types in the pump samples were similar overall to the proportions remaining in the guts, although there was considerable variation within prey types (Table 2).

We conclude that the water-offloading technique provided sound data on the prey types present in the guts of waders and that the samples were sufficiently representative of the gut contents to provide a good indication of the relative importance of each prey type in the diet. The technique is sufficiently simple to undertake during normal ringing operations and is unsuccessful only if the stomach is nearly empty. As in all dietary studies based on gut contents, the contribution of prey types with a long residence time in the stomach will be over-estimated (Goss-Custard 1983).

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