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Stomach Pumping: Is Killing Seabirds Necessary?

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Many seabird species regurgitate when handled,
allowing diet assessment without killing birds (e.g.
see Ashmole and Ashmole 1967, Harrison et al. 1983).
Other seabirds, notably penguins (Wilson 1984) and
petrels away from their breeding grounds (Harrison
et al. 1983, pers. obs.), are less willing to regurgitate.
A quantitative, but nonlethal, sampling technique is
needed for diet studies on these seabirds, particularly
in view of the growing opposition toward the killing
of animals for biological research.

Emetics and stomach pumps have been used to ob-
tain stomach contents from seabirds, but results have
been unsatisfactory (Wilson 1984, Duffy and Jackson
MS). Wilson (1984) described a simple technique for
sampling stomach contents in seabirds, but it has been
suggested that it does not always recover the entire
stomach contents (Lishman 1985; but see Horne 1985)
and is less effective on birds that have full stomachs
with tightly packed contents (Lishman 1985). We
tested the efficiency of Wilson's stomach pump on
four species of petrel and review its use in other birds.

Seven White-chinned Petrels (*Procellaria aequinoc-
tialis*) (mean mass 1,250 g) from Marion Island (46°52'S,
37°51'E) each were fed a large meal (125 g) of squid
(*Loligo* sp.), lightfish (*Maurolicus muelleri*), and antarc-
tic krill (*Euphausia superba*) in equal proportions, then

pumped and killed after varying intervals. The
amount (mass and number of prey items) of food
recovered by stomach pumping was expressed as a
proportion of the total stomach contents (determined
by dissecting out the oesophagus and proventricu-
lus) and compared with the total stomach contents.
In addition, single Cape Petrels (*Daption capense*), Sal-
vin's Prions (*Pachyptila vittata salvini*), and Wilson's
Storm-Petrels (*Oceanites oceanicus*) were collected at
sea off southern Africa, then similarly tested.

Mean pump efficiency (the proportion of food re-
covered by a single pumping) was 89.2% (SD = 13.3)
by mass and 99.1% (SD = 2.0) by number of prey items
($n = 10$). The proportion of food (by mass) recovered
by a single pumping was negatively correlated with
total stomach content mass in the 7 White-chinned
Petrels examined (Fig. 1; $r = -0.85$, $P < 0.01$ on arc-
sine transformed data). The proportion of prey items
recovered was also negatively correlated with the to-
tal number of items present ($r = -0.67$, $P < 0.05$, $n =$
10). Approximately equal masses and numbers of the
three prey types were recovered, irrespective of
stomach fullness. When stomachs were less than 20%
full, the entire contents were removed by a single
pumping. The three other petrel species tested all
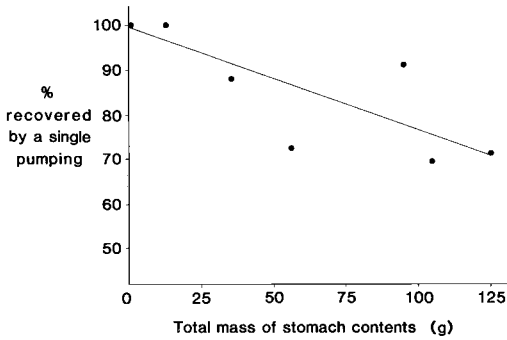yielded 100% of their stomach contents.

Fig. 1. Stomach pump efficiency as a function of stomach fullness in White-chinned Petrels.

The contents of the petrels' gizzards (ventriculi) were not removed by the pumping technique. This is apparently due to the narrow, U-shaped isthmus between the proventriculus and gizzard in petrels (McLelland 1979). This is not a major disadvantage, because the gizzard seldom contains fresh food items in petrels. Gizzard samples introduce a bias toward resistant prey remains (Furness et al. 1984). The only way to sample petrel gizzard contents accurately is to kill the birds (Furness 1985). In other seabird groups (e.g. Sphenisciformes, Pelecaniformes, Charadriiformes, and to some extent Diomedeidae) the gizzard is less clearly separated from the proventriculus, and its contents may be sampled by the pumping technique.

The high proportion of stomach contents recovered both by mass and by number of prey items indicates the usefulness of the stomach pump in seabird diet studies. Pumping birds that regurgitate when handled ensures that all the stomach contents are removed. If a bird is pumped twice, the entire stomach contents should be removed, even if the stomach is full and tightly packed with food. More than 60 Adélie (*Pygoscelis adeliae*), Chinstrap (*P. antarctica*), and Gentoo (*P. papua*) penguins with stomachs full of crustacean prey have been emptied completely by successive pumping (W. Z. Trivelpiece in litt.), contrary to the objections of Lishman (1985). The technique was tested by killing the first five penguins sampled and was found to be 100% efficient.

The overall efficiency of Wilson's stomach pump is to a large extent dependent on the experience of the operator. Workers without adequate training in the technique are unlikely to obtain representative samples at first. The advantages accruing from the pump's use, however, are great. More than 2,500 seabirds from 24 species (including penguins, albatrosses, petrels,

skuas, gulls, and terns) have been pumped with only 1 known mortality, which was due to worker incompetence (FitzPatrick Inst. unpubl. data). Many birds have been sampled repeatedly with no apparent ill effects (R. P. Wilson pers. comm.). Simple modifications using narrower catheter tubes and a syringe as a pump have enabled its successful use on small seabirds such as storm-petrels and diving petrels and other bird groups including waders (Charadrii) (G. D. La Cock pers. comm.). We recommend the use of Wilson's stomach pump as an effective and efficient, nonlethal sampling technique for determining bird diets. Birds should be pumped twice to ensure that the entire stomach contents are removed.

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