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- L. S. DAVIS, *Department of Zoology, University of Otago, P. O. Box 56, Dunedin*; G. D. WARD and R. M. F. S. SADLEIR<sup>1</sup>, *Ecology Division, DSIR, Private Bag, Lower Hutt.*
- <sup>1</sup>Present Address: *Department of Conservation, P.O. Box 10420, Wellington.*



## SHORT NOTE

### Diet of Adélie Penguins during the Incubation Period at Cape Bird, Ross Island, Antarctica

The food of the Adélie Penguin (*Pygoscelis adeliae*) has been examined at only a few localities — at Cape Crozier, Ross Island, Beaufort Island, and Franklin Island (Emison 1968), at Signy Island, South Orkney Islands (Lishman 1985, White & Conroy 1975) and at King George Island, South Shetland Islands (Volkman *et al.* 1980). Although euphausiids comprise the largest proportion of the diet by numbers and by weight at all localities sampled, on the islands of the Antarctic Peninsula *Euphausia superba* were taken, whereas at Cape Crozier, Beaufort Island and Franklin Island *E. crystallorophias* formed the bulk of the diet of parents feeding chicks.

Information on the diet of Adélies on Ross Island during the incubation period is scarce, although 10 of the 37 complete samples taken by Emison (1968) were obtained from incubating birds towards the end of the incubation period. Foraging trips during the incubation period can last up to 2 weeks or more; the female taking the first foraging trip after laying the eggs and, after 2 weeks, returning to relieve the male, which takes the second foraging trip. In this study I collected stomach contents from Adélie Penguins returning from the first and second foraging trips during the incubation period.

At Cape Bird, Ross Island, over a period of 3 weeks (18 November-8 December 1985), I captured penguins as they returned to the rookery from a foraging trip. I collected the stomach contents from 16 birds by the water off-loading technique (Wilson 1984).

Two flushes were adequate to empty the stomach of its contents. I then shook each regurgitation until it was homogeneous and removed a 500 mL sample. I identified euphausiids from Emison's (1968) description, counted euphausiid eyes in each sample and calculated the total number of euphausiids in the stomach content by measuring the total volume of fluid. The entire regurgitation was sorted for amphipods, fish otoliths and any other remains.

Of the 16 stomach contents, 14 contained euphausiids, *E. crystallorophias* comprising 77.8-100% (average 97.3%) of the total number of prey items (Table 1). Amphipods were present in low numbers in 12 out of the 16 stomach contents, including two stomachs in which they were the only prey organisms present. *E. crystallorophias*, then, comprised on average 85% of the total number of prey items from all 16 stomachs. Numbers of *E. crystallorophias* varied from 276 to 41 938 per stomach, although in only one case did numbers exceed 4500. Lengths ranged 21-29 mm, indicating that adult *E. crystallorophias* were being ingested.

TABLE 1 — Composition of stomach contents from 16 Adélie Penguins during the incubation period.

(1985)	<i>E. crystallorophias</i>	% <i>E. crystallorophias</i>	Amphipod Species 1	Amphipod Species 2	Fish otoliths	Decapods	<i>E. superba</i>
18-11	285	100	-	-	-	-	-
18-11	-	-	-	35	-	-	-
20-11	1030	94.3	-	63	-	-	-
20-11	815	99.9	1	-	-	-	-
21-11	1420	99.8	-	1	-	2	-
22-11	577	100	-	-	-	-	-
22-11	563	100	-	-	-	-	-
25-11	565	100	-	-	-	-	-
25-11	4490	99.6	18	2	-	-	-
29-11	1012	99.5	5	-	-	-	-
29-11	41938	99.9	9	9	-	-	1
1-12	-	-	20	-	-	-	-
1-12	480	95.4	23	-	-	-	-
4-12	1827	97.4	42	5	-	-	2
7-12	973	77.8	3	275	-	-	-
8-12	276	97.9	6	-	1	-	-

In the 10 stomachs that Emison (1968) collected from incubating birds in the first two weeks of December, an average of 1389 food organisms were found, of which about 95% can be assumed to have been euphausiids because Emison lumped these samples together with others collected during that time from chick-feeding birds. In my study, if the stomach containing 41 938 prey items is excluded, the remaining 15 stomachs contained a

mean of  $988 \pm 1067$  prey items. This value is similar to Emison's, although in my study more stomachs containing very low numbers of prey items were found and euphausiids comprised a slightly smaller proportion of the total number of prey items taken. While Emison found that fish made up a portion of his samples, only one fish otolith was recovered in this study. This could indicate a different feeding range or increased availability of fish later in the season. It could also be a consequence of sampling from a slightly different location on Ross Island. Two crabs and three *E. superba* were also found.

The maximum count of 41 938 individuals per stomach far exceeds Emison's maximum value of 12 500 from one stomach and his average value of 5300 food items from 37 samples, and it may have been the result of several days of feeding. However, if length-weight equations calculated for *E. superba* (Lockyer 1973) are applied to *E. crystallorophias* to gain an approximation of the weight of food that such a large number of individuals would represent, then 42 000 individuals of an average length of 25 mm, assuming a 50:50 ratio of males to females, would amount to about 3800 g of krill. This is not an impossibly large value and may be the result of no more than two days of foraging. Digestion rates of euphausiids have not yet been determined in penguins, and so it is impossible to calculate how many days of feeding so many pairs of eyes would represent, but observations made on the digestion of fish in the Yellow-eyed Penguin indicate that all hard parts are digested within 24 hours of ingestion (pers. obs.).

The marked preponderance of *E. crystallorophias* in the diet, with occasional *E. superba* and some amphipods, is very similar to the diet during the chick-feeding period described by Emison (1968) at Cape Crozier, Beaufort Island, and from one sample collected from Franklin Island. He found that at Cape Crozier 94.6% and 91.5% of the diet, numerically, was made up of euphausiids (>99% *E. crystallorophias* and <1% *E. superba*) in the 1964-65 and the 1965-66 seasons respectively. *E. crystallorophias* has been described by Marr (1962) as occurring almost exclusively in the shelf water of the Ross Sea region, which is cold to the bottom. The absence of *E. superba* from the greater part of the shelf water was attributed by Marr to the failure of the warm deep current carrying *E. superba* larvae to penetrate more than a short distance on to the shelf.

The results of the radio-tracking study on Adélie Penguins carried out at the same time as the stomach sampling at Cape Bird (Davis *et al.*, this issue) indicate that birds were travelling long distances while on foraging trips during the incubation period, i.e. at least 100 km. The contents of the stomachs collected in this study probably represented only what had been ingested within 24-48 hours before capture. However, with the large distances covered during 2-week long foraging trips, the penguins could possibly take other foods or, alternatively, similar prey but in different proportions, during a large part of the foraging trip.

The results from this study show that *E. crystallorophias* is at least an important food item in the diet of Adélie Penguins foraging within a few days of travelling and foraging from Cape Bird during the incubation period. They provide further evidence that the diet of Adélie Penguins in the Ross Sea region may be fundamentally different from that of penguins on the Antarctic Peninsula in terms of the species of euphausiids they feed on.

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YOLANDA VAN HEEZIK, *Department of Zoology, University of Otago, P.O. Box 56, Dunedin*