DIET OF THE SNOW PETREL *PAGODROMA NIVEA* AT LAURIE ISLAND, ANTARCTICA, DURING THE 1997/98 BREEDING SEASON

VANINA FERRETTI[1], GUILLERMO E. SOAVE[2], RICARDO CASAUX[1] & NESTOR R. CORIA[1]

[1]Departamento de Ciencias Biológicas, Instituto Antártico Argentino, Cerrito 1248, 1010 Buenos Aires, Argentina
(vanini71@yahoo.com)
[2]Departamento Científico Zoología Vertebrados, Museo de Ciencias Naturales, Paseo del Bosque s/n,
1900 La Plata, Argentina

Received 1 November 2000, accepted 29 June 2001

SUMMARY

FERRETTI, V., SOAVE, G.E., CASAUX, R. & CORIA, N.R. 2001. Diet of the Snow Petrel *Pagodroma nivea* at Laurie Island, Antarctica, during the 1997/98 breeding season. *Marine Ornithology* 29: 71–73.

The diet of the Snow Petrel *Pagodroma nivea* was investigated at Laurie Island, South Orkney Islands, Antarctica, during the period January–February 1998. Stomach contents and regurgitates of adults were sampled during the chick-rearing period. Fish, followed by Antarctic Krill *Euphausia superba*, were the main prey throughout the sampling period. Other crustaceans and cephalopods were scarcely represented. Among fish, myctophids dominated in the diet, *Electrona antarctica* being the most important prey.

Keywords: Snow Petrel, *Pagodroma nivea,* Antartica, diet

INTRODUCTION

The Snow Petrel *Pagodroma nivea* is endemic to Antarctica and the surrounding archipelagos with a circum-Antarctic distribution (Harrison 1983). The minimum population estimated for 108 of 195 breeding localities is approximately 63 000 pairs, although counts of birds at sea (Ainley *et al*. 1984, Cooper & Woehler 1994) suggest that the world population must be in the order of several million birds (Croxall *et al.* 1995).

Despite the wide distribution and the size of the population of the Snow Petrel, information on feeding ecology during the breeding season is scarce, and is limited to two localities (Ridoux & Offredo 1989, van Franeker & Williams 1992, van Franeker *et al*. 2001). Moreover, the diet of this fulmarine petrel in the western sector of Antarctica is still unknown. The aim of this study is provide preliminary information on the diet of breeding Snow Petrels from an unstudied site at the South Orkney Islands.

METHODS

The diet of the Snow Petrel on the eastern coast of the Mossman Peninsula (50 breeding pairs, N.R. Coria unpubl. data), Laurie Island, South Orkney Islands (60°46'S, 44°42'W)**,** was studied by the analysis of stomach contents and regurgitations collected from 10 January to 12 February 1998 (early chick-brooding to early chick-fledging periods). Snow Petrels arrive at the coast in September, eggs are laid in November/December and chicks hatch during early January. Sixteen stomach contents were obtained from adult individuals returning from foraging trips to feed their chicks by applying the stomach-flushing technique (Wilson 1984). Birds were flushed repeatedly (two to three times) until no more food was obtained. The number of samples obtained was limited by the scattered distribution of the nests and difficulties of access. When Snow Petrels were approached as close as one metre before flushing they usually regurgitated oil and food material. These regurgitations were collected using a funnel (18-cm diameter) mounted on a stick, which was held below the birds' bills, the material being retained in polythene bags tied to the neck of the funnel. Regurgitations and flushed stomach contents were then combined, drained and analyzed immediately.

At the laboratory the samples were washed through sieves of 0.50 mm mesh, blotted dry and weighed to the nearest 0.1 g. The contents were identified and sorted into prey classes using a binocular stereo microscope and then weighed. The numbers of individuals belonging to each prey taxa represented in the samples were estimated by counting intact specimens or undigested prey remains (e.g. krill eyes, fish and squid eye-lenses and otoliths). The minimum number of fish represented in the samples was determined by counting eye lenses or otoliths. The otoliths recovered from the samples were assigned to species using illustrations and descriptions in Hecht (1987) and Williams & McEldowney (1990) and by comparison with our own reference collection. The otoliths belonging to each species were sorted into right and left, the most abundant being considered as the number of individuals from that species present in the samples. The length and mass of the individuals identified were estimated from otolith length using equations in Hecht (1987) and Williams & McEldowney (1990).

RESULTS

The mean mass of the samples was 9.4 g (SD 9.4, range 1–30.5 g) which contained an average of 9.9 prey specimens (SD 8.3, range 1–26).

Fish, followed by the Antarctic Krill *Euphausia superba*, were the main prey throughout the sampling period (Table 1). Intact krill individuals were not found in the samples and so were not measured. Other crustaceans, such as the hyperiid *Themisto gaudichaudii* and unidentified lysianasiids, and squid were scarcely represented. Squid remains were not assigned to species because no intact diagnostic fragments were found.

TABLE 1

Composition of the diet of the Snow Petrel *Pagodroma nivea* at Laurie Island, South Orkney Islands as reflected by analysis of stomach contents and regurgitations collected during the 1997/98 breeding season (n = 16). Frequency of occurrence per cent (F%), importance by number (N%) and mass (M%) per cent

	Fish	Krill	Other crustaceans	Squid
F%	93.8	81.3	56.3	6.3
N%	53.2	36.1	10.1	0.6
M%	90.3	8.3	1.4	t

t = trace

TABLE 2

Fish represented in the diet of the Snow Petrel *Pagodroma nivea nivea* at Laurie Island, South Orkney Islands as reflected by analysis of stomach contents and regurgitations collected during the 1997/98 breeding season. Frequency of occurrence per cent (F%), importance by number (N%) and by drained mass per cent (M%)

Species	No.	F%	N%	M%
Myctophidae				
Electrona antarctica	45	100	95.8	86.6
Gymnoscopelus opisthopterus	1	6.3	2.1	9.1
Bathylagidae				
Bathylagus glacialis	1	6.3	2.1	4.3

Otoliths were present in 67% of the samples containing prey remains and represented 61 fish; 47 of them were identified as *Electrona antarctica*, *Gymnoscopelus opisthopterus* and *Bathylagus glacialis* and 14 remained unidentified. Among fish, myctophids dominated the diet, *E. antarctica* being the main prey (Table 2). The estimated size of the fish ingested ranged from 35–107 mm (0.6–12.1 g); the smallest and largest specimens belonged to *E. antarctica* and *G. opisthopterus*, respectively (Table 3).

DISCUSSION

Our results are similar to those reported in previous studies of the diet of the Snow Petrel during the chick-rearing period when fish, followed by krill, constituted the bulk of the diet (Ridoux & Offredo 1989, van Franeker & Williams 1992, van Franeker *et al*. 2001). In comparison, during the non-breeding period this petrel preys more frequently on squid (Bierman & Voous 1950, recalculated by Ainley *et al.* 1984, Griffiths 1983, Ainley *et al.* 1991). Although frequently occurring in the samples in comparison to fish, Antarctic Krill was scarcely represented by number and mass.

As reported by Ainley *et al.* (1991) for the Weddell-Scotia Confluence region during the austral autumn, winter and spring, *E. antarctica* was the dominant fish in the diet of the Snow Petrel at Laurie Island. Conversely, van Franeker & Williams (1992) and van Franeker *et al*. (2001) observed that during the 1984/85, 1986/87 and 1990/91 breeding seasons at Windmill Islands *Pleuragramma antarcticum* was the most important fish prey by mass. Ridoux & Offredo (1989) were not able to determine the fish species consumed by the Snow Petrel, which prevents a comparison with our study.

Although the impact of predators on myctophid fish populations in the Antarctic ecosystems is not well understood (Koslov 1995), in coincidence with our findings several studies indicated that these fish play an important role in the diet of several top predators not only during the breeding season (Williams 1988, Green *et al.* 1989, Casaux *et al.* 1998) but also throughout the annual cycle (Ainley *et al*. 1991, Green *et al.* 1991, Daneri & Coria 1994). There are no collateral data on the availability of *E. antarctica* around the South Orkney Islands but their importance as prey reported in this and other studies (Ainley *et al.* 1991, Daneri &

TABLE 3

Size (mean±standard deviation; range in parentheses) of the fish represented in the diet of the Snow Petrel *Pagodroma nivea* at Laurie Island, South Orkney Islands during the 1997/98 breeding season

Species	No.	Length (mm)	Mass (g)
Electrona antarctica	45	57.7±9.4 (35.3–72.7)	2.7±1.2 (0.6–5.1)
Gymnoscopelus opisthopterus	1	107.1	12.1
Bathylagus glacialis	1	90.0	6.1

Coria 1994, Coria *et al.* 1997, Casaux *et al.* 1998, Ferretti 1998) seems to indicate that this fish is abundant and well distributed in waters adjacent to this archipelago.

ACKNOWLEDGEMENTS

This research was supported by the Instituto Antártico Argentino and was conducted within the framework of Protocols for Collaboration between IAA and the Departamento Científico Zoología Vertebrados of the Universidad Nacional de La Plata. G.E. Soave participated in the research as personnel of the Comisión de Investigaciones Científicas de la Provincia de Buenos Aires (CIC), under the direction of Hugo L. López. We are grateful to J.A. van Franeker and an anonymous referee for helpful comments on the manuscript.

REFERENCES

AINLEY, D.G., FRASER, W.R., SMITH, Jr, W.O., HOPKINS, T.L. & TORRES, J.J. 1991. The structure of upper level pelagic food webs in the Antarctic: effect of phytoplankton distribution. *Journal of Marine Systems* 2: 111–122.

AINLEY, D.G., O'CONNOR, E.F. & BOEKELHEIDE, R.J. 1984. The marine ecology of birds in the Ross Sea, Antarctica. *Ornithogical Monographs* 32: 1–97.

BIERMAN, W.H & VOOUS, K.H. 1950. Birds observed and collected during the whaling expeditions of the Willem Barendsz in the Antarctic, 1946–47 and 1947–48. *Ardea* 37, extra number: 1–132.

CASAUX, R., SOAVE, G.E. & CORIA, N.R. 1998. Lanternfish (Myctophidae) in the diet of the Cape Petrel *Daption capense* at the South Shetland and South Orkney Islands, Antarctica. *Polar Biology* 20: 364–366.

COOPER, J. & WOEHLER, E.J. 1994. Consumption of Antarctic Krill (*Euphausia superba*) by seabirds during summer in the Prydz Bay region, Antarctica. In: El-Sayed, S.Z. (Ed.). Southern Ocean ecology: the BIOMASS perspective. Cambridge: Cambridge University Press. pp. 247–260.

CORIA, N.R., SOAVE, G.E. & MONTALTI, D. 1997. Diet of the Cape Petrel *Daption capense* during the post-hatching period at Laurie Island, South Orkney Islands, Antarctica. *Polar Biology* 18: 236–239.

CROXALL, J.P., STEELE, W.K, MC INNES, S.J. & PRINCE, P.A. 1995. Breeding distribution of the Snow Petrel *Pagodroma nivea*. *Marine Ornithology* 23: 69–99.

DANERI, G.A. & CORIA, N.R. 1994. Fish prey of Antarctic Fur Seals, *Arctocephalus gazella*, during the summer–autumn period at Laurie Island, South Orkney Islands. *Polar Biology* 13: 287–289.

FERRETTI, V. 1998. Estudio comparado de la dieta del Pinguino barbijo *Pygoscelis antarctica* y el Petrel damero *Daption capense* en la Isla Laurie, Orcadas del Sur, Antártida. Thesis. Universidad CAECE, Buenos Aires.

GREEN, K., BURTON, H.R. & WILLIAMS, R. 1989. The diet of Antarctic Fur Seals *Arctocephalus gazella* during the breeding season at Heard Island. *Antarctic Science* 1: 317–324.

GREEN, K., WILLIAMS, R. & BURTON, H.R. 1991. The diet of Antarctic Fur Seals *Arctocephalus gazella* (Peters) during the late autumn and early winter around Heard Island. *Antarctic Science* 3: 359–361.

GRIFFITHS, A.M. 1983. Factors affecting the distribution of the Snow Petrel (*Pagodroma nivea*) and Antarctic Petrel (*Thalassoica antarctica*). *Ardea* 71: 145–150.

HARRISON, P. 1983. Seabirds. An identification guide. Beckenham: Croom Helm.

HECHT, T. 1987. A guide to the otoliths of Southern Ocean fishes. *South African Journal of Antarctic Research* 17: 1–87.

KOSLOV, A.N. 1995. A review of the trophic role of mesopelagic fish of the family Myctophidae in the Southern Ocean ecosystem. *CCAMLR Science* 2: 71–77.

RIDOUX, V. & OFFREDO, C. 1989. The diets of five summer breeding seabirds in Adélie Land, Antarctica. *Polar Biology* 9: 137–145.

VAN FRANEKER, J.A. & WILLIAMS, R. 1992. Diet of fulmarine petrels in the Windmill Islands, Wilkes Land, Antarctica. Preliminary results. *Circumpolar Journal* 7: 134–138.

VAN FRANEKER, J.A., WILLIAMS, R., IMBER, M.J. & WOLFF, W.J. 2001. Diet and foraging ecology of Southern Fulmar *Fulmarus glacialoides*, Antarctic Petrel *Thalassoica antarctica*, Cape Petrel *Daption capense* and Snow Petrels *Pagodroma nivea* ssp. on Ardery Island, Wilkes Land, Antarctica. In: Van Franeker, J.A. Mirrors in ice. Fulmarine petrels and Antarctic ecosystems. PhD Thesis, University of Groningen, The Netherlands: Alterra. Chapter 11.

WILLIAMS, R. & Mc ELDOWNEY, A. 1990. A guide to the fish otoliths from waters off the Australian Antarctic Territory, Heard and Macquarie Islands. ANARE *Research Notes* 75: 1–173.

WILSON, R.P. 1984. An improved stomach pump for penguins and others seabirds. *Journal of Field Ornithology* 55: 109–112.