

DIET OF THE MACQUARIE ISLAND CORMORANT *Phalacrocorax atriceps purpurascens*

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The diet of the Macquarie Island Cormorant *Phalacrocorax atriceps purpurascens* was investigated through examination of regurgitated casts. Fish remains occurred in all of 64 casts with the next major food items (either primarily ingested by the cormorants or their fish prey) being crustaceans (17.2%), gastropods (7.8%) and polychaetes (4.7%). Plant material, mainly algae, occurred in 32.8 per cent of casts. There has been little temporal change in the diet of *P. a. purpurascens* at Macquarie Island, but polystyrene beads were recorded in five of 64 casts, which is in contrast to the lack of any ingested plastic recorded for the same subspecies in the 1970s. There are important geographical differences in diet among subspecies of *P. atriceps*.

INTRODUCTION

The current taxonomic status of the *Phalacrocorax atriceps* group is confused but many authors recognize eight subspecies (Harrison 1983). There have been few studies of the differences in the diets among the subspecies, but the group as a whole is thought to be largely piscivorous throughout its range (Espitalier-noel *et al.* 1988), although recent studies suggest that some subspecies do not follow this pattern (Green *et al.* 1990). It is possible that there may be geographical or temporal differences in diet, as elsewhere in the Southern Ocean spatial and temporal differences in diet have been demonstrated within a single species (Puddicombe and Johnstone 1988; Green and Johnstone 1988).

Phalacrocorax a. purpurascens is endemic to Macquarie Island. The present study investigates the diet of this subspecies through examination of regurgitated casts in order to examine any differences in the diet since the mid 1970s (Brothers 1985) and to compare these data with those from *P. a. nivalis* at Heard Island (Green *et al.* 1990).

METHODS

Regurgitated casts were collected at Handspike Point, Macquarie Island (54°30'S, 158°57'E) in March 1989. Casts were frozen in a plastic bag and were separated on return to Australia. Casts were broken open in water and sorted beneath a dissecting microscope. Fish otoliths, vertebrae, polychaete mouthparts, crustacean remains and cephalopod beaks were removed for further identification and measurement.

RESULTS

A total of 64 regurgitated casts was collected. All 64 contained fish remains with the next major food items (either primarily ingested by the cormorants or their fish prey) being crustaceans and gastropods. Crustacean remains were found in 17.2 per cent, and gastropods in 7.8 per cent of casts. Polychaete mouthparts were identified from less than 5 per cent of casts. Plant material, mainly algae, occurred in 32.8 of casts (Table 1).

Most fish otoliths were too eroded for specific identification but most (about 64%) belonged to the Notothenioidei. The fish identified were *Notothenia rossii*, *Paranotothenia magellanica*, *Dissostichus eleginoides*, *Paradiplospinus* sp., *Muraenolepis* sp., *Harpagifer* sp., and *Gymnoscopelus nicholsi* (Table 2).

DISCUSSION

Espitalier-noel *et al.* (1988) concluded that *P. atriceps* was largely piscivorous throughout its range, and the diet has been summarized by Harper *et al.* (1985) as usually fish, together with cephalopods, amphipods and molluscs. There have, however, been few studies of the diet of any subspecies of *P. atriceps*, and most of these have concentrated on *P. a. melanogenis* from Marion Island, and *P. a. nivalis* from Heard Island. The diet of the Marion Island subspecies was reported as being largely piscivorous (Blankley 1981; Espitalier-noel *et al.* 1988).

Early reports on the diet of the Heard Island Cormorant also suggested a piscivorous diet (Falla 1937; Downes *et al.* 1959). However, a recent, more comprehensive investigation into the diet of *P. a. nivalis* revealed that polychaetes were the most common component of the diet with fish and gastropods being less common (Green *et al.* 1990). This study also revealed there to be marked differences in diet between breeding colonies at the western end of Heard Island and the roost sites at the eastern end. The only dietary information available for the Macquarie Island Cormorant *P. a. purpurascens* also suggested a piscivorous diet (Brothers 1985). The results presented here for the Macquarie Island Cormorant are similar to those of Brothers (1985), although the present study reports the presence of polychaetes in the diet at Macquarie Island for the first time.

TABLE 1

Frequency of occurrence (%) of remains of prey items and non-prey material in the casts of Macquarie Island and Heard Island Cormorants collected at breeding colonies.

Prey	Macquarie Island 1988/89	Heard Island 1987/88
Fish	100.0	100.0
(Skate	1.6	0.0)
Gastropod	7.8	68.2
Other Mollusc	15.6	0.0
Isopod	0.0	4.5
Other Crustacean	17.2	0.0
Polychaete	4.7	95.5
Parasites	18.8	31.8
Vegetable matter	32.8	0.0
Polystyrene	7.8	0.0
Unidentified	0.0	9.1
Sample size	64	22

TABLE 2

Species of fishes identified from otoliths in pellets of Cormorants at Macquarie Island and Heard Island as a percentage of the total number of otoliths.

	Macquarie Island 1988/89	Heard Island 1987/88
Nototheniidae		
<i>N. acuta/N. mizops</i>		4.9
<i>N. rossii</i>	0.6	
<i>N. cyanobrancha</i>		15.1
<i>P. magellanica</i>	7.2	0.6
<i>D. eleginoides</i>	0.4	
Harpagiferidae		
<i>Harpagifer</i> sp.	33.5	7.4
unidentified Notothenioidei	55.5	67.9
sub total	97.2	95.9
Muraenolepididae		
<i>Muraenolepis</i> sp.	0.8	3.4
Myctophidae		
<i>Gymnoscopelus nicholsi</i>	0.2	
Gempylidae		
<i>Paradiplospinus</i>	0.4	
Unidentified	1.5	0.6
Sample Size	1 130	324

Brothers (1985) reported that *Harpagifer* sp. made up 8.3 per cent and nototheniids 91.7 per cent of the fish diet by weight. With *Harpagifer* sp. weighing on average 3.4 g and nototheniids 26.5 g (Brothers 1985) the percentage by numbers would be approximately 42 and 58. In the present study, 33.5 per cent of otoliths were from *Harpagifer* sp. and 63.7 per cent were from other Notothenioidei, although some unidentified *Harpagifer* sp. may be among these. Brothers (1985) was able to identify four fish species in the diet compared to seven species recorded here. The greater diversity of fish species found in casts from 1989 may reflect a shift in the diet but also may reflect differences in sampling technique. Brothers (1985) examined stomach regurgitations and found a mean mass of stomach contents of 77 g. In the present study a mean of 17.6 otoliths per cast was recorded which, based on the mass of fish from different taxa taken by Macquarie Island Cormorants (Brothers 1985), represents approximately 159 g of fish prey. Although these figures are only a rough guide, at a food intake of 0.45 kg/day (Brothers 1985), a cast would represent a minimum one-third of a full day's intake, and with the heavy erosion leading to loss of some otoliths

could conceivably represent close to a full day's intake. Thus, the greater diversity of fish species recorded in the present study may be simply a result of larger sample size, particularly as the additional species are taken uncommonly by cormorants (Table 2).

It is in the minor prey species that the main differences in the diet occur. Brothers (1985) only recorded fish in the regurgitations he collected from Macquarie Island Cormorants. Whereas some of the minor items reported here, such as gastropods and crustaceans, may have been ingested with their fish predators, evidence from *P. a. nivalis* suggests that polychaetes can be an important prey, with material in one cast from Heard Island representing a minimum of 465 polychaetes (Green *et al.* 1990). The numbers of polychaetes taken at Macquarie Island were far lower, and at the time of this study, did not appear to be a major food source (Table 1).

The diet of the Macquarie Island Cormorant *P. a. purpurascens* appears to be similar to *P. a. melanogenis* at Marion Island in that it is largely piscivorous with smaller contributions from polychaetes and molluscs (Harper *et al.* 1985; Espitalier-noel *et al.* 1988). However, there were major differences between the diets of *P. a. purpurascens* at Macquarie Island, and *P. a. nivalis* at Heard Island. The diet at Heard Island was unusual for cormorants in the amount of polychaete material taken, whereas at Macquarie Island, polychaete mouthparts occurred in less than 5 per cent of casts. Gastropods were also less commonly found in casts at Macquarie Island, occurring in 7.8 per cent of casts compared to 68.2 per cent at Heard Island. A difference in the benthic substratum was probably responsible for the greater amount of plant material (mainly algae) in casts from Macquarie Island where 33 per cent of casts contained plant material compared with none at Heard Island (Table 1)

Polystyrene beads (a result of breakdown of expanded polystyrene material) were recorded in five of 64 casts. This is in marked contrast to the contents of over 400 casts of *P. a. nivalis* from Heard Island which showed no evidence of plastic

ingestion (Green *et al.* 1990). It is also in contrast to the lack of any plastic pollution recorded by Brothers (1985) for the 1970s. These differences may have important implications for the study of plastic ingestion by seabirds in the Southern Ocean.

This study shows that, apart from a minor presence of polychaetes in 1988/89, there has been little temporal change in the diet of *P. a. purpurascens* at Macquarie Island. However, variation in the diet among the widely separated subspecies of *P. atriceps* can be marked and this is illustrated here with important differences in the diets of *P. a. purpurascens* and *P. a. nivalis*. Full details of the study of the diet of *P. a. nivalis* will be published elsewhere.

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