FISHES IN THE DIET OF THE IMPERIAL CORMORANT *PHALACROCORAX ATRICEPS* AT PUNTA LOBERÍA CHUBUT, ARGENTINA

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SUMMARY

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The diet of the Imperial Cormorant *Phalacrocorax atriceps* was studied from 43 whole stomachs obtained at Punta Lobería, Chubut, Argentina, with special emphasis on the fishes consumed. Eleven teleost and one agnathan species, and various invertebrates (crustaceans, cephalopods, polychaetes, gastropods and echiurids, in that order) were identified. *Tripterygion cunninghami*, besides being the most frequently occurring species, was numerically also the best represented (up to 70 specimens in one stomach), with a mean number of 17 specimens per stomach, followed by the anchovy *Engraulis anchoita* and *Raneya brasiliensis.* Other fish species were much more poorly represented, both in terms of frequency of occurrence and relative abundance. The mean number of fish species per stomach was 2.7.

INTRODUCTION

The Imperial Cormorant *Phalacrocorax atriceps* (both "*atriceps*" and "*albiventer*" colour morphs, *sensu* Rasmussen 1991) is one of several cormorants breeding along the southern coast of South America. Some biological aspects of the species have been described (Murphy 1936, Malacalza l984, Siegel-Causey 1986, Malacalza & Hall 1988, Malacalza *et al*. 1994), but information on diet is scarce (Punta *et al*. 1993, Malacalza *et al*. 1994), the latter paper referring to *P. atriceps* as *P. albiventer*. The study of a collection of 43 whole stomachs, obtained in the early 1980s at Punta Lobería, Chubut, Argentina, offered an opportunity to add to the knowledge of the species' diet.

METHODS

Forty-three whole stomachs of the Imperial Cormorant, obtained by taxidermists in 1981, before the breeding season, at Punta Lobería (44°35'S, 65°22'W) Chubut, Argentina, (Fig. 1) were analysed. Stomach contents, fixed with 10% formalin, were stained *in toto*, with alizarin red solution following Gosztonyi (1984) to ease the recognition and separation of bony or calcified materials.

Fish material, mostly consisting of strongly digested specimens, was identified to species or genus levels by comparing the bony remains with a reference collection, whereas invertebrate material was classified at various and generally much higher taxonomic levels.

No gravimetric or volumetric analyses were undertaken. For fish, the number of individuals per sample was determined, depending on the degree of digestion of the specimens, either by direct counts or by bone counts. In the latter case, by counting the unpaired bones (e.g. vomers, basioccipitals, parasphenoids, etc.), or halving the number of easily identifiable paired bones we estimated the minimum number of specimens involved. For invertebrates only the occurrence of the different items was recorded.

The occurrence of each prey taxon was calculated in two ways: a) percentage occurrence per stomach; and b) percentage occurrence of major groups (fish, crustaceans, cephalopods, gastropods, polychaetes and echiurids). For fish, relative abundance was also calculated.

RESULTS

Ten of the 43 stomachs (23.3%) contained fish only, four (9.3%) only invertebrates, while 31 (72.1 %) contained both fish and invertebrate material. Information on the invertebrates and fish found is shown in Tables 1 and 2, with each food category ranked according to the frequency of occurrence of its components.

Among invertebrates, crustaceans stood out, representing 56% of all the occurrences and 23.4% of major group occurrences. The remaining 44% of all occurrences comprised polychaetes (19.6%), cephalopods (18.7%), the echiurid *Pinuca chilensis* (4.1%) and gastropods (1.6%).

Eleven teleost and one myxinid agnathan fish species were identified by means of skull and pectoral girdle bones or by multicusps, the latter as defined by Wisner & McMillan (1994). The mean number of species by stomach was 2.7.

The most common species, both by frequency of occurrence and relative abundance, was *Tripterygion cunninghami*, present in 62.8% of the stomachs and with a mean number of specimens per stomach of 17.0. It was followed by Patagonian Notothens *Patagonotothen* spp., Ironclad Sculpin *Agonopsis chiloensis*, anchovy *Engraulis anchoita*, a small clinid *Ribeiroclinus eigenmanni* and the Patagonian Rockfish *Sebastes oculatus*, with frequencies of occurrence from 18.6–48.8% and a mean number

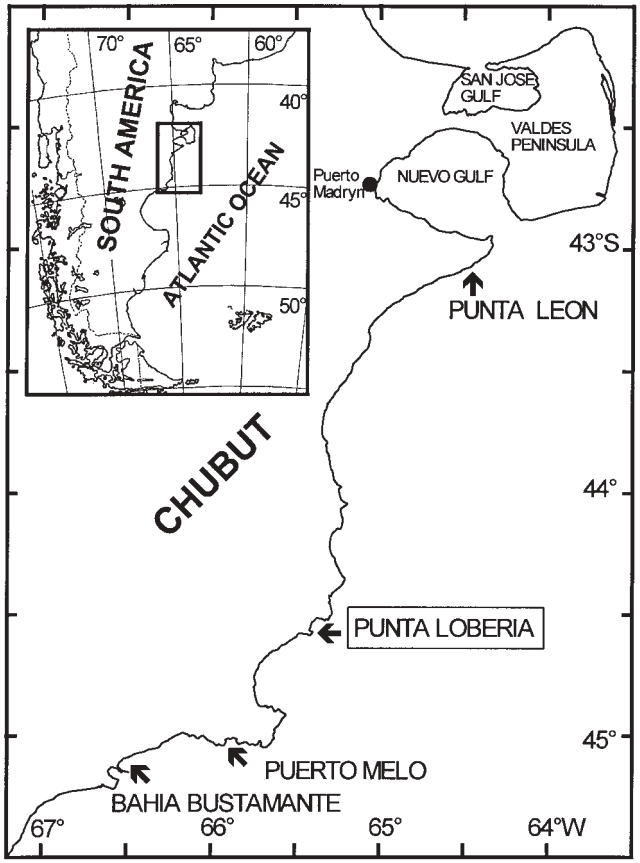

Fig. 1. *Location of Punta Lobería and of previous investigations of the diet of the Imperial Cormorant* Phalacrocorax atriceps *in Chubut Province, Argentina.*

TABLE 1

Diet of the Imperial Cormorant as reflected by the analysis of 43 stomachs collected at Punta Lobería, Chubut, Argentina

Prey taxa	Frequency of occurrence (%)	Group occurrence (%)
Fishes	95.3	33.1
Crustaceans	67.4	23.4
Isopoda	16.3	5.7
Amphipoda	4.7	1.6
Campylonotus sp.	4.7	1.6
Caridea	44.2	15.5
Brachyura	44.2	15.5
Munida sp.	18.6	6.5
Stomatopoda	7.0	2.4
Unidentified Crustacea	20.9	7.3
Cephalopods	53.5	18.7
Gastropods	4.7	1.6
Polychaetes	55.8	19.5
Echiurids		
Pinuca chilensis	11.6	4.1

per stomach from 8.5 (*E. anchoita*) to 1.6 (*R. eigenmanni*). The remaining species had low frequencies of occurrence (2.5–9.3%).

Due to the advanced degree of digestion of the ingested fish no measurements of their lengths could be taken, but it can be safely stated that *T. cunninghami*, *Patagonotothen* spp., *A. chiloensis*, *R. eigenmanni*, *R. brasiliensis* and *E. anchoita* were mostly represented by adult or sub-adult specimens, whereas *S. oculatus*, *A. brasilianus*, *Odontesthes* spp. and *N. bergi* were found as juveniles only.

DISCUSSION

Among the observed fishes only the anchovy, the Patagonian Rockfish, Argentine Bass *Acanthistius brasilianus*, Silversides *Odontesthes* spp. and the Papamoscas or "Argentine Morwong" *Nemadactylus bergi* are of commercial value during their adult life. Of these species, only the anchovy, represented mostly by adult specimens, was significantly preyed upon by the Imperial Cormorant, which would indicate that this bird, at least at this locality, would not directly compete with commercial fisheries, although an impact on the overall community can not be disregarded.

Of the species most frequently consumed by the Imperial Cormorant, *T. cunninghami*, *Patagonotothen* spp., *A. chiloensis*, *R. eigenmanni* are mostly inshore fishes living among algae, sometimes even reaching the intertidal zones. *S. oculatus*, *A. brasiliensis*, and *N. bergi* are widely distributed on the Patagonian continental shelf forming part of important demersal fisheries, but spending their early life-stages in inshore waters (Otero *et al.* 1982, Bellisio *et al.* 1979, pers. obs.). Our results suggest that at Punta Lobería the Imperial Cormorant forages on a wide spectrum of species in shallow waters.

A comparison of our observations with those of previous studies on the diet of *P. atriceps* or its synonym *P. albiventer* in the area (Punta *et al.* 1993, Malacalza *et al.* 1994) shows both similarities and differences. Seven fish taxa observed in this study, anchovy, Patagonian Notothens, *A. brasilianus*, *Raneya brasiliensis*, *Ribeiroclinus eigenmanni*, *Odontesthes* spp. and Myxinidae, have been previously reported in the diet of the cormorant, whereas *Triathalassothia argentina*, the Argentine Hake *Merluccius hubbsi* and *Pinguipes brasilianus*, previously reported as prey of the Imperial Cormorant were absent in our samples. *Tripterygion cunninghami*, *Agonopsis chiloensis*, *Sebastes oculatus*, *Bovichthys argentinus* and *Nemadactylus bergi* have not previously been reported.

The most important difference with the other studies is the higher diversity of species recorded from Punta Lobería. The number of species found almost doubled the six species found in *P. albiventer* (= *P. atriceps*) in Punta León (Malacalza *et al.* 1994), and the five species found in Bahía Bustamante and Puerto Melo (Punta *et al.* 1993). This could be due to differences in the diversity of fish fauna among localities or to biases related to differences in the analytical methods applied. The first hypothesis may be disregarded because all the fish species involved are common along the coast of Chubut Province. The second hypothesis therefore seems to be the more probable.

Traditionally, students of piscivorous bird diets have tended to limit their research (though not exclusively, Blaber &

TABLE 2

Fish represented in 43 stomachs of the Imperial Cormorantcollected at Punta Lobería, Chubut, Argentina

Prey taxa		Frequency of occurrence (%)	Relative abundance (%)	Mean	Range
Tripterygiidae	*Tripterygion cunninghami*	62.8	56.7	17.0	1–70
Engraulidae	*Engraulis anchoita*	39.5	17.8	8.5	1–33
Nototheniidae	*Patagonothen* sp.	48.8	8.7	3.3	1–10
Agonidae	*Agonopsis chiloensis*	41.9	5.6	2.5	1–13
Clinidae	*Ribeiroclinus eigenmanni*	20.9	1.7	1.6	1–3
Scorpaenidae	*Sebastes oculatus*	18.6	4.1	4.1	1–8
Serranidae	*Acanthistius brasilianus*	9.3	2.0	4.0	1–8
Atherinopsidae	*Odontesthes* sp.	9.3	1.0	2.0	1–4
Ophididae	*Raneya brasiliensis*	7.0	1.7	4.7	1–9
Myxinidae		7.0	0.4	1.0	
Bovichthyidae	*Bovichthys argentinus*	2.3	0.3	2.0	2–2
Cheilodactylidae	*Nemadactylus bergi*	2.3	0.1	1.0	

Wasserburg, 1989) to the examination of otoliths only, disregarding skeletal remains. By this method various factors may affect the final qualitative and quantitative results. Otoliths of different species can be differentially digested in the stomach, being eroded and significantly modified in their morphology, if not completely dissolved, usually becoming unfit for taxonomic identification and/or measurements. This fact can lead to the underestimation or ignorance of the presence of certain prey species and also to misleading results in back-calculations of original fish sizes (Jobling & Breiby 1986, Johnstone *et al.* 1990). The examination of bony material offers a good and perhaps safer alternative to identify prey and perform back-calculations to original sizes, even if otoliths have been strongly eroded or completely dissolved by digestion and/or formalin fixation.

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