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Notes on the Food and Feeding Habits of Cormorants on a Tropical Floodplain

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Ecological aspects of feeding in the Little Pied Cormorant *Phalacrocorax melanoleucos* and the Little Black Cormorant *P. sulcirostris* have been well documented for populations inhabiting temperate Australia. Studies by McNally (1957) in Victoria and McKeown (1944), Vestjens (1977) and Miller (1979) in inland New South Wales reveal the environmental separation of the two species as a result of differences in feeding habits, foraging behaviour and habitat preference between the species. In summary, individual *P. melanoleucos* hunt solitarily in the shallow margins of waterbodies and feed predominantly on decapod crustacea and aquatic insects. *P. sulcirostris*, in contrast, usually feeds co-operatively in open water, and ingests mainly fish. However, the feeding habits of these cormorants in tropical Australia have not been reported.

This note presents results of stomach analyses of small samples of *P. melanoleucos* and *P. sulcirostris* collected on a tropical wetland in the Alligator Rivers Region of the Northern Territory, 250 km east of Darwin. The samples were collected from the Magela floodplain, a freshwater basin that is filled during the wet season by the Magela Creek. Conditions on this floodplain differ from those of most others of the Region in that large areas remain inundated throughout much of the dry season. Both species of cormorant tend to be more abundant there during the dry season, probably as a result of movement of birds from other floodplains of the Region as these dry out. Systematic ground-counts from 1981 to 1984 provided estimates of mean densities for the Little Pied Cormorant of 0.7 km^{-2} (wet season) and 2.9 km^{-2} (dry season), and for the Little Black Cormorant of 1.0 km^{-2} (wet season) and 2.4 km^{-2} (dry season) (S.R. Morton, K.G. Brennan & M.D. Armstrong, unpubl. data). Despite similarities in the mean densities, Little Black Cormorants occurred more sporadically but in larger aggregations than did Little Pied Cormorants.

Methods

Ten *P. melanoleucos* and 11 *P. sulcirostris* were collected by shooting on the Magela floodplain approximately 15 km north of Jabiru, N.T. The birds were collected by use of an airboat during the early dry season. Two specimens of *P. melanoleucos* were collected on 16-22 June 1982, seven on 6-29 July 1983, and one on 5 August 1983. All specimens of *P. sulcirostris* were collected between 4-29 July 1983.

On return to the laboratory, each bird was weighed, the culmen, gape, wing, tail and tarsus were measured and the stomach contents removed and stored in 70% ethanol. Stomach contents were later sorted and identified in a Petri dish and using a Wild M3 binocular microscope. If necessary, fish specimens were identified from scale morphology using known reference material. The length of each organism was measured to the nearest 0.1 mm using calipers. Fish length was taken as being length from the anterior-most part of the skull to the caudal fork. Where fish were partially digested, length was estimated using regression equations developed by the authors based on width of caudal base, or length of pectoral spine (plotosids). Lengths of fragmented invertebrate types were calculated from body dimensions (e.g. head width, carapace length) using appropriate regression equations. Dry weights were calculated using log transformed length-weight regression equations (Dostine unpubl.) Fish taxonomic classification follows that used by Bishop *et al.* (1986).

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TABLE 1 Prey items found in Little Pied Cormorants and Little Black Cormorants, expressed as percentages of total dry weight of prey and of total number of prey items. (+ indicates taxa present but not included in numerical tabulations).

Prey	Little Pied Cormorant % dry wt.	% no.	*n*	Little Black Cormorant % dry wt.	% no.	*n*
Osteichthyes:						
F. Melanotaeniidae						
Melanotaenia splendida	17.3	7.7	13	14.9	27.9	105
F. Atherinidae						
Pseudomugil tenellus	0.2	1.8	3	1.2	6.1	23
F. Centropomidae						
Ambassis agrammus	8.4	26.6	45	13.9	43.0	162
Denariusa bandata	0.5	0.6	1	0.2	0.5	2
F. Eleotridae						
Mogurnda mogurnda	5.0	2.4	4	6.4	4.2	16
Oxyeleotris nullipora	1.0	2.4	4	3.1	8.0	30
F. Plotosidae						
Porochilus rendahli	11.7	2.4	4	37.7	5.6	21
Neosilurus hyrtlii	5.2	0.6	1	5.6	0.3	1
Unidentified plotosid	4.9	0.6	1	14.0	2.4	9
Unidentified teleost	0.1	0.6	1	2.1	1.6	6
Total Osteichthyes	54.2	45.6		99.0	99.5	
Amphibia:						
F. Hylidae						
Litoria dahlii	10.2	1.8	3			
Unidentified larvae	0.8	0.6	1			
Total Amphibia	11.0	2.4				
Mollusca:						
F. Planorbidae						
Physastra sp.				0.7	0.3	1
Crustacea:						
F. Parastacidae						
Cherax quadricarinatus	15.6	3.0	5		trace	
Porifera:						
F. Spongillidae						
Unidentified	0.7	+			trace	
Odonata:						
F. Aeschnidae						
Unidentified larvae	6.0	3.0	5			
Unid. Anisopteran larvae	0.5	3.0	5	1.0	0.3	1
Total Odonata	6.5	5.9		1.0	0.3	
Coleoptera:						
Unidentified adults	< 0.1	1.2	2			
F. Dytiscidae						
Cybister sp. larvae type C	2.9	2.4	4			
Cybister sp. larvae type A	0.3	0.6	1			
Total Coleoptera	3.2	4.1				
Hemiptera:						
F. Belostomatidae						
Diplonychus sp.	8.6	39.1	66			
Plants	0.2	+		0.2	+	
Total dry weight (mg) and no. of items.	26770	169		40727	377	
Sample size		10			11	

Results

Composition of the diet

Prey of both species are listed in Table 1. *P. melanoleucos* fed on both fish and invertebrates; these groups comprised 54.2% and 34.6% respectively by dry weight. Eight species of fish from five families were included in the diet, and species from at least five invertebrate families were represented. In decreasing importance by dry weight were plotosid catfish, rainbowfish *Melanotaenia splendida* and crayfish *Cherax quadricarinatus*. These groups were represented by few individuals. The most numerous items in the diet were the belostomatid hemipteran *Diplonychus* sp. and sail-fin perchlet *Ambassis agrammus*. These two species comprised almost 66% of the number of prey, but only 17% of the total dry weight. Minor contributions were made by aeschnid dragonfly larvae and late instar larvae of *Cybister* spp. (Dytiscidae). Plants formed an insignificant component of the diet, and only the floating seeds of *Caldesia oligococca, Heliotropium indicum* and *Nymphaea* sp. were identified in stomach contents.

The stomach contents of *P. sulcirostris* consisted almost exclusively of fish. Eight species of fish comprised 99% of the number of prey. Plotosid catfish, particularly *Porochilus rendahli*, dominated the diet by dry weight. *A. agrammus* and *M. splendida* together comprised over 70% of the number of prey. Invertebrates were represented by a single planorbid snail and a single dragonfly larva. Traces of crayfish and sponge were also present.

Prey size

The frequency distribution of prey length in the stomach contents of each cormorant species is shown in Figure 1. Prey items within the length range 15-35 mm comprised nearly three-quarters of the prey of both species, (i.e. 70.5% of prey of *P. melanoleucos*; 84.7% of prey of *P. sulcirostris*). Specimens of *A. agrammus*, the most numerous fish in the stomach contents of both cormorant species, were from 15-39 mm long. Larger prey were predominantly plotosid catfish. The frequency distributions of prey lengths did differ significantly (Kolmogorov-Smirnov test, $P < 0.001$), primarily because of the large numbers of small belostomatid hemiptera (mean length, 16.3 mm) eaten by *P. melanoleucos*. Most other invertebrate prey eaten by *P. melanoleucos* were relatively large, and measured between 40-65 mm in length.

Discussion

These results are in broad agreement with other published studies, all of which show that invertebrate prey is substantially more important for *P. melanoleucos* than for its congener. Miller (1979) found that both species consumed the same types of prey in different proportions, although

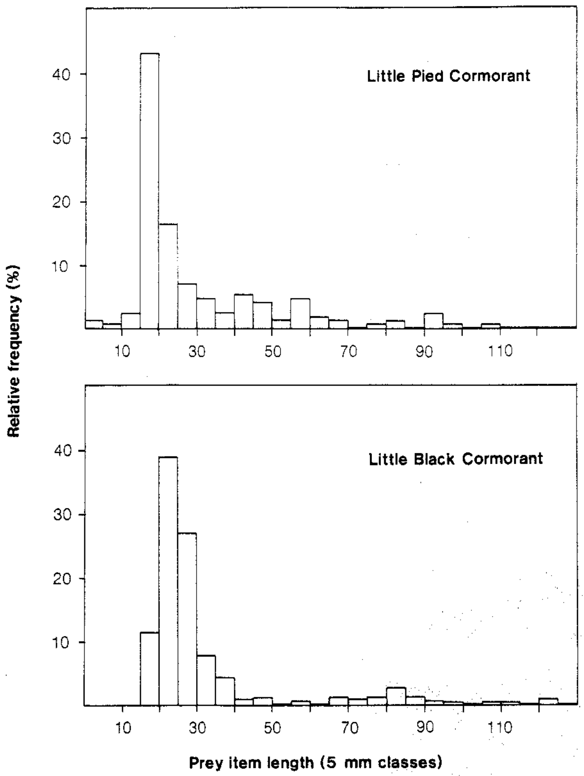

FIGURE 1 Frequency distribution of classes of prey item lengths for Little Pied Cormorants (above) and Little Black Cormorants (below).

from the small number of samples in our study it is suggested that invertebrates are of minor importance to *P. sulcirostris*. Our work showed that both cormorants ate a similar variety of fish species, with *A. agrammus* and *M. splendida* being prominent in the food of both. These two fish species are the two most abundant fish of upper floodplain lagoon habitats (Bishop *et al.* 1980). Fish communities of these areas are diverse and include twenty-seven species from sixteen families. *P. melanoleucos* and *P. sulcirostris* ate eight species of these fishes, the majority of which are small omnivores or insectivores associated with the littoral zone.

The food of *P. melanoleucos* and *P. sulcirostris* recorded by McNally (1957) and Miller (1979) was characterised by comparatively large exotic fish, particularly carp (Cyprinidae) and English perch *Perca fluviatilis.* Native fish were relatively unimportant. The six native species taken by *P. sulcirostris* made up, according to Miller (1979), just over 5% of the total fish in the food.

McNally (1957) and Miller (1979) emphasised the importance of decapod crustacea, notably crayfish and palaemonid shrimps, in the diet of *P. melanoleucos*. *Cherax* was not a common food item in our study, though it comprised 15.6% of the total dry weight of food and was the most important invertebrate taxon in the food on a weight basis. *Cherax* is uncommon on the floodplain, and was not recorded in a survey of billabong invertebrates by Marchant (1982). The absence of palaemonid shrimps from the food in our study is somewhat surprising because these animals are abundant on the floodplain and form a major component of the food of wading birds e.g. ardeids.

These comparisons suggest that there are substantial differences in the taxonomic composition and size distribution of the prey available to cormorants inhabiting the Magela floodplain compared with those of habitats in inland temperate Australia. However, the results should be interpreted with caution due to potential bias from the small sample size for each cormorant species and the limited period of sampling. The abundance and availability of prey types may vary according to seasonal factors.

We observed different habitat preferences in *P. melanoleucos* and *P. sulcirostris*. *P. melanoleucos* tends to forage mainly in quiet backwaters and shallow pools. In contrast to other cormorant species in Australia, *P. melanoleucos* possesses a modified shoulder hinge which permits steep ascent from the water surface (van Tets undated). This ability permits *P. melanoleucos* to exploit small waterbodies in a range of habitats; it is, for example, frequently seen feeding in shallow vegetated areas of lowland floodplain and also frequents the remnant creek pools in upstream areas during the dry season. In these habitats it is observed to forage solitarily. *P. sulcirostris* is confined to deeper, more open stretches of water on the lowland floodplain, and often occurs in small parties; it is particularly abundant in deep channels during the mid- to late wet season. At this time such areas have high densities of small fish, which presumably enables a high capture rate to be achieved.

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