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Food Preferences of the Common Tern, *Sterna hirundo* (Linnaeus, 1758) at the Densu Floodplains, Accra

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Abstract

Seabirds are important in the dynamics of marine ecosystems because they recycle important biomass of lower trophic level organisms. Their faeces and carcasses provide important food sources for terrestrial and benthic scavengers. As a result of the abundance of food resources along the coast of Ghana, common terns (*Sterna hirundo*) are found in large numbers in productive brackish or saltwater wetlands, and are notable for indicating location of rich fish stocks at sea and in lagoons. The study aimed to determine the variety of food available, and any food preferences exhibited by *S. hirundo* at the Densu floodplains near Accra. While earlier studies of food habits of seabirds worldwide used examination of regurgitates and telescopic observations, the study quantitatively analyzed guts of common tern for their food content using standardized methods. The utilization by common terns of the Panbros lagoon fish resource during roosting in the night was quantified. Results showed that food available to the birds included marine and fresh or brackish water fish, crustaceans and worms. During caging, only one bird fed on 15 individuals of *Hemichromis fasciatus*. Prey items such as exoskeleton of crab zoea larvae, capitellid worms, fish otolith, pieces of fish bones and vertebrae, detrital materials and sand grains were found in the guts. The presence of capitellid worms in the guts, a known indicator of excess nutrient enrichment, showed that *S. hirundo* utilized the Panbros lagoon fish resource in feeding, and the roosting ground was under much stress. The study stressed the importance of complementing conservation efforts for common terns with attempts to manage the fish resources in the Densu floodplains.

Introduction

Seabirds are birds living in, and making their living from, the marine environment, which includes coastal areas, islands, estuaries, wetlands and oceanic islands (Schreiber & Burger, 2002). They are important in the dynamics of marine ecosystems for at least two reasons: (i) They recycle important biomass of lower trophic level organisms and their faeces, and (ii) carcasses provide important food sources for terrestrial and benthic scavengers. High metabolic rates and numerous activities make birds to consume huge amounts of food. They are, therefore, most plentiful where food is abundant, and their presence near aquatic systems is a good indicator of high productivity in surface waters (Duxbury & Duxbury, 1997). Ghana is on the boundary of two flyways of waterbirds, the East Atlantic Flyway and the Mediterranean Flyway (Smit & Piersma, 1989). The coastal wetlands of Ghana receive significant numbers of waterbirds from a greater breeding range than most wetland sites in West Africa (Piersma & Ntiamoa–Baidu, 1995). At least 15 species of seabirds including Common terns (*Sterna hirundo*), occur in internationally important populations in Ghana (Ntiamoa–Baidu, 1991).

Seabird feeding activities are stimulated by actual appetite and a drive to hunt for food (Croxall, 1987). Most species have a primary mode of foraging but may use one to several alternative methods opportunistically. The most common foraging method used by the cormorants (*Pelicaniformes*) for instance, is diving from the surface and pursuing prey while swimming underwater using either the wings or the feet. Penguins (*Sphenisciformes*), and diving-petrels (*Procellariformes*) use pursuit diving extensively. Picking prey from the surface or "dipping" is the second most common foraging method used by storm petrels, skuas, gulls, terns, and large petrels. Some species such as albatrosses and pelicans, may use a combination of dipping while floating on the surface, and occasional pursuit diving. Specialized mode of foraging is plunge diving, which is used by sulids (gannets and boobies), tropic birds, many terns, and pelicans. Other less common foraging behaviours are aerial pursuit of prey, scavenging, and kleptoparasitism commonly used by terns and gulls (Schreiber & Burger, 2002).

There are varied adaptations to feeding exhibited by seabirds. These adaptations include modes of locomotion during feeding, and structure of the bill and digestive system. Birds may sit, walk, hop, fly and dive in search of food. The sizes of food eaten and feeding areas depend on the length and size of their legs and neck, and shape and strength of bill. The varied lengths and curvatures of shorebird bills determine which sorts of prey they can reach. Even slight variations in bill dimension greatly influence the rate at which food can be ingested (Anon., 1969; Gill 1990).

Studies by earlier authors on food habits have been far from conclusive on specific prey types taken by waterbirds. Fish otoliths found in faecal pellets of *Phalacrocorax varius*, *P. melanoleucos* and *S. bergii* in Moreton Bay, Australia showed that waterbirds fed on fishes (Blaber & Wassenberg, 1989). However, fish otoliths were found to be digested rapidly by stomach acid solutions resulting in inaccurate inferences on food habits from bird stomach contents or faeces (Duffy & Laurenson, 1983). In Ghana, Van der Winden *et al.* (2000) made direct observations of feeding black terns using telescopes and binoculars at the Densu floodplains. The study observed that both live fish and shrimps, as well as fish discards were taken by black terns. The prey items were mainly tilapia species (in the Densu river) and Clupeids (offshore). Furthermore, Piersma & Ntiamoa-Baidu (1995) studied the feeding ecology of some waterbirds at the Songhor and Keta lagoons in Ghana using telescopes. Fish and other prey items taken by birds could not be fully identified due to observation points being farther away from the feeding grounds.

For a fuller understanding of the feeding ecology of waterbirds it is crucial to know the specific prey types consumed with reasonable confidence. This study to determine food preferences of waterbirds (*S. hirundo*) using gut content analyses is the first of its kind in West Africa. The specific aims were to determine:

- the variety of food available to *S. hirundo* at the Densu floodplains
- food preferences of *S. hirundo* through gut content analysis and caging experiments
- if *S. hirundo* utilized the Panbros lagoon fish resource during roosting at night, since they are believed to feed exclusively at sea.

Materials and methods

The study area was the Panbros mud pans found within the Densu floodplains 05^0 33'N 000^0 18' W, a Ramsar site established in 1992. The area has an elevation of 152 m, covers an area of 4,620 ha, and is located west of Accra where the Densu River enters the sea (Fig. 1). The site is a delta estuary containing sand dunes. The main vegetation in the saltmarsh, lagoons, saltpans, marsh and scrub are scattered mangrove stands dominated by *Avicennia germinans*. A total of 15 fin fishes belonging to 14 genera and 9 families occur in the area, with *Sarothero-don melanotheron* and *Tilapia zillii* being dominant (*Http//www.ramsar.org/profiles_ ghana.htm)***.** Annual temperatures range between 25 and 30 ^{o}C, and average annual rainfall is 657 mm. The water is shallow with depth ranging between 0 and 2 m.

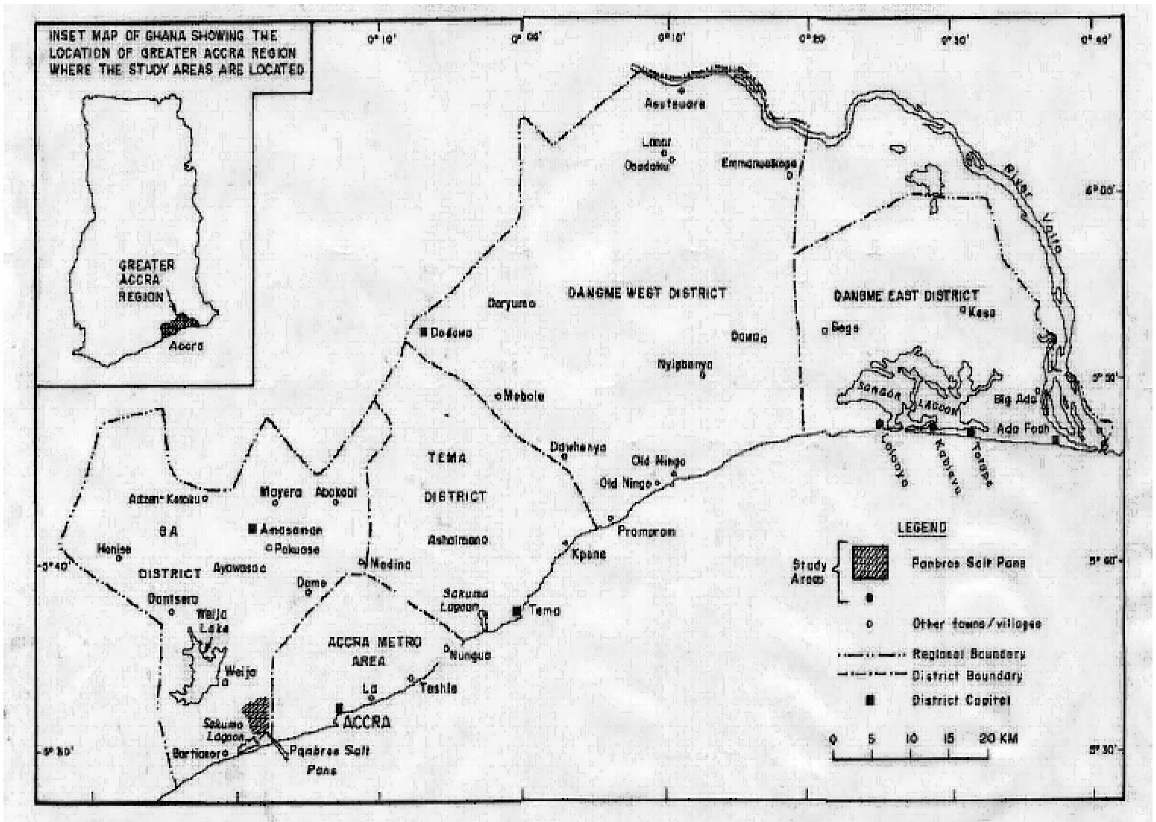

Fig. 1. Map showing location of Densu floodplains in Ghana

To study the food habits of *S. hirundo*, birds were trapped using six 12 × 8 m mist nets with mesh size of 35 mm, from 21st to 24th January 2004. With the exception of common terns, other bird species caught in the net were released back to the wild. Three individual common terns were required for each day's caging experiment. Individuals were weighed and various morphological measurements taken (bill, neck, tarsus, tarsus and toe, wings and total head length). Birds were subsequently kept in a cage (dimensions 1.50 × 2.20 × 0.97 m), which was sited about 500 m away from the roosts. The cage had three sub-divisions, each carrying one bird. In order to starve the birds to increase their desire for food, they were kept in captivity for 10 h prior to feeding experiments. *S. hirundo* were each introduced to 50 individuals of live juvenile fishes caught by fishers in the floodplains (total lengths ranging from 4.0 to 6.6 cm and weights ranging from 0.365 to 4.852 g) kept in bowls of water. The fishes comprised *Hemichromis fasciatus*, red-chinned tilapia (*Tilapia guineensis*), Schlegel's gobid (*Porogobius schlegeli*) and black-chinned tilapia (*Sarotherodon melanotheron*).

Feeding behaviour of *S. hirundo* was observed over a period of 12 h. Three replicates of the experiment were carried out on different days and birds. To analyse bird gut contents, three wild birds were captured, abdomens cut open and full length of guts removed and immediately immersed in 4% formalin before transportation to the laboratory. In the laboratory, the formalin was washed off the guts, the lengths and weights were recorded with and without prey items. The contents of the guts were emptied into petri dishes and observed under a light microscope. Prey items were counted, weighed and identified to the genera level. They were analyzed quantitatively using standardized methods such as:

(i) frequency of occurrence (FO), (ii) per-centage composition by number (Cn), (iii) percentage composition by weight (Cw), and (iv) Index of Relative Importance (IRI). One sample t-tests were performed to test for the differences in IRI values among the birds for prey items.

Results

Morphometric features of S. hirundo

The birds captured for the study were medium-sized birds (body weight ranging between 120–140 g) with very identical morphometric indices (Table 1 and 2).

Tables 1 and 2 show the body weight before (Weight 1) and after (Weight 2) caging experiment, wing length (WL), tarsus (TL), tarsus plus toe (TTL), bill length (BL), neck length (NL) and total head length (THL) of birds captured. Lengths in cm and weight in g; SD = standard deviation, n = sample size.

TABLE 1

Mean and standard deviations of morphometric features of S. hirundo *at the Densu floodplains*
*(*Birds used for gut content analyses were weighed only once)*

Statistics	*Weight 1*	*Weight 2*	*WL*	*TL*	*TTL*	*BL*	*NL*	*THL*
Mean	112.08	72.08	23.9	2.41	4.24	3.82	4.17	7.45
SD	16.16	45.1	1.9	0.08	0.38	0.16	0.44	0.27
n	12	9*	12	12	12	12	12	12

TABLE 2

Morphometric features of S. hirundo *used for gut content analyses (n = 3)*

Morphometric features of Sterna hirundo	*Specimens* 1	2	3
Weight (g)	120	140	130
Length of bill (mandible) (cm)	3.9	4	3.6
Length of wing (cm)	26	26.8	25.7
Length of neck (cm)	3.5	4	4
Length of crown to upper mandible (cm)	7.7	7.3	7.6
Length of tarsus (cm)	2.5	2.5	2.4
Length of tarsus to feet (cm)	4.2	4	4.2

Caging

The birds did not feed well in captivity (during caging). Only one individual, *S. hirundo*, fed on 15 specimens of *Hermi-chromis fasciatus.* The bird clearly showed a preference for *H. fasciatus* out of the four different fish species presented. Due to starvation, there was a 10 ± 1.67 g mean loss in weight of birds during the caging period (Fig. 2), leaving most of them weak.

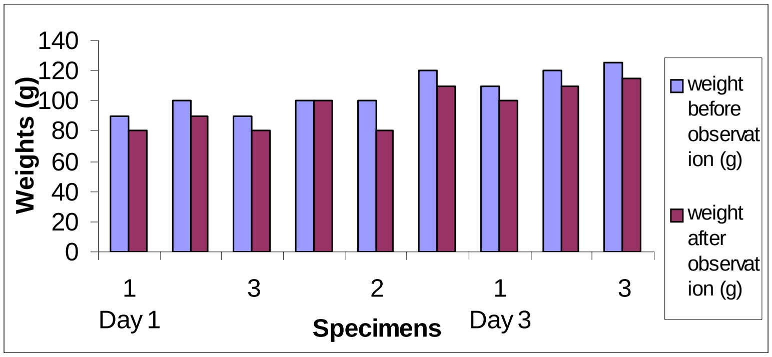

Fig. 2. Differences in weight (g) of *S. hirundo* before and after caging experiment

Gut content

All three guts were of identical lengths and found to be three-quarter full of a variety of prey items (Tables 3 and 4). The most important prey item for *S. hirundo* was fish. From the IRI values, the most important prey items in order of priority were pieces of fish bones and vertebrae, capitellid worms, detritus, crab zoea larvae and fish sagittal otolith (Table 4). Differences in IRI values for prey items found for the guts of three birds were not significant (one sample t – test, t value = 1.053, df = 5, p = 0.34).

TABLE 3

Measurements taken on guts of S. hirundo *(n = 3)*

	Specimens	*Mean*	*Standard deviation*		
Measurement of gut	1	2	3		
Weight of full gut (g)	10.93	15.18	13.64	13.25	2.15
Weight of empty gut (g)	9.08	11.14	2.37	7.53	4.59
Weight of food taken (g)	1.85	4.04	11.27	5.72	4.93
Length of gut (cm)	48	43	46	45.67	2.52

TABLE 4

Percentage composition of prey items in guts (n = 3)

Prey items	*FO (%)*	*Cn (%)*	*Cw (%)*	*IRI (%)*
Exoskeleton of crab zoea larvae	33.33	1.32	1.52	94.66
Capitellid sp (Grube,1862)	33.33	0.53	8.86	314.64
Fish sagittal otolith	33.33	0.26	0.06	10.67
Pieces of bones and vertebrae	66.67	97.89	88.29	12412.6
Detritus	100	0	1.22	122
Sand grains	66.67	0	0.12	8

Discussion

Food available to the terns at the Densu floodplains included marine and fresh or brackish water fish and shellfish, pelagic crustaceans and worms. However, the most important prey item for *S. hirundo* at the Densu floodplains was fish. Although the fish bones, vertebrae and otolith found in the guts were too tiny to be directly associated with any particular fish, the preference for *H. fasciatus* in captivity was significant. Moreover, the fact that terns fed in mixed flock shows that other tern species might also prefer the prey items fed on by *S. hirundo.* The findings for common terns could, therefore, enable an understanding of the feeding ecology and food habits of other tern species as well. The common tern that fed on *H. fasciatus* during the caging experiment maintained a constant weight. This finding supports the view that gain in body weight of birds is dependent on feeding rates (Duxbury & Duxbury, 1997). Prey items found in the guts were similar to that recorded by earlier authors (Ntiamoa-Baidu *et al*., 1995; Schreiber & Burger, 2002). The dependence of common terns on fish for food had conservation and management implications. The birds are naturally in competition with humans for fish (Furness, 1982). The heavy human pressure on fish (Entsua-Mensah, 1998) at the site is likely to affect numbers of *S. hirundo*. It would be important for efforts at managing the fish resource to be part of bird conservation efforts at Densu floodplains.

Further, the capitellid worms found in the gut of *S. hirundo* indicated that the roosting ground might be polluted since capitellids are known indicators of stressed environments. Capitellids, which are often found in estuaries, are capable of tolerating the very low oxygen concentrations typical of polluted areas. They are, therefore, opportunist species since they take advantage of harsh environments (Day, 1967).

Terns are generally shy birds that do not behave normally with human interference. Almost all the caged *S. hirundo* refused to feed because they were not in their natural environment and, therefore, felt threatened. A few of the birds were still strong on completion of the experiment, although they also did not feed. These birds might have accumulated lots of fats to withstand unfavourable conditions (Schreiber & Burger, 2002).

Conclusion and recommendations

The variety of food available to *S. hirundo* at the Densu floodplains included marine and fresh or brackish water fish, including *H. fasciatus*, pelagic crustaceans, worms and crab zoea larvae. Gut content analyses and caging experiment confirmed a preference for fish, especially *H. fasciatus* by the common tern. Finally the presence of the capitellid worm in the gut indicated that these birds utilize the Panbros lagoon fishery found within the Densu floodplains and also take advantage of the prey items present at the roosting grounds. Holistic efforts towards managing and conserving both the fish and bird populations are suggested. For instance efficient curtailing of fishing pressure and reduction of quantities of pollutants emptied into the floodplains coupled with punitive measures on humans who rampantly trap terns for food would go a long way to sustainably manage these resources. It is recommended that further work on the food and feeding habits of *S. hirundo* at Densu floodplains should be carried out to determine temporal variations in diet. To help with identification of sagittal otoliths found in guts, there is a need to undertake studies towards designing of an otolith atlas for both common marine and freshwater fish species in Ghana.

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