FISH PREY OF THE BLACK SKIMMER *RYNCHOPS NIGER* AT MAR CHIQUITA, BUENOS AIRES PROVINCE, ARGENTINA

ROCÍO MARIANO-JELICICH, MARCO FAVERO & MARÍA PATRICIA SILVA

Laboratorio de Vertebrados, Departamento de Biología, Facultad de Ciencias Exactas y Naturales, Universidad Nacional de Mar del Plata, Funes 3250 (B76002AYJ), Mar del Plata, Buenos Aires, Argentina (rmjelic@mdp.edu.ar)

Received 13 September 2002, accepted 20 February 2003

SUMMARY

MARIANO-JELICICH, R., FAVERO, M. & SILVA, M.P. 2003. Fish prey of the Black Skimmer *Rynchops niger* at Mar Chiquita, Buenos Aires Province, Argentina. *Marine Ornithology* 31: 199-202.

We studied the diet of the Black Skimmer *Rynchops niger* during the non-breeding season (austral summer-autumn 2000) by analyzing 1034 regurgitated pellets from Mar Chiquita, Buenos Aires Province, Argentina. Fish was the main prey, with five species identified: *Odontesthes argentinensis*, *O. incisa*, *Anchoa marinii*, *Engraulis anchoita* and P*omatomus saltatrix*. *O. incisa* and *O. argentinensis* were present in all the sampled months, showing also larger values of occurrence, numerical abundance and importance by mass than other items. The average size of the fish was 73±17 mm in length and 2.2±1.7 g in mass. Significant differences were observed in the comparison of the occurrence, importance by number and by mass throughout the study period. The presence of fish in the diet of the Black Skimmer coincides with a study carried out on the North American subspecies. Our analysis of the diet suggests that skimmers use both estuarine and marine areas when foraging.

Keywords: Black Skimmer, *Rynchops niger*, Argentina, South America, diet

INTRODUCTION

Black Skimmers *Rynchops niger* are known by the morphological characteristics of the bill and their particular feeding technique, skimming over the water surface to catch fish and other prey. Despite available information on their breeding biology (Erwin 1977a, Burger 1982, White *et al*. 1984) and feeding ecology (e.g. Erwin 1977b, Black & Harris 1983, Burger & Gochfeld 1990), only general descriptions of the diet are given, with no extensive quantitative analysis (see Zusi 1996). Earlier investigators described skimmers feeding in shallow pools and streams with calm water (Erwin 1977b, Black & Harris 1983). They also reported skimmers to be restricted in their habitat use, feeding almost exclusively in marsh channels and tide pools, with open waters occasionally used (Erwin 1977b). Coincidentally, their diet consisted mainly of small inshore fish species, while marine fish species were less important (Erwin 1977a,b, Black & Harris 1983, White *et al*. 1984). All these earlier works were carried out in North America during the breeding season (see Black & Harris 1983). Recent studies (Favero *et al*. 2001) undertaken in southern South America (Buenos Aires Province, Argentina) during the non-breeding season, showed an alternate use of foraging areas by these birds, consuming both estuarine and marine fish prey. Thus, Black Skimmers may be more plastic in their habitat use during the non-breeding season (Favero *et al*. 2001). In this study, we provide additional detailed information on the diet of non-breeding Black Skimmers at Mar Chiquita coastal lagoon, the only coastal lagoon along the Argentine shore.

METHODS

Study area

We studied the diet of Black Skimmers by analyzing 1034 regurgitated pellets collected from roosting sites between February and May 2000 at Mar Chiquita coastal lagoon (37º 40'S, 57º 22'W), Buenos Aires Province, Argentina. During the austral summer-autumn from 5000 to 10 000 Black Skimmers (by far the most abundant seabird species) roost in Mar Chiquita, which is the most important wintering area in Argentina.

Field procedures and analyses

Diet was studied by analyzing regurgitated pellets. Once collected, each sample was dried at ambient temperature, dissected and the hard remains were identified using a stereomicroscope (20–60). Fish otoliths were identified to species using descriptions and illustrations from the literature (Torno 1970, Vilela 1988) and reference material from our own collections. Otoliths were separated into right and left, and the most abundant was considered as representing the number of fish prey of each species in the sample. The total length and width of otoliths was used to estimate the fish size (total length) and mass by regression equations used in previous studies (Favero *et al*. 2000a,b, Favero *et al*. 2001). Urostyles found in samples were also used for prey identification. The urostyles were separated into two types by using reference material in our own collection: “atheriniform (Atherinidae) type” and “clupeiform (Engraulidae and Clupeidae) type”. Individuals belonging to each type were assigned to species accordingly to the proportion by number observed by the otoliths. The importance of prey categories was quantified as: (1) frequency of occurrence (F%), which is the percentage of samples in which a particular food type appeared, (2) numerical abundance (N%) as the percentage of prey items of one type out of all prey items, and (3) importance by mass (W%) as the percentage of biomass provided by one prey item out of the total biomass consumed (Duffy & Jackson 1986, Rosenberg & Cooper 1990).

Data analysis

The composition of the diet was compared throughout the samples by chi-square tests (χ^2). The prey sizes and masses estimations at the different samplings were compared by ANOVAs (F) and by Tukey post-hoc comparisons. In all cases we followed the statistical methods proposed by Underwood (1997) and Zar (1999). The degrees of freedom of the mentioned tests are given as sub-indices. Comparisons through the breeding season were performed by using month as the unit size.

RESULTS

Fish was the main prey in the diet (n = 98%), followed in importance by insects (1.1%, mainly coleoptera), crustaceans (0.5%, decapods, amphipods and isopods), molluscs (0.2%, cephalopods and gasteropods) and chelicerates (0.1%, aracnids). The overall comparison of the diet throughout the sampling period showed significant differences both in the occurrence (χ^2 = 116.74, P <0.0001) and the importance by number (χ^2 = 47.57, P <0.0001). Thirty-eight percent (n = 396) of the pellets analyzed contained otoliths; other samples contained fish bones and scales only. A total of 1680 fish prey was identified to species level from otoliths and bone remains. From 740 otoliths identified to species, 423 of them were measured and used to calculate prey size and mass.

Identified fish prey corresponded to the following species: "Pejerrey" Silverside *Odontesthes argentinensis*, "Cornalito" Silverside *Odontesthes incisa*, Marini's Anchovy *Anchoa marinii*, Argentine Anchovy *Engraulis anchoita* and Bluefish *Pomatomus saltatrix* (Table 1). The first is considered an estuarine fish whereas the others are marine species (Rico 2000, Cousseau *et al*. 2001). Cornalito Silverside and Pejerrey Silverside were the most frequent prey and the most important by number and mass. Marini's Anchovy and Argentine Anchovy were less frequent and important by number but accounted together for more than 19% by mass (Table 1). Argentine Anchovy, Bluefish and the unidentified items had values of importance by number lower than 2%.

Significant differences were observed in the comparison of the frequency of occurrence (χ^2 = 68.81, P <0.0001), numerical abundance (χ^2 = 233.86, P <0.0001) and importance by mass (χ^2 = 289.15, P <0.0001) of fish prey observed throughout the study. Silversides were present in all the sampled months, whereas Marini's Anchovy and Argentine Anchovy were only present in samples from February and March (Fig. 1a, b).

Fish prey averaged 73±17 mm in length (range 25.6-127.5 mm, n = 423), and 2.2±1.7 g in mass (range 0.1-11.6 g, n = 423). The average size (total length) of consumed fish varied significantly through the study period ($F_{3,419}$ = 4.04, P <0.01), with smaller sizes observed in February (70.4 mm) and larger ones in April (78.8 mm). The differences observed in the size of Pejerrey Silversides consumed through the season (ANOVA $F_{3,175}$ = 4.75, P <0.005) were due to a significant increase of the sizes taken in April (Tukey P <0.05) (Fig. 2a). In the case of Cornalito Silverside the differences were the result of the progressive increase of the sizes consumed through the study period ($F_{3,201}$ = 12.58, P <0.0001) (Fig.

TABLE 1
Frequency of occurrence (f%), numerical abundance (n%) and total length of fish prey in the diet of the Black Skimmer *Rynchops niger* at Mar Chiquita, Argentina

Species	F%[a]	N%[b]	W%	Total length (mm) Mean ± sd	Range
Cornalito Silverside *Odontesthes incisa*	46.7 (185)[c]	48.6 (816)[d]	38.7	67.5 ± 15.3 (205)[d]	25.9 - 113.5
Pejerrey Silverside *Odontesthes argentinensis*	40.9	38.2 (162)	39.3 (642)	75.2 ± 14.9	45.4 - 127.5 (179)
Marini's anchovy *Anchoa marinii*	9.09 (36)	9.6 (161)	16.8	89.3 ± 22.8 (31)	25.6 - 122.5
Argentine Anchovy *Engraulis anchoíta*	2.02 (8)	1.8 (31)	2.5	71.8 ± 21.3 (7)	48.9 - 102.7
Bluefish *Pomatomus saltatrix*	0.5 (2)	0.1 (2)	2.0	101 (1)	-
Unidentified fish	7.07 (28)	1.6 (28)	?	-	-

a. Only considering samples containing otoliths (n = 396).
b. Including samples containing otoliths and/or bones (n = 1680).
c. Number of samples.
d. Number of fish-prey.

2b). The same trend was observed while considering the average mass variations of Pejerrey and Cornalito Silversides ($F_{3,175} = 12.47$, $P < 0.0001$, $F_{3,201} = 12.57$, $P < 0.0001$, respectively). Despite the low importance by number of Anchovy, the importance by mass during February and March reached the values observed in both silverside species (Fig. 1b). These large asymmetries between the importance by number and mass were related to the larger mass/length ratio observed in anchovies (0.061 g. cm^{-1}) in respect to those observed in silversides (0.037 and 0.039 g. cm^{-1}) (R.M-J. unpubl. data).

In this study, the number of fish prey per sample estimated by using otoliths (0.7±1.1) was significantly smaller than the number based on urostyles (1.4±1.2) (paired $t = 16.6$, df = 1033, $P < 0.0001$), thus accounting for some loss of information. However, some of these differences could be mediated by the large number of samples analyzed and the fact that the number of meals represented in one regurgitated pellet may be higher than those represented in other kind of samples, such as stomach contents or the observation of prey delivered to chicks (Casaux *et al*. 1997, 1998). Regardless of the possible methodological problems, regurgitated pellets are useful for the identification of individual food items consumed and for studying seabird diets during the non-breeding season (Brown & Ewins 1996). Preliminary results of the estimation of the minimum sample size needed to get accurate information about the diet of Black Skimmers showed that in the case of important prey (silversides in this study), samples larger than 150 pellets are enough to fit into 95% confidence interval of their importance by number. However, results should be carefully considered when considering less important prey such as clupeiform species (minimum sample size >400) (R. Mariano-Jelicich unpubl. data). The contrasting occurrence of clupeiform prey in the diet could be linked with seasonal migration patterns reported for these fish species in the area (Cousseau & Perrota 1998). In spite of the fact that an under-representation of soft-bodied prey is also suspected, this is probably unimportant because this prey type was low in previous studies (Leavitt 1957, Erwin 1977a; 1977b, Black & Harris 1983, Robert *et al*. 1989, Burger & Gochfeld 1990).

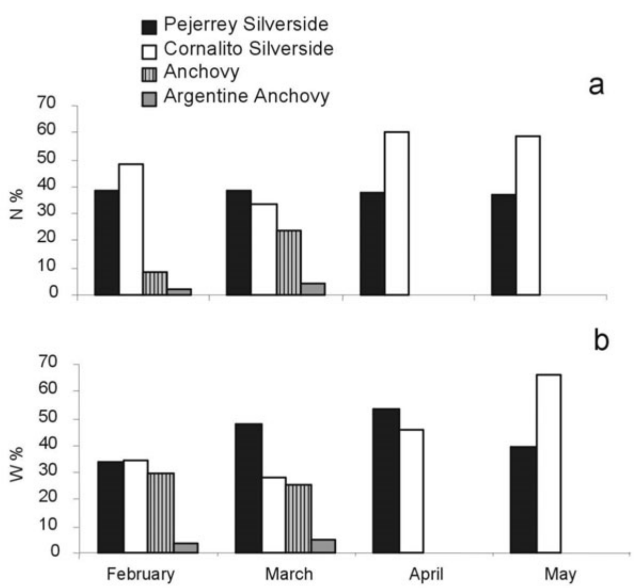

Fig. 1. Importance by number (a) and by mass (b) of the main prey in the diet of the Black Skimmer at Mar Chiquita, Argentina.

DISCUSSION

These results are similar to North American studies of the diet of the Black Skimmer, in which one of the most important prey was the silverside *Menidia* sp. (Atherinidae), whereas Anchovy and Bluefish were reported as occasional prey (Erwin 1977a,b). The only reference in areas reasonably close to the study area (200 km distance) comes from Punta Rasa, the southern tip of Samborombón Bay, Argentina (Favero *et al*. 2001) where the diet of skimmers was much more diverse (12 fish prey species, n = 642) than that observed in this work (five species, n = 1034). Both silversides were the most important fish prey in the diet in Mar Chiquita, whereas in Samborombon the main prey (in order of abundance) were Marini's Anchovies, White Croakers *Micropogonias furnieri*, Pejerrey Silversides, Argentine Anchovies and Cornalito Silversides (Favero *et al*. 2001). These differences in prey diversity might be partially related to the large fish diversity reported for Samborombón Bay (35 fish species, Lasta 1995), as compared to Mar Chiquita (28 species, Cousseau *et al*. 2001).

The average length of the prey consumed by Black Skimmers at Mar Chiquita was very close to the average length found in the diet of skimmers at nearby areas such Samborombon Bay (77±34 mm) (Favero *et al*. 2001). However, these data differed from the North American studies that reported an average prey length of 55 mm at Florida (Leavitt 1957), and between 10 and 50 mm at colonies from Virginia (Erwin 1977b). Since these previous studies are referred to

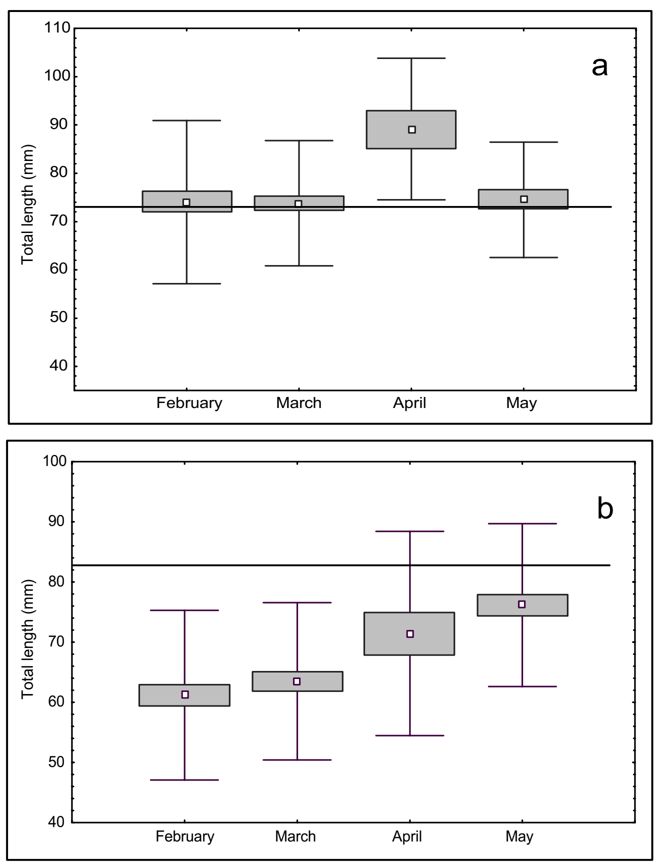

Fig. 2. Variation in the total length of Pejerrey (a) and Cornalito Silversides (b) consumed through the season by Black Skimmers. Means (dots) are shown together with ± one SE (boxes) and ± one SD (whiskers). Lines show median prey sizes (estimated on the basis of size ranges) reported by Cousseau *et al*. (2001)

prey found in stomachs or brought to the chicks, these differences in the sizes could be due to different sampling methods, seasonal variations of the diet, geographic differences, or to a combination of these.

The small proportion of samples with otoliths give rise to some uncertainty about the accuracy of the methodology (i.e. how well the recovered otoliths accurately reflected the fish consumed). Biases due to the loss by digestion and/or loss of the otoliths through the gastrointestinal tract can produce an important underestimate of fish larvae or small juvenile fish consumed (Duffy & Laurenson 1983, Jobling & Breiby 1986, Johnstone *et al*. 1990). These biases have been experimentally demonstrated in feeding trials on several bird species (Duffy & Laurenson 1983, Johnstone *et al*. 1990, Casaux *et al*. 1995).

Our results were consistent with previous studies carried out in Buenos Aires Province (Favero *et al*. 2001), showing that Black Skimmers in their non-breeding grounds feed both in fresh-water, estuarine and marine habitats, and are not restricted to foraging in estuarine and fresh-water environments as reported for breeding areas in the northern hemisphere. Further studies focused on the foraging behaviour of this species will allow a better understanding about foraging plasticity and constraints linked with their stereotyped foraging behaviour.

ACKNOWLEDGEMENTS

We thank Charlie García-Mata, Sofi Pimpollo Copello, Mariela Tornado Ghys, Camilo Khatchikian, Gabriela Palomo and Carla Maringolo for their field assistance. Oscar Iribarne and Alicia Escalante provided helpful comments on the earlier versions of the manuscript. This study was supported by Mar del Plata University Grant (15-E/110).

REFERENCES

BLACK, B.B. & HARRIS, L.D. 1983. Feeding habitat of Black Skimmers wintering on the Florida Gulf coast. *Wilson Bulletin* 95: 404-415.

BROWN, K.M. & EWINS, P.J. 1996. Technique-dependent biases in determination of diet composition: an example with Ring-billed Gulls. *Condor* 98: 34-41.

BURGER, J. 1982. The role of reproductive success in colony-site selection and abandonment in Black Skimmers (*Rynchops niger*). *Auk* 99: 109-115.

BURGER, J. & GOCHFELD, M. 1990. The Black Skimmer: social dynamics of a colonial species. New York: Columbia University Press.

CASAUX, R., BARRERA-ORO, E., FAVERO, M. & SILVA, P. 1998. New correction factors for the quantification of fish represented in pellets of the Imperial Cormorant *Phalacrocorax atriceps*. *Marine Ornithology* 27: 54-59.

CASAUX, R., FAVERO, M., BARRERA-ORO, E. & SILVA, P. 1995. Feeding trial on an Imperial Cormorant *Phalacrocorax atriceps*: preliminary results on fish intake and otolith digestion. *Marine Ornithology* 23: 101-106.

CASAUX, R., FAVERO, M., CORIA, N. & SILVA, P. 1997. Diet of the Imperial Cormorant *Phalacrocorax atriceps*: comparison of pellets and stomach contents. *Marine Ornithology* 25: 1-4.

COUSSEAU, M.B.; DIAZ DE ASTARLOA, J.M. & FIGUEROA, D.E. 2001. La ictiofauna de la Laguna Mar Chiquita. In: Iribarne, O. (Ed.). Reserva de Biósfera Mar Chiquita. Características Físicas, Biológicas y Ecológicas. UNESCO – Ed. Martín. pp. 187-203.

COUSSEAU, M.B. & PERROTA, R. 2000. Peces marinos de Argentina: biología, distribución y pesca (2ª edición). Mar del Plata: Instituto Nacional de Investigación y Desarrollo Pesquero.

DUFFY, D.C. & JACKSON, S. 1986. Diet studies of seabirds: a review of methods. *Colonial Waterbirds* 9: 1-17.

DUFFY, D.C. & LAURENSON, L. 1983. Pellets of Cape Cormorants as indicators of diet. *Condor* 85: 305-307.

ERWIN, R.M. 1977a. Black Skimmer breeding ecology and behavior. *Auk* 94: 709-717.

ERWIN, R.M. 1977b. Foraging and breeding adaptations to different food regimes in three seabirds: the Common Tern, *Sterna hirundo*, Royal Tern, *Sterna maxima*, and Black Skimmer, *Rynchops niger*. *Ecology* 58: 389-397.

FAVERO, M., BÓ, M.S., SILVA, M.P. & GARCÍA-MATA, C. 2000a. Food and feeding biology of the South American Tern during non-breeding season. *Waterbirds* 23: 125-129.

FAVERO, M., SILVA, M.P. & MAUCO, L. 2000b. Diet of Royal Tern (*Thalasseus maximus*) and Sandwich Tern (*Thalasseus sandvicensis*) during the austral winter in the Buenos Aires Province, Argentina. *Ornitologia Neotropical* 11: 259-262.

FAVERO, M., MARIANO-JELICICH, R., SILVA RODRÍGUEZ, M.P., BÓ, M.S. & GARCÍA-MATA, C. 2001. Food and feeding biology of Black Skimmer in Argentina: evidence supporting offshore feeding in non-breeding areas. *Waterbirds* 24: 413-418.

JOBLING, M. & BREIBY, A. 1986. The use and abuse of fish otoliths in studies of feeding habits of marine piscivores. *Sarsia* 71: 265-274.

JOHNSTONE, I., HARRIS, M., WANLESS, S. & GRAVES, J. 1990. The usefulness of pellets for assessing the diet of adult Shags *Phalacrocorax aristotelis*. *Bird Study* 37: 5-11.

LASTA, C.A. 1995. La Bahía Samborombón: zona de desove y cría de peces. Tesis doctoral. Universidad Nacional de La Plata. 304 pp.

LEAVITT, B.B. 1957. Food of the Black Skimmer (*Rynchops nigra*). *Auk* 74: 394.

RICO, R. 2000. Salinidad y distribución espacial de la ictiofauna en el estuario del Río de la Plata. Tesis de grado. Universidad Nacional de Mar del Plata.

ROSENBERG, K.V. & COOPER, R.J. 1990. Approaches to avian diet analysis. *Studies in Avian Biology* 13: 80-90.

TORNO, A.E. 1970. Descripción y comparación de los otolitos de algunas familias de peces de la plataforma Argentina. *Revista Museo Argentino de Ciencias Naturales Bernardino Rivadavia* 70: 3-20.

UNDERWOOD, A. 1997. Experiments in ecology. Their logical design and interpretation using analysis of variance. Cambridge: Cambridge University Press.

VILELA, N.M. 1988. Morfología y morfometría de los otolitos sagitta de peces del Mar Argentino. Tesis de grado. Universidad Nacional de Mar del Plata.

WHITE, D.H., MITCHEL, C.A. & SWINEFORD, D.M. 1984. Reproductive success of Black Skimmers in Texas relative to environmental pollutants. *Journal of Field Ornithology* 55: 18-30.

ZAR, J.H. 1999. Biostatistical analysis. Englewood Cliff: Prentice-Hall, Inc.

ZUSI, R.L. 1996. Family Rynchopidae (Skimmers). In: del Hoyo, J. Elliott, A. & Sargatal, J. (Eds.). Handbook of the birds of the world. Vol. 3. Hoatzin to Auks. Barcelona: Lynx Edicions. pp. 668-677.