

# STOMACH CONTENTS OF THE MAGELLANIC PENGUIN *SPHENISCUS MAGELLANICUS* FROM THE NORTHERN DISTRIBUTION LIMIT ON THE ATLANTIC COAST OF BRAZIL

MARINA B.L.C. PINTO<sup>1</sup>, SALVATORE SICILIANO<sup>2</sup> & ANA PAULA M. DI BENEDITTO<sup>1</sup>

<sup>1</sup>Laboratório de Ciências Ambientais, CBB, Universidade Estadual do Norte Fluminense,  
Av. Alberto Lamego 2.000, Campos, RJ, 28013-600, Brazil  
(anapaula@uenf.br)

<sup>2</sup>Laboratório de Ecologia, Departamento de Endemias Samuel Pessoa, Escola Nacional de Saúde Pública,  
FIOCRUZ, Rua Leopoldo Bulhões 1.480, Rio de Janeiro, RJ 21041-210, Brazil

Received 14 December 2005, accepted 28 September 2006

The Magellanic Penguin *Spheniscus magellanicus* is widely distributed along the southern coast of South America. On the Atlantic coast, the species breeds from Peninsula Valdez (42°04'S, 63°21'W) to Tierra del Fuego (54°54'S, 67°23'W), Argentina (Gandini *et al.* 1996). First-year penguins migrate to lower latitudes during the austral winter, reaching Brazilian waters between 20°S and 33°S, which represents the northern limit of the species' distribution along the Atlantic coast (Sick 1997, Nacinovic 2005).

Information on the diet of the Magellanic Penguin has been collected mainly during breeding, when fish are the most abundant prey (Scolaro & Badano 1986, Frere *et al.* 1996, Scolaro *et al.* 1999). However, little information is available on the species' diet outside of the breeding season when it seems to switch to cephalopods (Fonseca *et al.* 2001). Moreover, no information is available on diet in the species' northern distributional limits. Here, we report on the diet of Magellanic Penguins at the limit of their northern migration on the Atlantic coast. We examined the stomach contents of beach-washed penguins found along the coast of Rio de Janeiro State, Brazil.

In September 2000, more than 100 first-year Magellanic Penguins were beach-washed along the coast of Arraial do Cabo (23°00'S, 41°50'W), Brazil. Forty penguins in the early decomposition stage were randomly selected, but the sex of birds was not determined. The stomachs were preserved in 70% ethanol for later analysis.

Lower or upper cephalopod beaks (or both) recovered in the stomachs were used to detect prey presence and to identify, quantify and back-calculate the length and mass of the prey species using equations from Clarke (1986) and Di Benedetto *et al.* (2001). Beaks were measured using a stereomicroscope with a reticulated micrometer eyepiece. Beaks were categorized according to the degree of digestion, including damage to the wing and wall (Clarke 1986). The index of relative importance [IRI (Pinkas *et al.* 1971)] was used to determine the importance of these prey species. Other remains recovered from the penguins' stomachs such as teleost bones, crustacean carapaces, crystalline lenses and items accidentally ingested (e.g. plastic and paper) were also recorded and identified whenever possible.

Most stomachs contained only hard remains, and only in two stomachs did we find some tissue attached to beaks. Cephalopods were the most frequent prey species (Table 1). The otoliths of

Largehead Hairtail *Trichiurus lepturus*, the only fish remains found in this study, were recorded in two stomachs (Table 1). The crustaceans (isopods and barnacles) were probably an incidental or secondary ingestion (Table 1).

Cephalopod beaks consisted of three species: *Argonauta nodosa*, *Loligo plei* and *L. sanpaulensis* (Tables 1 and 2). The smallest cephalopod was *A. nodosa*, followed by *L. sanpaulensis* and *L. plei* (Table 2). Despite its small size, *A. nodosa* was the most abundant prey, with the highest IRI value (Table 2). In 35 stomachs (87.5%), the horny structure of recovered cephalopod beaks was damaged, with both wing and wall extensively broken. In only 12 stomachs (12.5%) were the beaks intact.

Magellanic Penguins, like other penguin species, have opportunistic feeding behaviour and prey upon fish, cephalopods and crustaceans, which are also the most abundant species in their distribution (Radl & Culik 1999). The cephalopod *A. nodosa* was the most important

**TABLE 1**  
Items recorded in the stomach contents of  
Magellanic Penguins *Spheniscus magellanicus*  
from the coast of Rio de Janeiro State, Brazil

| Type                 | Prey Item                         | Stomachs with item [n (%)] | Total Items (n) | Mass (g) |
|----------------------|-----------------------------------|----------------------------|-----------------|----------|
| Molluscs             | <i>Argonauta nodosa</i>           | 39 (97.5)                  | 1547            | 4776.2   |
|                      | <i>Loligo plei</i>                | 30 (75)                    | 128             | 5719.9   |
|                      | <i>Loligo sanpaulensis</i>        | 26 (65)                    | 102             | 1841.8   |
|                      | Crystalline lenses of cephalopods | 35 (87.5)                  | 1387            | —        |
| Crustaceans          | Isopods                           | 2 (5)                      | 4               | —        |
|                      | Barnacles                         | 1 (2.5)                    | 2               | —        |
| Fish                 | <i>Trichiurus lepturus</i>        | 2 (5)                      | 4               | —        |
| Seagrass             |                                   | 13 (32.5)                  | 52              | —        |
| Stones               |                                   | 3 (7.5)                    | 7               | —        |
| Plastic <sup>a</sup> |                                   | 12 (35)                    | 52              | —        |
| Fishing line         |                                   | 3 (7.5)                    | 13              | —        |
| Paper                |                                   | 10 (25)                    | 12              | —        |

<sup>a</sup> Probably plastic bag remains.

food for penguins off Rio de Janeiro State, similar to their diet on the southern Brazilian coast (29°–33°S) (Fonseca *et al.* 2001).

The cephalopod *A. nodosa* is an epipelagic species with a worldwide distribution in tropical and warm-temperate waters (Roper *et al.* 1984). The semipelagic squids of the family Loliginidae, *L. plei* and *L. sanpaulensis*, are abundant in southern and southeastern Brazilian coastal waters (Haimovici & Perez 1991). The distribution pattern of the preferred prey of Magellanic Penguins seems to indicate a migratory movement along the continental shelf. Evaluation of prey from the stomach contents showed a uniformity in both the species and the size of cephalopods taken by individual penguins.

Beaks of cephalopods are horny structures, which are very resistant to mechanical and chemical digestion (Heezik & Seddon 1989). Most of the beaks recovered from the stomach contents of the penguins were damaged, suggesting that the cephalopods may have been taken far from the Arraial do Cabo region. As compared with fish remains such as otoliths, cephalopod beaks may last for many days in seabird stomachs (Heezik & Seddon 1989). In this case, retention of beaks in the stomach may have led to an overestimation of cephalopods to fish in the penguin diet.

The presence of seagrass and marine debris remains (i.e. plastic and paper) in penguin stomachs is likely to reflect incidental or secondary ingestion. Along the coast of southern Brazil, Petry *et al.* (2004) also reported plastic remains in the stomach of beach-washed Magellanic Penguins. This solid waste (plastic and paper) is related to environmental pollution and could be considered a conservation concern for this species and for other seabirds.

#### ACKNOWLEDGMENTS

We express our appreciation to Tatiana Fernandes and Érico Demari e Silva, who helped with the collection of penguin carcasses. Dr. Roberta Aguiar dos Santos of the Laboratório de Recursos Demersais e Cefalópodes da Fundação Universidade de Rio Grande helped in the identification of squid beaks. A.P.M. Di Benedetto was supported by CNPq (Process nº 300322/03-8). This work is a contribution of the Graduate Program of Ecology and Natural Resources/UENF.

#### REFERENCES

CLARKE, M.R. 1986. A handbook for the identification of cephalopod beaks. Oxford: Clarendon Press. 273 pp.

- DI BENEDETTO, A.P.M., RAMOS, R.M.A. & LIMA, N.R.W. 2001. Os golfinhos: origem, classificação, captura accidental e hábito alimentar. Porto Alegre: Cinco Continentes. 148 pp.
- FONSECA, V.S., PETRY, M.V. & JOST, A.H. 2001. Diet of the Magellanic Penguin on the coast of Rio Grande do Sul, Brasil. *Waterbirds* 24: 290–293.
- FRERE, E., GANDINI, P. & LICHTSCHEIN, V. 1996. Variación latitudinal en la dieta del Pinguino de Magallanes (*Spheniscus magellanicus*) en la costa Patagónica, Argentina. *Ornitología Neotropical* 7: 35–41.
- GANDINI, P., FRERE, E. & BOERSMA, P.D. 1996. Status and conservation of the Magellanic Penguin *Spheniscus magellanicus* in Patagonia, Argentina. *Bird Conservation International* 6: 307–316.
- HAIMOVICI, M. & PEREZ, J.A.A. 1991. Coastal cephalopod fauna of southern Brazil. *Bulletin of Marine Science* 49: 221–230.
- HEEZIK, Y.V. & SEDDON, P. 1989. Stomach sampling in the Yellow-eyed Penguin: erosion of otoliths and squid beaks. *Journal of Field Ornithology* 60: 451–458.
- NACINOVIC, B. 2005. Aves marinhas na Bacia de Campos. Série Guias de Campo: fauna marinha da Bacia de Campos. Rio de Janeiro: Fundação Oswaldo Cruz. 60 pp.
- PETRY, M.V., FONSECA, V.S.S. & JOST, A.H. 2004. Registro de pingüim-de-Magalhães (*Spheniscus magellanicus*) mortos no Rio Grande do Sul. *Acta Biologica Leopoldinense* 26: 139–144.
- PINKAS, L., OLIPHANT, M.S. & IVERSON, I.L.K. 1971. Food habits of albacore, bluefin tuna and bonito in Californian waters. *California Fish and Game* 152: 1–105.
- RADL, A. & CULIK, B.M. 1999. Foraging behaviour and reproductive success in Magellanic Penguins (*Spheniscus magellanicus*): a comparative study of two colonies in southern Chile. *Marine Biology* 133: 381–393.
- ROPER, C.F.E., SWEENEY, M.J. & NAUEN, C.E. 1984. FAO Species catalogue. Vol. 3. Cephalopods of the world. Rome: Food and Agriculture Organization of the United Nations. 277 pp.
- SCOLARO, J.A. & BADANO, L.A. 1986. Diet of the Magellanic Penguin *Spheniscus magellanicus* during the chick-rearing period at Punta Clara, Argentina. *Cormorant* 13: 91–97.
- SCOLARO, J.A., WILSON, R.P., LAURENTI, S., KIERSPEL, M., GALLELLI, H. & UPTON, J.A. 1999. Feeding preference of the Magellanic Penguin over its breeding range in Argentina. *Waterbirds* 22: 104–110.
- SICK, H. 1997. Ornitología Brasileira. Rio de Janeiro: Nova Fronteira. 862 pp.

**TABLE 2**  
Mantle length, mass and index of relative importance of the cephalopods recorded in the stomach contents of Magellanic Penguins *Spheniscus magellanicus* from the coast of Rio de Janeiro State, Brazil

| Species                    | Mantle length (mm) |       |            | Mass (g) |       |           | Index of relative importance <sup>a</sup> |
|----------------------------|--------------------|-------|------------|----------|-------|-----------|---|
|                            | Min                | Max   | Mean±SD    | Min      | Max   | Mean±SD   |   |
| <i>Argonauta nodosa</i>    | 8.5                | 76.7  | 24.0±9.4   | 0.1      | 81.4  | 3.1±5.8   | 12 216.7                                  |
| <i>Loligo plei</i>         | 26.7               | 260.9 | 132.1±51.6 | 1.0      | 170.7 | 44.7±36.3 | 3 975.0                                   |
| <i>Loligo sanpaulensis</i> | 19.6               | 152.6 | 54.5±32.8  | 0.9      | 86.1  | 18.1±19.0 | 1 339.0                                   |

<sup>a</sup> (%number + %mass) \* (%occurrence).

SD = standard deviation.