

CEPHALOPODS IN THE DIET OF MAGELLANIC PENGUINS *SPHENISCUS MAGELLANICUS* FOUND ON THE COAST OF BRAZIL

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Magellanic Penguins, *Spheniscus magellanicus* Forster, 1781, are breed mainly along the coasts of Chile and Argentina (Bingham, 2002). Although they do not breed in Brazil, they are found alive and dead, along the Brazilian coast outside the breeding season, during the fall and winter. This has been happening for many years as shown from archeological remains (Gaspar, 1999). After the breeding season (September to March), adults and juveniles leave their colonies and migrate north, along with the movement of ocean currents, such as the Falkland current (Williams, 1995; Sick, 1997). During these movements, Magellanic Penguins reach the waters off the Brazilian coast, especially off states in southern Brazil as far north as Rio de Janeiro. Occasionally, specimens can be found as far north as the state of Bahia (Roos, 2008).

The present study describes the occurrence of cephalopods in the stomachs of 16 specimens of *S. magellanicus* found on the Brazilian coast in 2006. The specimens examined were live juveniles found on the northern coast of the state of São Paulo and the southern coast of the state of Rio de Janeiro. On initial examination they exhibited debilitation, dehydration and lethargy and subsequently died within hours or days. During necropsy, the stomachs were removed and the contents fixed in 70% alcohol.

Cephalopod fragments were separated and beaks, corneas or mandibles were identified with the help of the reference collection the Research and Management Center for Fishery Resources on the Southeastern and Southern Coast, at the Chico Mendes Biodiversity Conservation Institute and deposited at the same Institute (lot numbers 0072 to 0087). Mantle length (ML, mm) and total weight (Wt, g) were estimated from regressions against the measurements

of lower rostrum length (LRL) and upper rostrum length (URL) for squids and lower hood length and upper hood length for octopi (Santos, 1999).

All specimens necropsied contained cephalopods. A total of 502 beaks were found, originating from three species of cephalopods, the most abundant of which was the pelagic octopus *Argonauta nodosa* Lightfoot, 1786 (95.8% of beaks), followed by the squid *Loligo plei* Blainville, 1823 (3.0%) and the sepiolid *Semirossia tenera* Verrill, 1880 (0.2%) (Table 1). Among the material analyzed, five (1.0%) of the beaks from squids were only identified to the family level (Loliginidae).

Most of the mantle lengths estimated for the cephalopods corresponded to small individuals. The mean ML estimate was 21.2 mm for *Argonauta nodosa* (Fig.1), with at least 286 individuals found. This species was found in 100% of the stomach contents analyzed, with the number of individuals per stomach ranging from two to 65 (Table 2). *L. plei* (mean ML 8.1 mm) occurred in 25% of the stomachs, with beaks corresponding to 14 squids, ranging from one to 11 individuals per stomach. The beaks of unidentified Loliginidae were found in 1.0% of the stomachs (1 to 2 individuals per stomach), whereas only one upper beak from *S. tenera* was found, with an estimated ML of 21.7 mm. Some stomachs had more than one cephalopod species and, in one stomach, four *taxa* were represented.

Magellanic Penguins are considered opportunistic predators, feeding on the most abundant prey available throughout their distribution, such as fish, crustaceans and cephalopods (Radl & Culik, 1999). The species *A. nodosa*, which was the most frequent food item in the

TABLE 1
Prevalence (% of number of beaks) and number of beaks (maximum and minimum in parentheses: upper and lower) in the stomach contents of *Spheniscus magellanicus* found on the coast of Brazil.

	<i>Argonauta nodosa</i>	<i>Loligo plei</i>	Loliginidae	<i>Semirossia tenera</i>
Prevalence (%)	95.8	3.0	1.0	0.2
Mean (SE)	19.18 (4.4)	0.87 (0.7)	0.25 (0.1)	0.06 (0.1)
Deviation	17.6	2.7	0.6	0.3
Number of beaks	481 (246, 235)	15 (13, 2)	5 (2, 3)	1 (1, 0)
Beaks per stomachs	3 – 123	1 – 11	1 - 3	1

SE = standard error

present study, is a pelagic octopus that exhibits sexual dimorphism in size. The female is larger; its ML can reach up to 300 mm (Nesis, 1987) and it secretes an external egg sac in the shape of a shell, which also assists its floatability (Young, 1960). The male only reaches 15 mm in ML (Naef, 1923). The squid *L. plei* is a coastal species, abundant on the southern and southeastern coasts of Brazil between the states of Santa Catarina and Rio de Janeiro. This species has considerable commercial importance, especially during the summer months (Perez *et al.*, 2005). *S. tenera* is a small demersal sepiolid that inhabits muddy and sandy bottoms on the continental shelf and upper continental slope (Haimovici & Perez, 1991).

Fonseca *et al.* (2001) analyzed 144 stomachs from *S. magellanicus* individuals found on the coast of the state of Rio Grande do Sul (southern Brazil) and identified five species of cephalopods, the most abundant of which were *A. nodosa* and *L. plei*, as observed in the present study, indicating predation in coastal waters. The authors also found beaks from *Loligo sanpaulensis* Brakoniecki, 1984, *Ilex argentinus* Castellanos, 1960 and *Histiteutis* sp. Orbigny, 1841, the latter two of which are more oceanic species, suggesting that these penguins remain in waters away from the coast at least during part of their migration. Azevedo & Schifler (1991) analyzed stomach contents of *S. magellanicus* specimens found on the beaches of the state of Santa Catarina and found five species of cephalopods, including *A. nodosa* and *L. plei*, as well as three other species: *I. argentinus*, an unidentified sepiolid and *L. sanpaulensis*, which was the most abundant. On the northern coast of the state of Rio de Janeiro, Pinto *et al.* (2007) identified only one fish species and three cephalopod species: *A. nodosa*, *L. plei* and *L. sanpaulensis*. As in

the present study, *A. nodosa* was the most frequent species both in number of stomachs in which it occurred as well as in the number of beaks per stomach. The length obtained also demonstrated predation on small individuals of this pelagic octopus, although the squid found by these authors larger than those found in the present study. Frere *et al.* (1996) identified a latitudinal variation in the occurrence of food items in the diet of *S. magellanicus* in Argentine Patagonia with the frequencies of occurrence of cephalopod samples from the genera *Illex* and *Loligo*, ranging from 8% to 83%, depending on the region analyzed. Fish were the predominant food items.

Cephalopod beaks are structures that are very resistant to digestive processes and consequently remain in the stomachs for longer than some other food types. This means they may be ingested in a region distant from the one in which they are found (Heezik & Seddon 1989). Consumption of *A. nodosa* by Magellanic Penguins in southeastern Brazil appears to be greater than for other squids, such as *L. sanpaulensis* in the southern region, thereby corroborating the latitudinal variation in their diet observed by other authors.

REFERENCES

- AZEVEDO, T.R. & SCHIFLER, A. 1991. Notes on the diet ingestion of plastic material by the Magellanic Penguin *Spheniscus magellanicus* on Santa Catarina Island and mainland (Brazil). *Research Report*, Unjiversity of Liège, Institution of Zoologie, Belgium, pp. 1-8.
- BINGHAM, M. 2002. The decline of Falkland Islands penguins in the presence of a commercial fishing industry. *Revista Chilena de Historia Natural* 75: 805-818.
- FONSECA, V.S., PETRY, M.V., & JOST, 2001. Diet of the Magellanic Penguin on the Coast of Rio Grande do Sul, Brazil. *Waterbirds* 24: 290-293.
- FRERE, E., GANDINI, P. & LICHTSCHEIN, V. 1996. Variacion latitudinal en la dieta del pinguino de magallanes (*Spheniscus magellanicus*) en la Costa Patagónica, Argentina. *Ornitologia Neotropical* 7: 35-41.
- GASPAR, M. D. 1999. Sambaqui: arqueologia do litoral brasileiro [Shellmound: Brazilian Coast Archaeology]. Rio de Janeiro: Jorge Zahar Editor. pp 89.
- 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.

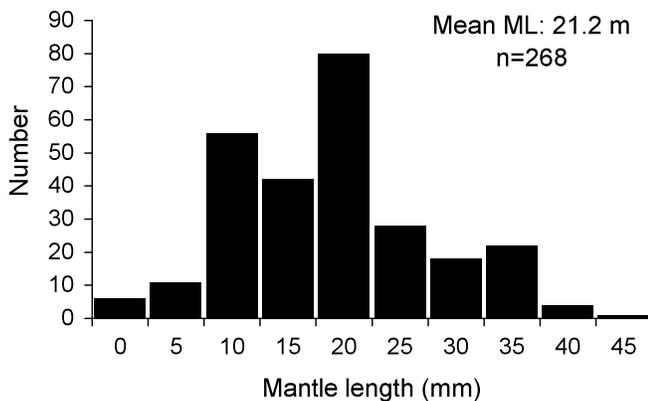


Fig. 1. Distribution of mantle lengths of the species *Argonauta nodosa* in the stomach contents of *Spheniscus magellanicus* found on the coast of Brazil.

TABLE 2
Occurrence in number of stomachs, number of individuals (N) (between parentheses: range per stomach), estimated mantle length (ML) and estimated total weight (Wt) of the cephalopods in the stomach contents of *Spheniscus magellanicus* found on the coast of Brazil.

Species	Occurrence	N	ML (mm)		Wt (g)	
			Mean (SE)	Range	Mean (SE)	Range
<i>Argonauta nodosa</i>	16	268 (2 – 65)	21.2 (0.5)	1.9 – 46.9	2.29 (0.15)	0.03 – 15.46
<i>Loligo plei</i>	4	14 (1 – 11)	8.1 (0.9)	2.9 – 12.8	0.20 (0.03)	0.04 – 0.44
Loliginidae	3	3 (1 – 2)				
<i>Semirossia tenera</i>	1	1	21.7		5.07	

- NAEF, A. 1923. Fauna e Flora d. Golfo d. Napoli, 35. *Teil* 1, 1: 1-863.
- NESIS, K.N. 1987. Cephalopods of the world. Squids, cuttlefishes, octopuses and allies. New Jersey: TFH Publications.
- PEREZ, J.A.A., GASALLA, M.A., AGUIAR, D.C., OLIVEIRA, U.C., MARQUES, C.A. & TOMÁS, A.R.G. 2005. *Loligo plei*. In: Cergole, M.C., Ávila-da-Silva, A.O. & Rossi-Wongtschowski, C.L.B (Eds). Análise das principais pescarias comerciais da região Sudeste-Sul do Brasil: dinâmica populacional das espécies em exploração [Analysis of the major commercial fisheries in the Southeast and Southern Brazil: population dynamics of species exploitation]. São Paulo: *Série documentos REVIZEE*, IO USP. pp. 62-68.
- PINTO, M.B.L.C., SALVATORE S. & DI BENEDITTO, A.P.M. 2007. Stomach contents of the Magellanic penguin *Spheniscus magellanicus* from the northern distribution limit on the Atlantic coast of Brazil. *Marine Ornithology* 35: 77-78
- 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.
- ROOS, A.L. 2008. Pinguins-de-magalhães (*Spheniscus magellanicus*) no Nordeste: migrantes ou errantes? [Magellanic Penguins (*Spheniscus magellanicus*) in the Northeast: migrants or wanderers?] *Boletim Eletrônico do CEMAVE* Ano II - nº 2.
- SANTOS, R.A. 1999. Cefalópodes nas relações tróficas do sul do Brasil. Rio Grande: Fundação Universidade do Rio Grande.
- SICK, H. 1997. Ornitologia Brasileira. Rio de Janeiro: Nova Fronteira.
- STRIEDER, R.S. 1991. Ocorrência de *Spheniscus magellanicus* (Forster 1781) no Litoral do Rio Grande do Sul, com abordagens sobre a biologia da espécie. [Occurrence of *Spheniscus magellanicus* (Forster 1781) on the Coast of Rio Grande do Sul, Brazil, with notes on the biology]. Porto alegre: Universidade do Vale do Rio dos Sinos.
- NAEF, A. 1923. Die Cephalopoden, Systematik. *Fauna flora Golf. Napoli* 35:1-863
- YOUNG, J.Z., 1960. Observations on Argonauta and especially its method of feeding. *Proceedings of the Zoological Society of London* 133: 471-479.
- WILLIAMS, T.D. 1995. The Penguins. Oxford: Oxford University Press.
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