

## Helminths of *Sotalia guianensis* (Cetacea: Delphinidae) from the South and Southeastern Coasts of Brazil

J. Marigo,<sup>1,2,9</sup> V. Ruoppolo,<sup>1,3</sup> F. C. W. Rosas,<sup>4</sup> A. L. S. Valente,<sup>5</sup> M. R. Oliveira,<sup>6</sup> R. A. Dias,<sup>7</sup> and J. L. Catão-Dias<sup>8</sup> <sup>1</sup> Projeto BioPesca, Rua Paraguai 241, Praia Grande, São Paulo, 11702-070, Brazil; <sup>2</sup> Laboratório de Avaliação e Promoção da Saúde Ambiental (LAPSA), Laboratório de Genética Molecular de Microorganismos (LGMM), Instituto Oswaldo Cruz (IOC-FIOCRUZ), Rio de Janeiro, RJ, Brazil; <sup>3</sup> International Fund for Animal Welfare (IFAW), Emergency Relief Team; <sup>4</sup> Instituto Nacional de Pesquisas da Amazônia (INPA), Manaus, AM, Brazil; <sup>5</sup> Instituto de Biologia, Universidade Federal de Pelotas (UFPEL), Pelotas, RS, Brazil; <sup>6</sup> Centro de Estudos do Mar, Universidade Federal do Paraná (CEM/UFPR), Pontal do Paraná, PR, Brazil; <sup>7</sup> Departamento de Medicina Veterinária Preventiva e Saúde Animal, Faculdade de Medicina Veterinária e Zootecnia, Universidade de São Paulo (FMVZ-USP), São Paulo, SP, Brazil; <sup>8</sup> Departamento de Patologia, Faculdade de Medicina Veterinária e Zootecnia, Universidade de São Paulo (FMVZ-USP), São Paulo, SP, Brazil; <sup>9</sup> Corresponding author (email: jumarigo@hotmail.com)

**ABSTRACT:** From May 1997 to October 2000, 49 *Sotalia guianensis* (tucuxi dolphin) incidentally caught in fishing nets or stranded in São Paulo (SP) and Paraná (PR) states in Brazil were necropsied. In total, 17 lungs, 35 stomachs, and 30 intestines were analyzed. Contents were washed through a sieve (mesh, 150 mm) and examined under a stereoscopic microscope for parasites. Histopathologic analyses were performed in the lungs of five infected dolphins. The nematode *Halocercus brasiliensis* was found in 88% of all lungs examined, inducing moderate-to-severe pneumonia. *Braunina cordiformis*, *Anisakis* sp., and acanthocephalans were found in the stomachs. The trematode *Synthesium tursionis* was the only parasite found in the intestines, and it was identified in 73% of the animals necropsied. No macroscopic lesions were seen due to parasites in the stomachs and intestines analyzed.

**Key words:** Cetacea, helminths, dolphin, pathology, *Sotalia guianensis*.

*Sotalia* is a genus of Neotropical dolphins with wide distribution along the western Atlantic coast and in the Amazon Basin (da Silva and Best, 1984; Cunha et al., 2005; Caballero et al., 2007). The marine tucuxi dolphin, *Sotalia guianensis*, is probably the second most incidentally captured dolphin in fishing activities in Brazil (IBAMA, 2001). One of the research priorities for the species is to identify its stocks by different methods, including the study of parasites as biologic tags (IBAMA, 2001). Worldwide, parasite studies in cetaceans have progressed in

recent years. However, these studies are still scarce in Brazil.

From May 1997 to October 2000, 49 tucuxi dolphins (30 male, 17 female, 2 undetermined) were incidentally caught in fishing nets or stranded on beaches located in Cananéia, São Paulo state (ca. 25°00'S, 47°56'W) and Paraná state (ca. 25°30'S, 48°23'W). The dolphins were collected and when possible, a complete necropsy was performed, emphasizing parasitologic and histopathologic sampling.

Total length and gender of each specimen were recorded. Age class was determined based on body length data and following guidelines of Rosas and Monteiro-Filho (2002) and Rosas et al. (2003). According to these two previous studies, sexual maturity is attained when males and females are 170–175 and 164–169 cm in length, respectively. In the present study, the average total length for *S. guianensis* was 166.88 ± 25.63 cm, suggesting that most animals were close to reaching maturity or mature.

From these 49 specimens, 17 lungs, 35 stomachs, and 30 intestines were studied. The tissues were macroscopically inspected individually, washed in a sieve (mesh, 150 mm), and the contents were examined under a stereoscopic microscope at 10× magnification. All parasites were fixed and stained according to Amato et al. (1991)

and Dailey (1978). Due to the fragility of the lung parasites and the difficulty in separating them, the levels of pulmonary infection were established as follows: low, + (up to 25 parasites); medium, ++ (26–50 parasites); high, +++ (51–75 parasites); and very high, ++++ (>75 parasites). The 17 lungs of *S. guianensis* analyzed presented different levels of infection: two animals did not have any parasites (12%, 2/17), six animals had low levels of infection (35%, 6/17), three had medium levels (18%, 3/17), and six had high levels (35%, 6/17). For identification purposes, pulmonary nematodes in good condition were sampled from each host. Of the 20 worms examined under microscopy, only a single species was found. *Halocercus brasiliensis* (Nematoda: Pseudaliidae: Metastrongyloidea) were observed with different infection levels in the bronchi of 88% of the cetaceans. Representative parasite specimens of *H. brasiliensis* were deposited at the Helminthological Collection kept by the Museu de Zoologia at Universidade de São Paulo (MZUSP 6484, 6484, 6486). This parasite is known to infect the respiratory tract of odontocete cetaceans, with a worldwide distribution (Howard et al., 1983; Measures, 2001). In Brazil, this nematode has been found within bronchi of the striped dolphin (*Stenella coeruleoalba*; Rosas et al., 2002).

The lungs of five *S. guianensis* were examined histopathologically. Moderate-to-severe pulmonary lesions related to the presence of parasites were observed in 80% of the cases (4/5). Parasitic pneumonia associated with *H. brasiliensis* was the most important lesion seen in 40% of the five animals studied, probably causing their death. Regardless of the small sample size, this finding indicates that lung parasitism may be an important debilitating condition for the species. Gross lesions observed during necropsy included nematodes within the bronchial tree, moderate-to-severe pulmonary congestion, and edema. Other findings included lobar multifocal abscedation and

fibrinous ascites. Fibrinous pleuropneumonia was a common finding in all cases. The most pronounced microscopic finding included moderate-to-severe chronic interstitial pneumonia and fibrinopurulent bronchopneumonia. Polymorphonuclear infiltrates, predominantly eosinophilic, were a common finding. Lung consolidation and lymphadenitis also were noted. A juvenile dolphin (total body length, 143.5 cm) died due to parasitic pneumonia, suggesting that the lesions associated with the infection may be more severe to young hosts. Prenatal infection has already been reported in other odontocete species (Dailey et al., 1991; Parsons et al., 1999). Fixed tissues, paraffin-embedded blocks, and histopathologic glass slides were deposited at Laboratório de Patologia Comparada de Animais Silvestres, Departamento de Patologia, Universidade de São Paulo, Brazil.

No parasites were found in the only stomach of *S. guianensis* analyzed from São Paulo state and gastric parasites (*Braunina cordiformis*, *Anisakis* sp., and acanthocephalans) were found in 23% of animals from Paraná state.

The trematode *B. cordiformis* was found in six animals and was recorded previously in Brazil (Santos et al., 1996), and despite small chronic gastritic foci, it is unlikely that it could compromise the dolphins' health (Schryver et al., 1967).

The nematode *Anisakis* spp. was found in four stomachs, and it is currently under molecular identification. Anisakid nematodes are widely spread and have a high prevalence in the marine environment, including South America (Santos et al., 1996; Andrade et al., 2001; Dailey, 2001; Motta et al., 2008). Parasite-induced ulcers are typically shallow and have the anterior end of the worm embedded; but in some cases, there may be numerous adult and larval anisakid parasites free within the lumen. Ulcers may be acute and hemorrhagic, or chronic, healing by fibrosis and granulation (Howard et al., 1983; Motta et al., 2008).

Acanthocephalans were found in six animals from Paraná state. In three of these cases, the acanthocephalans were identified as *Bolbossoma* sp. and were considered rare, with prevalence <10%. In Brazilian waters, this genus was reported previously in the intestines of La Plata dolphin (*Pontoporia blainvillei*), false killer whale (*Pseudorca crassidens*), and striped dolphin (Andrade et al., 1997, 2001; Rosas et al., 2002).

A single parasite species, the trematode *Synthesium tursionis*, was identified in the intestines of 73% of the animals. The intestines have been described previously as the main habitat for the genus *Synthesium* (Dans et al., 1999). These parasites were not regularly distributed within the intestines but were generally found in the anterior segment, as described previously for *P. blainvillei* (Marigo et al., 2002). *Synthesium tursionis* has been identified in other cetacean species (Torres et al., 1992; Marigo et al., 2008), including *S. guianensis* from other regions in Brazil (Andrade and Pereira, 1998). Andrade et al. (1997) describes *P. blainvillei* heavily infected with *Synthesium pontoporiae*, but no macroscopic lesions were observed.

No significant gross lesions were observed in the stomachs and intestines of the dolphins analyzed in the present study. Conversely, the severity of lesions related to lungworms is a serious condition for *S. guianensis*; as an aquatic animal, it is highly dependent on lung capacity. Pulmonary lesions will affect their health and ability to dive, subsequently affecting their feeding capabilities, growth, and survival (Measures, 2001).

The results of this study suggest that along the Brazilian coast, lungworms should be considered as an important cause of death in cetacean populations due to their direct effects through parasitic and bacterial pneumonias, cardiovascular complications, and hypersensitive reactions to the parasites as mentioned previously by Jepson et al. (2000) in dolphins stranded in England and Wales.

The present study also highlights the importance of surveying the health status of *S. guianensis* in other areas of the Brazilian coast.

The information presented is part of the MSc dissertations presented by J.M. and V.R. to the Department of Pathology at Faculdade de Medicina Veterinária e Zootecnia, Universidade de São Paulo, Brazil, and supported by FAPESP grants 00/14669-0 and 99/12335-8, respectively. It is also part of the MSc dissertation presented by M.R.O. to the Zoology Department, Universidade Federal do Paraná, Brazil. We thank FAPESP, Yaqu Pacha, Project Aware-PADI, Society for Marine Mammalogy, Cetacean Society International, Família Bahadian Moreira, Família Freire, and Fundação Marigo for financial support. J.L.C.-D. is the recipient of a professorship by Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq 301517-2006-1). We also thank other institutions and researchers who assisted with projects, especially Instituto de Pesquisas de Cananéia (IPeC, SP), Centro de Estudos do Mar (CEM, UFPR), and Projeto BioPesca and Projeto Atlantis (São Paulo). Tissues and parasite samples are stored at The Marine Mammal Tissue Bank (LAPCOM-FMVZ-USP). We thank S. Corey and C. H. Gardiner for critical reviews.

#### LITERATURE CITED

- AMATO, J. F. R., W. A. BOEGER, AND S. B. AMATO. 1991. Protocolo para Coleta e Processamento de Parasitos de Pescado, J. F. R. Amato (ed.). Universidade Rural do Rio de Janeiro, Rio de Janeiro, Brazil, 78 pp.
- ANDRADE, A. L. V., AND A. R. PEREIRA. 1998. Ocorrência de *Hadwenius tursionis* (Digenea: Campulidae) em *Sotalia fluviatilis* no litoral da Bahia. In Proceedings: 8<sup>a</sup> Reunião de Trabalho de Especialistas em Mamíferos Aquáticos da América do Sul, Organized by Centro Peixe-boi, IBAMA/PE, Fundação Mamíferos Marinhos Olinda, Pernambuco, Brazil, 25–29 October, p. 8.
- , ———, M. C. PINEDO, AND A. S. BARRETO. 2001. Gastrointestinal parasites and prey items from a mass stranding of false killer whales, *Pseudorca crassidens*, in Rio Grande do Sul, southern Brazil. *Revista Brasileira de Zoologia* 61: 55–61.

- , ———, ———, AND J. PEREIRA, JR. 1997. The gastrointestinal helminths of Franciscana, *Pontoporia blainvilliei*, in southern Brazil. Report of the International Whaling Commission 47: 669–673.
- CABALLERO, S., F. TRUJILLO, J. VIANNA, H. BARRIOS-GARRIDO, M. G. MONTELL, S. BELTRÁN-PEDREROS, M. MARMONTEL, M. C. SANTOS, M. ROSSI-SANTOS, F. R. SANTOS, AND C. S. BAKER. 2007. Taxonomic status of the genus *Sotalia*: Species level ranking for “tucuxi” (*Sotalia fluviatilis*) and “costero” (*Sotalia guianensis*) dolphins. *Marine Mammal Science* 23: 358–386.
- CUNHA, H., V. M. F. SILVA, J. LAILSON BRITO, M. C. O. SANTOS, A. F. AZEVEDO, P. A. FLORES, A. MARTINS, A. B. L. FRAGOSO, AND A. M. SOLE-CAVA. 2005. Riverine and marine ecotypes of *Sotalia* dolphins are different species. *Marine Biology* 148: 449–445.
- DAILEY, M. D. 1978. Preparation of parasites for identification and cataloging. *Journal of Zoo and Animal Medicine* 9: 13–15.
- . 2001. Parasitic diseases. In *Handbook of marine mammal medicine*, 2.ed, L. A. Dierauf and F. M. D. Gulland (eds.). CRC Press, Boca Raton, Florida, pp. 357–379.
- , M. WALSH, D. ODELL, AND T. CAMPBELL. 1991. Evidence of prenatal infection in the bottlenose dolphin (*Tursiops truncatus*) with the lungworm *Halocercus lagenorhynchi* (Nematoda: Pseudaliidae). *Journal of Wildlife Diseases* 27: 164–165.
- DANS, S. L., L. M. REYES, S. N. PEDRAZA, J. A. RAGA, AND E. A. CRESPO. 1999. Gastrointestinal helminths of the dusky dolphin, *Lagenorhynchus obscurus* (Gray, 1828), off Patagonia, in the southwestern Atlantic. *Marine Mammal Science* 15: 649–660.
- DA SILVA, V. M. F., AND R. C. BEST. 1984. Tucuxi: *Sotalia fluviatilis* (Gervais) 1853. In *Handbook of marine mammals*, Vol. 5. 1st Edition, S. Ridgway and R. Harrison (eds.). Academic Press, London, UK, pp. 43–69.
- HOWARD, E. B., J. O. BRITT, G. K. MATSUMOTO, R. ITAHARA, AND C. N. NAGANO. 1983. Parasitic diseases. In *Pathobiology of marine mammal diseases*. Vol. 1, E. B. Howard (ed.). CRC Press, Boca Raton, Florida, pp. 119–239.
- INSTITUTO BRASILEIRO DO MEIO AMBIENTE E DOS RECURSOS NATURAIS RENOVÁVEIS (IBAMA). 2001. Mamíferos aquáticos do Brasil: Plano de Ação, versão II. 2nd Edition. Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis, Brasília, Brazil, 102 pp.
- JEPSON, P. D., J. R. BAKER, T. KUIKEN, V. R. SIMPSON, S. KENNEDY, AND P. M. BENNET. 2000. Pulmonary pathology of harbour porpoises (*Phocoena phocoena*) stranded in England and Wales between 1990 and 1996. *Veterinary Record* 146: 721–728.
- MARIGO, J., F. C. W. ROSAS, A. L. V. ANDRADE, M. R. OLIVEIRA, R. A. DIAS, AND J. L. CATÃO-DIAS. 2002. Parasites of *Pontoporia blainvilliei* from São Paulo and Paraná states, Brazil. *Latin American Journal of Aquatic Mammals* 1: 115–122.
- , A. C. P. VICENTE, L. MEASURES, A. L. VALENTE, AND C. P. SANTOS. 2008. Redescription of *Synthesium pontoporiae* n. comb. with notes on *S. tursionis* and *S. seymouri* n. comb. (Digenea: Brachycladiidae). *Journal of Parasitology* 94: 505–514.
- MEASURES, L. N. 2001. Lungworms of marine mammals. In *Parasitic diseases of wild animals*. 2nd Edition, W. M. Samuel, M. J. Pybus and A. A. Kocan (eds.). Iowa State University Press, Ames, Iowa, pp. 279–300.
- MOTTA, M. R. A., D. C. S. N. PINHEIRO, V. L. CARVALHO, D. A. VIANA, A. C. P. VICENTE, AND A. M. INIGUEZ. 2008. Gastric lesions associated with the presence of *Anisakis* spp. Dujardin, 1845 (Nematoda: Anisakidae) in cetaceans stranded on the coast of Ceara, Brazil. *Biota Neotropica* 8: 91–95.
- PARSONS, E. C. M., G. D. BOSSART, AND R. E. KINOSHITA. 1999. Postmortem findings in a finless porpoise (*Neophocaena phocaenoides*) calf stranded in Hong Kong. *Veterinary Record* 144: 75–76.
- ROSAS, F. C. W., AND E. L. A. MONTEIRO-FILHO. 2002. Reproduction of the estuarine dolphin (*Sotalia guianensis*) on the coast of Paraná, southern Brazil. *Journal of Mammalogy* 83: 507–515.
- , A. S. BARRETO, AND E. L. A. MONTEIRO-FILHO. 2003. Age and growth of *Sotalia guianensis* (Cetacea, Delphinidae) on the coast of Paraná State, southern Brazil. *Fishery Bulletin* 101: 377–383.
- , E. L. A. MONTEIRO-FILHO, J. MARIGO, R. A. SANTOS, A. L. V. ANDRADE, M. RAUTENBERG, M. R. OLIVEIRA, AND M. O. BORDIGNON. 2002. The striped dolphin, *Stenella coeruleoalba* (Cetacea: Delphinidae), on the coast of São Paulo State, southeastern Brazil. *Aquatic Mammals* 28: 60–66.
- SANTOS, C. P., K. ROHDE, R. RAMOS, AND A. P. DI BENEDITTO. 1996. Helminths of cetaceans on the southeastern coast of Brazil. *Proceedings of the Helminthological Society of Washington* 63: 149–152.
- SCHRYVER, H. F., W. MEDWAY, AND J. F. WILLIAMS. 1967. The stomach fluke *Braunina cordiformis* in the Atlantic bottlenose dolphin. *Journal of the American Veterinary Medical Association* 151: 884–886.
- TORRES, P., J. A. OPORTO, L. M. BRIEVA, AND L. ESCARE. 1992. Gastrointestinal helminths of the cetaceans *Phocoena spinipinnis* (Burmeister, 1865) and *Cephalorhynchus eutropia* (Gray, 1846) from the southern coast of Chile. *Journal of Wildlife Diseases* 28: 313–315.

Submitted for publication 7 December 2007.