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Shark attacks on Irrawaddy dolphin in Chilika lagoon, India

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Abstract

Irrawaddy dolphin *Orcaella brevirostris* Gray, 1866 inhabit Chilika lagoon, Odisha on the east coast of India. The narrow outer channel connecting the main lagoon and the Bay of Bengal harbour approximately 60% of the Irrawaddy dolphin population. The bull shark *Carcharhinus leucas* Müller and Henle, 1839 travels from the sea 5-10 km inward to the outer channel during late gestation period. Mortality of Irrawaddy dolphins related to bull shark attack ranged from 1 to 3% of the population. An account of the shark attack on Irrawaddy dolphin was first recorded on 24th April, 2003 from the Chilika lagoon. Salinity and depth parameters of the outer channel are conducive for both the shark and the dolphin show the overlapping of the habitat. This study indicates that habitat or prey overlap may be responsible for the fatal bull shark attacks on Irrawaddy dolphin in Chilika lagoon.

Keywords: Irrawaddy dolphin, bull shark, shark attack

Introduction

The Irrawaddy dolphin *Orcaella brevirostris* Gray, 1866 occur in scattered pockets from southeast Asia to parts of south Asia. Irrawaddy dolphins in most parts of its distributional range are classified as "Critically Endangered" according to IUCN Red List Criteria (Kreb and Smith, 2000; Smith, 2004; Smith and Beasley, 2004a,b). In India Irrawaddy dolphin inhabits a few estuaries having an easy access to sea as in Chilika and Bhitarkanika (Brahmani and Baitarani estuaries) of Odisha and Sundarbans of West Bengal. From India, there is hardly any published record of predation, attacks, fatal bites or scavenging by sharks on Irrawaddy dolphins or other cetacean species. The shark attack on an Irrawaddy dolphin was first recorded on 24th April 2003 from the outer channel of Chilika lagoon.

The Chilika lagoon is located 19° 28′ to 19° 54′ N lat. and 85° 05′ to 85° 38′ E long. in Odisha along the east coast of India (Fig. 1). The lagoon covers an area of 1165 km^2 during monsoon and it shrinks to 906 km^2 in summer. Ecologically, the lagoon is sub-divided into four sectors; *viz*., northern, central and southern sectors and the outer channel. This paper delineates the observed findings, frequency and reasons for shark attacks on Irrawaddy dolphins in the outer channel of Chilika lagoon.

Material and Methods

Monthly boat surveys were carried out for the

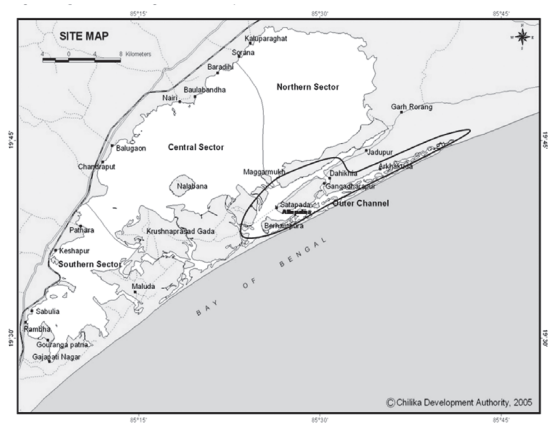

Fig. 1. Map of Chilika lagoon and study site

study of dolphin distribution and their habitat-use patterns using Garmin Global Positioning System (GPS 12), binoculars, rangefinders, compass, digital camera, water quality checker, measuring tape and echo-sounder. Geographical Information System (GIS) software (ArcView) was used for generating monthly distribution and habitat-use maps.

A detailed fish diversity study of outer channel was conducted from 2003 to 2009. Fifteen sampling points were identified and selected for uniform coverage of the outer channel (Fig. 2). Each sampling point covered an area of 500 m^2. Five random samples were taken from each sampling point which included various fishing gears. Weekly samplings were taken in all active fishing days throughout the study period. Sampling data included sample area code, date, time, types of fishing gears, mesh size, deployment duration, number of man-power

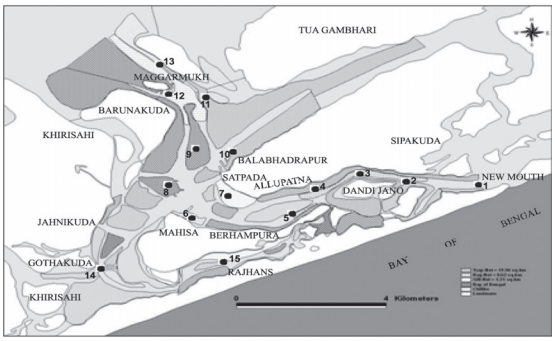

Fig. 2. Fish sampling points in fishing areas of outer channel

involved, approximate coverage area of fishing gear, fish species, approximate quantity and local market price. Expertise and cooperation of local fishermen and their fishing gears were helpful in this study. Fishermen use 1mm diameter monofilament seine nets (local name: Almi Jaal) to catch large sharks in deeper pools as well as hooks for smaller sharks and rays from winter till summer. Rays and small sharks were also recorded from gillnets and fixed trap nets. Information on sharks or rays caught in any fishing gear were shared by the fisherman to authors irrespective of the sampling period. For the purpose of this paper field data relating to large bull sharks have been considered.

After the first instance of shark attack on Irrawaddy dolphin, a continuous monitoring was undertaken to collect information on all sharks caught from the study area. Cooperation of local fishermen, tourist boat operators and forest staff (Dolphin Protection Squad, Satpada Wildlife Range, Chilika Wildlife Division) was very much helpful to improve the surveillance. In the event of recovery of Irrawaddy dolphin carcasses bearing shark bites, data were collected on the date and time of recovery, sex, size, approximate weight, length and breadth of the shark bite wound. Autopsy was undertaken by veterinary Assistant Surgeons and the first author under the supervision of officials from Chilika Wildlife Division. Data regarding capture of large sharks focused on date of shark caught, sex, length, approximate weight, site of catch and approximate market price. Usually fishermen remove the viscera of large sharks and stuff with rock salt before transportation to the market. This provided an opportunity to investigate stomach contents and litters in the womb of captured sharks. Based on the locality of shark catch, GPS readings were taken and GIS maps were generated for delineation of shark habitat in the outer channel. This study is a secondary outcome of Irrawaddy dolphin research program undertaken in Chilika lagoon from 2003 to 2009.

Results and Discussion

Irrawaddy dolphin population, distribution and habitat-use : Irrawaddy dolphins inhabit primarily in three ecological sectors of the lagoon *i.e.*, outer

channel, central sector and southern sector while a few dolphins from the outer channel swim up to dredged channel of the northern sector during winter. In February 2009, 146 dolphins were recorded from Chilika lagoon (Source: Chilika Development Authority, CDA). About 14 km^2 (approximately 47% of water-spread area) in outer channel is the primary habitat of Irrawaddy dolphins (Fig. 2). This area is inhabited by high density of Irrawaddy dolphins throughout the year (Pattnaik *et al.*, 2007).

Fish diversity in outer channel *:* During the study period, predominantly 70 species of Osteichthyes (bony fishes), 10 species of Chondrichthyes (cartilaginous fishes) and 14 species of Crustacea (6 species of shrimps and 8 species of crabs) were recorded from the outer channel of the Chilika lagoon. Review of published literature on fish diversity of Chilika has enlisted 13 species of elasmobranchs (Chaudhuri, 1916a, b, c, 1917, 1923; Hora, 1923; Devasundaram, 1954; Jhingran *et al.*, 1966; Rao, 1995; Mohanty, 2002; Satapathy and Panda, 2009; Froese and Pauly, 2010). Mohanty *et al.* (2007) assessed fish diversity from Chilika and recorded one shark species (*Scoliodon laticaudus* Müller and Henle, 1839) and four ray species. We recorded three shark species and four rays from the study area, among the three species, *Scoliodon laticaudus* Müller and Henle, 1839 reported earlier was reconfirmed. The bamboo shark *Chiloscyllium indicum* Meuschen, 1781 and bull shark *Carcharhinus leucas* Müller and Henle, 1839 are new records for Chilika lagoon (Khan unpublished). The other members of Carcharhinidae family *i.e*., *Carcharhinus limbatus* Müller and Henle, 1839, *Carcharhinus melanopterus* Quoy and Gaimard, 1824 and *Glyphis gangeticus* Müller and Henle, 1839 reported earlier from Chilika lagoon were not found during this study period. Thus, in seven years of study period the authors recorded only three species of sharks entering from the sea into the Chilika lagoon.

Bull sharks: Incidences of shark-bite on fishermen were mostly witnessed from Allupatna (2 km east of Satapada) and Berhampura villages. Interview with victims revealed that shark attacks were primarily at dawn or dusk from 0.5 m to 1.5 m depth of water. Information on locations of bull shark catches indicated that large sharks enter from the sea and travel roughly 5-10 km into the outer channel through the mouth during December-January. These sharks reside temporarily for 6-7 months (December-June) in deeper pools of the outer channel. Totally 11 adult female bull sharks were caught by the fishermen from outer channel, of this 9 sharks (2.36 - 3.38 m long) had 5-9 litters in their womb. No adult males were recorded indicating migration of only adult females (Table 1).

Fig. 3 shows that occurrence of sharks increases the interaction between the shark and dolphin. However all interactions do not lead to fatal attacks on Irrawaddy dolphins. Analysis of stomach content of both species indicated that 70% of prey species was common to both species (Khan unpublished). Competitive interactions for common prey may be the important reason for such fatal shark attacks on Irrawaddy dolphins.

Shark attacks on Irrawaddy dolphin*:* From January 2003 to December 2009, 72 carcasses of Irrawaddy dolphin were examined which were recovered from Chilika lagoon. Routine examination of these carcasses revealed that 10 Irrawaddy dolphin carcasses (7 males and 3 females) had succumbed to shark attack/bites. Distinct crescent-shaped shark-bites were found in 9 carcasses of Irrawaddy dolphin. Details of Irrawaddy dolphins which succumbed to

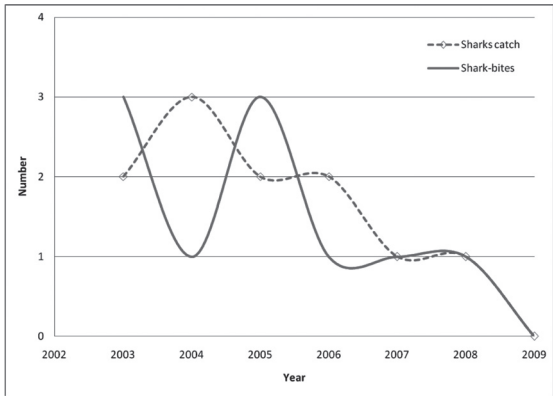

Fig. 3. Graphical presentation of shark catch versus shark bites

Table 1. Details of bull sharks caught from outer channel of Chilika

Year	Sex	Length (cm)	Approx. weight (kg)	Site of catch	Gut content	Litters in womb (No.)	Approx. market price (INR)
2003	Female	322	270	Allupatna	Fishes & Crustaceans	5	23,500
2003	Female	315	270	Allupatna	Fishes & Crustaceans	5	23,500
2004	Female	287	250	Allupatna	Fishes & Crustaceans	7	22,500
2004	Female	275	250	Allupatna	Fishes & Crustaceans	5	22,500
2004	Female	292	250	Balabhdrapur	Fishes & Crustaceans	5	22,500
2005	Female	308	260	Allupatna	Fishes & Crustaceans	5	23,000
2005	Female	338	300	Allupatna	Fishes, Crustaceans & Young shark litters	9	25,000
2006	Female	263	235	Allupatna	Fishes & Crustaceans	5	22,500
2006	Female	242	228	Sipakuda	Fishes & Crustaceans	0	21,500
2007	*Female	312	270	Allupatna	Fishes, Crustaceans & Remnants of dolphin skin and blubber	0	23,500
2008	Female	236	200	Allupatna	Fishes & Crustaceans	5	21,500
Total Amount in Indian Rupees (INR)							2,51,500

*Examination of stomach content of the shark revealed remnants of dolphin skin and blubber of Irrawaddy dolphin

Table 2. Details of Irrawaddy dolphins which succumbed to shark attacks

Date	Sex	Length (cm)	Approx. weight (kg)	Length of shark-bite (cm)	Breadth of shark-bite (cm)
24.04.2003	*Male	163	60	15	12
27.05.2003	Male	215	120	44	35
31.05.2003	Male	227	125	44	34
09.04.2004	Male	225	125	42	33
02.02.2005	Female	212	120	43.5	35.2
11.02.2005	Male	226	125	49	40
12.02.2005	**Female	211	120	-	-
05.04.2006	Male	219	115	41	33
30.01.2007	Female	228	125	45	36
14.03.2008	***Male	180	90	40	32

* This animal lost its fluke completely by shark bite. The measurement of shark bite taken at fluke-base does not reflect the actual size of shark bite.

** Opportunistic observation of shark chasing the dolphin near Dandi Jano. The dolphin jumped high out of water and landed on mudflat. Author found dolphin dead with no sign of shark bite.

*** Minimum autopsy was undertaken as carcass was in a state of decomposition.

shark bites are given in Table 2.

Most of the shark attacks were on the ventral side of the dolphins. In seven cases, shark bites were recorded between epigastric (thorax) and hypogastric (uro-genital) region along the length of the dolphin. The width extended from right lumber muscle to left lumber muscle. In some cases, shark-bites were witnessed first between neck-crease and thorax and second between thorax and genital (Fig. 4). In another instance, an Irrawaddy dolphin had lost the fluke from its fluke-base.

Examination of dolphin carcass: Detailed autopsy of eight Irrawaddy dolphin carcasses revealed that the carcasses were fresh having little

Fig. 4. Irrawaddy dolphins succumb to shark attack/ bite

or no foul smell except distinct smell of blood. Cadaveric spasm or rigor mortis had set-in and the jaws were closed tight. On exploration, it was found tongues were light pinkish in colour, no signs of dryness in buccal cavity and mucus was present in the gullet. Neck, flippers, dorsal fin and fluke were stiff. Edges of flipper, dorsal fin and fluke were smooth and soft. Eyes were fresh and glistening, blowhole flaps were tight, no purging of fluid from blowhole and blowhole wet by mucus. Dorsal and lateral side skin was mostly intact while sloughing skin on ventral side of the dolphin carcasses was observed. No signs of livor mortis were observed under the skin (purple-red colouration due to settling of blood resulting from gravity). Often the shark bite wounds were bleeding.

Internal organs were found with little or no signs of autolysis. Stomach mucus membrane of glandular sacs was intact in seven cases. Fresh fishes, remnants of undigested and partially digested fishes, fish scales, spines and otoliths were noticed in the stomach of six dolphin carcasses. Other two carcasses had no remnants of fishes except a few spines and otoliths in the stomach. No gaseous distension or bloating of intestines was observed in five carcasses. Three carcasses had intestines in part due to shark bite. Stool in small intestine were light brown in colour and slurry in nature while towards rectum it was semi-solid in nature. No signs of livor mortis were observed in lungs (may be due excessive haemorrhage). Minimal autopsy was done for one carcass bearing two shark bites as it was in a state of decomposition with foul smell and maggots and internal organs were putrefied. In two events a few shark teeth were lodged at the margin of the inflicted bite and a few fixed to rib bones of the dolphin carcasses (Fig. 5).

Autopsy report indicated shark bites may be ante-mortem in eight cases. For example, no sign of external livor mortis, fresh haemorrhaged wounds, little or no signs of autolysis in internal organs, no signs of livor mortis in lungs indicated that the dolphins were alive before shark attack. Perhaps fatal shark bite caused rupture and serration in arteries and veins of abdomen, leading to massive haemorrhage before death. From the shark species recorded during this study, dimensions of shark bites, and shark tooth samples, it is evident that only adult bull sharks could inflict such bites. The shark attacks/ bites in Chilika lagoon are probably unprovoked but are habitual patterns of strategic attacks from beneath the dolphin. Lack of shark-bite scars on live Irrawaddy dolphin in Chilika supports the hypothesis of Norris *et al.* (1994) and Heithaus (2001a).

Irrawaddy dolphins which had succumbed to bull shark bites showed loss of skin, blubber, muscles, rib bones, sternum, oesophagus and portion of intestine from the inflicted areas. Dimension and depth of skin, blubber and muscle taken from carcasses indicates that a bull shark can devour up to 10 kg meat in each bite from abdomen of an adult

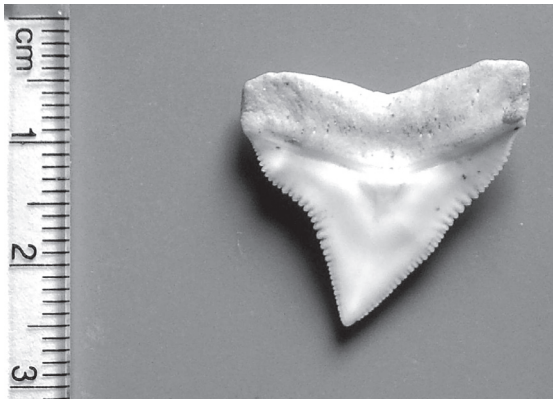

Fig. 5. Shark tooth found impregnated on margins of shark bite on Irrawaddy dolphin

Table 3. Comparison of annual mortality rate of Irrawaddy dolphins with shark-bite

Year	Irrawaddy dolphin population* A	Mortality** B	Mortality (%) [(Bx100)/A]	Annual catch of sharks	Shark attack/bite** C	Shark attack/bite (%) of dolphin population [(Cx100)/A]
2003	89	15	16.9	2	3	3.4
2004	124	11	8.9	3	1	0.8
2005	111	15	13.5	2	3	2.7
2006	131	6	4.6	2	1	0.8
2007	135	7	5.2	1	1	0.7
2008	138	8	5.8	1	1	0.7
2009	146	10	6.8	0	0	0
Total		72	Avg. 8.8	11	10	Avg. 1.5

* Source: Irrawaddy Dolphin Research Project, Chilika Development Authority

**Source: Offence Case records of Chilika WL Division, Forest Dept., Govt. of Odisha

Irrawaddy dolphin.

Bull sharks have been reported to swim upstream in the Ganges River and are responsible for attacking people in water and feeding on corpses (Compagno, 1984, 1988). Cockcroft *et al.*, 1989 reported bull sharks predating on the bottlenose dolphin *Tursiops truncatus* off Natal in South Africa. These observations are unique as well as similar in nature to those reported by previous researchers on shark predation or scavenging on various marine mammals (Ross and Bass, 1971; Arnold, 1972; Leatherwood *et al.*, 1972-1973; Ainley *et al.*, 1981; Brodie and Beck, 1982; Corkeron *et al.*, 1987; Cockcroft *et al.*, 1989; Cockcroft, 1991; Cliff and Dudley, 1991; Long and Jones, 1996; Urian *et al.*, 1998; Mann and Barnett, 1999; Heithaus, 2001a,b).

Although annual mortality due to shark attacks/ bites appears to be relatively low (1-3 individuals recorded between 2003-2008), it could have serious consequences on a population that has been estimated to number only 146 individuals as per statistics of 2009. There is an annual mortality of about 1.8% due to entanglement in fishing gears and 1.5% due to propeller strike and collisions with motorized boats (Table 3, Source: CDA). The observation of this study may provide a clue for researchers on the mortality caused by the shark attacks on various cetacean species.

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References

Ainley, D. G., C. S. Strong, H. R. Huber, T. J. Lewis and S. H. Morrell. 1981. Predation by sharks on pinnipeds at the Farallon Islands. *U.S. Fisheries Bulletin,* 78: 941 - 945.

Arnold, P. W. 1972. Predation on harbor porpoise, *Phocoena phocoena,* by a white shark, *Carcharodon carcharias. J. Fish. Res. Bd. Canada,* 29: 1213 - 1214.

Brodie, P. and B. Beck. 1982. Predation by sharks on the grey seal (*Halichoerus grypus*) in Eastern Canada. *Can. J. Fish. Aquat. Sci.,* 40: 267-271.

Chaudhuri, B. L. 1916a. Description of two new fishes from Chilika lake. *Rec. Indian Mus.,* 12(3): 105 - 108.

Chaudhuri, B. L. 1916b. Fauna of the Chilika lake: Fish Part I. *Mem. Indian Mus.,* 5(4): 403 - 440.

Chaudhuri, B. L. 1916c. Fauna of the Chilika lake: Fish Part II. *Mem. Indian Mus.,* 5(5): 441 - 458.

Chaudhuri, B. L. 1917. Fauna of the Chilika lake: Fish Part III. *Mem. Indian Mus.,* 5(6): 491 - 580.

Chaudhuri, B. L. 1923. Fauna of the Chilika lake: Fish Part IV. *Mem. Indian Mus.,* 5(11): 711 - 736.

Cliff, G. and S. F. Dudley. 1991. Sharks caught in the protective gill nets off Natal, South Africa. The Bull shark *Carcharhinus leucas* (Valenciennes). *S. Afr. J. Marine Sci.,* 10: 253 - 270.

Cockcroft, V. G. 1991. Incidence of shark bites on Indian Ocean hump-backed dolphins *(Sousa plumbea)* off Natal, South Africa. *Reports of the International Whaling Commission, Special Issue,* 12: 277 - 282.

Cockcroft, V. G., G. Cliff and G. J. B. Ross. 1989. Shark predation on Indian Ocean bottlenose dolphins *Tursiops truncatus* off Natal, South Africa. *S. Afr. J. Zool*., 24: 305 - 310.

Compagno, L. J. V. 1984. FAO species catalogue, Vol-4. Part-2, *An Annotated and Illustrated Catalogue of Shark Species Known to Date.* FAO, Rome. p. 478 - 481.

Compagno, L. J. V. 1988. *Sharks of the Order Carcharhiniformes*. Princeton University Press, Princeton. 570 pp.

Corkeron, P. J., R. J. Morris and M. M. Bryden. 1987. Interactions between bottlenose dolphins and sharks in Moreton Bay, Queensland. *Aquat. Mammals,* 13: 109 - 113.

Devasundaram, M. P. 1954. A report on the fisheries of the Chilika lake from 1948 to 1950. Odisha Government Publication, p. 1 - 34.

Froese, R. and D. Pauly (Eds.). 2010. FishBase. World Wide Web electronic publication. on *http://www.fishbase.org,* version (04/2010)

Heithaus, M. R. 2001a. Predator-prey and competitive interactions between sharks and cetaceans: A review. *J. Zool.,* 253: 53 - 68.

Heithaus, M. R. 2001b. Shark attacks on bottlenose dolphins (*Tursiops aduncus*) in Shark Bay, Western Australia: attack rate, bite scar frequencies, and attack seasonality. *Mar. Mammal Sci.,* 17: 526 - 539.

Hora, S. L. 1923. Fauna of the Chilika lake: Fish Part V. *Mem. Indian Mus.,* 5(11): 737 - 770.

Jhingran, V. G. and A. V. Natarajan. 1966. Final report on the fisheries of the Chilika lake (1957-65). *CIFRI Bulletin,* 8: 1 - 12.

Kreb, D. and B. D. Smith. 2000. *Orcaella brevirostris* (Mahakam subpopulation). *2004 IUCN Red List of Threatened Species. <http://www.redlist.org/>*

Leatherwood, S., W. F. Perrin, R. Garvie and J. LaGrange. 1972-73. Observations of sharks attacking porpoises *(Stenella* spp. and *Delphinus* cf. *Delphinus delphis). Naval Undersea Center Technical Note,* 908: 1 - 7.

Long, D. J. and R. E. Jones. 1996. White shark predation and scavenging on cetaceans in the eastern North Pacific Ocean. *In*: A. P. Klimley and D. G. Ainley (Eds.) *Great White Sharks: The Biology of Carcharodon carcharias,* Academic Press, New York. p. 293 - 307.

Mann, J. and H. Barnett. 1999. Lethal tiger shark *(Galeocerdo cuvier)* attack on bottlenose dolphin (*Tursiops* sp.) calf: Defense and reactions by the mother. *Mar. Mammal Sci.,* 15: 568 - 575.

Mohanty, S. K. 2002. Fisheries biodiversity of Chilika lagoon. *Chilika Newsletter,* January, 11 - 12.

Mohanty, S. K., K. S. Bhatta, R. K. Mohanty, S. Mishra, A. Mohapatro and A. K. Pattnaik. 2007. Eco-Restoration impact on fishery biodiversity and population structure in Chilika lake. *In*: P. K. Mohanty (Ed.) *Lakes and Coastal Wetlands: Conservation,*

Restoration and Management, Capital Publishing Company, New Delhi. p. 24 - 44.

Norris, K. S., B. Wursig, R. S. Wells and M. Wursig. 1994. *The Hawaiian Spinner Dolphin.* Los Angeles, California, University of California Press. 408 pp.

Pattnaik, A. K., D. Sutaria, M. Khan and B. P. Behera. 2007. Review of the status and conservation of Irrawaddy dolphin *Orcaella brevirostris* in Chilika lagoon of India. *In*: B. D. Smith, R. H. Shore and A. Lopez (Eds.) *Status and Conservation of Freshwater Populations of Irrawaddy Dolphin,* Wildlife Conservation Society, Bronx, New York. Working Paper Series No. 31, p. 41 - 51.

Rao, K. V. R. 1995. Pisces: Wetland Ecosystem Series I: Fauna of the Chilika lake. *Zool. Surv. India.* 483 - 506.

Ross, G. J. B. and A. J. Bass. 1971. Shark attack on an ailing dolphin *Stenella coeruleoalba* Meyen. *S. Afr. J. Sci.,* 1971: 413 - 414.

Satapathy, D. and S. Panda. 2009. *Fish Atlas of Chilika,* Chilika Development Authority, Bhubaneswar, India. p. 3 - 14.

Smith, B. D. 2004. *Orcealla brevirostris* (Ayeyarwady River subpopulation). *2004 IUCN Red List of Threatened Species. <http://www.redlist.org/>*

Smith, B. D. and I. Beasley. 2004a. *Orcealla brevirostris* (Mekong River subpopulation). *2004 IUCN Red List of Threatened Species. <http://www.redlist.org/>*

Smith, B. D. and I. Beasley. 2004b. *Orcealla brevirostris* (Songkhla Lake subpopulation). *2004 IUCN Red List of Threatened Species. <http://www.redlist.org/>*

Urian K. W., R. S. Wells, M. D. Scott, A. B. Irvine, A. J. Read and A. A. Hohn. 1998. When the shark bites: an analysis of shark bite scars on wild bottlenose dolphins (*Tursiops truncatus*) from Sarasota, Florida. The World Marine Mammal Conference, Monaco, 20-24 January, Abstract No. 139.

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