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First record of the Indo-Pacific bottlenose dolphin, *Tursiops aduncus*, in Korean waters

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Bottlenose dolphins (*Tursiops* sp.) commonly inhabit Korean waters, including the coastal waters of Jeju Island. However, their taxonomic position was unclear because of the validity of this genus. The genus *Tursiops* has recently been determined to comprise two species: the common bottlenose dolphin (*Tursiops truncatus*) and the Indo-Pacific bottlenose dolphin (*Tursiops aduncus*). To confirm the taxonomic position of bottlenose dolphins frequenting the coastal waters of Jeju Island, the external morphology and osteology of specimens from Jeju Island were examined. Photographs of free-swimming individuals were also used for determining external morphological characters. The cranial and meristic measurements fell within the ranges of *T. aduncus.* Osteological ratios were also consistent with those of *T. aduncus.* The presence of a prominent ventral spot was observed among some individuals. As a result, the dolphins mainly distributed in the coastal waters of Jeju Island were identified as Indo-Pacific bottlenose dolphins (*T. aduncus*) in terms of their cranial characters and ventral spotting. We propose a new Korean name, 'Nam-bang-keun-dol-go-rae'.

Keywords: bottlenose dolphin; *Tursiops aduncus*; Jeju Island; first record; Korea

Introduction

Bottlenose dolphins (genus *Tursiops*) are one of the most well studied cetacean species because of their wide distribution in tropical and temperate waters and human-friendly behavior. In spite of their reputation, the classification of this genus was controversial. Due to morphological variation by region, many species, such as *T. gillii* (Dall, 1873), *T. nuuanu* (Andrews, 1911) and *T. gephyreus* (Lahille, 1908), were variously accepted for the genus (Hershkovitz 1966; Ross, 1977; Rice, 1998). However, until recently, the validity of this genus was in doubt for many years, and most researchers generally considered that these species are synonyms of *Tursiops truncatus* (Montagu, 1821) (Tomilin 1957; Ross and Cockcroft 1990; Jefferson et al. 1993; Gao et al. 1995; Mead and Potter 1995).

Based on concordance in genetics, osteology and external morphology in Chinese waters, two sympatric forms of *Tursiops*, the common bottlenose dolphin, *T. truncatus*, and the Indo-Pacific bottlenose dolphin, *T. aduncus* (Ehrenberg, 1832), are currently recognized (Wang et al. 1999, 2000a, 2000b). Subsequent studies in several areas have also supported the distinct species status of *T. aduncus* (Hale et al. 2000; Möller and Beheregaray 2001; Yang et al. 2005).

Although *T. truncatus* has been frequently observed in Korean waters and well recognized (An et al. 2004; Kim et al. 2005, 2007), *T. aduncus* has not yet been recorded. Kim et al. (2007) described the population of *T. truncatus* off Jeju Island with a relatively long rostrum and slender body shape compared with those of common *T. truncatus.* Therefore, we assumed that the Jeju population can be identified as *T. aduncus.* The objective of the present study is to document the first reliably recorded *T. aduncus* in Jeju Island, Korea. Additionally, we provide information on osteological and external morphology characters of *Tursiops* sp. in Jeju Island.

Material and methods

Boat surveys were carried out in the coastal area of Jeju Island from 2007 to 2009 with R/V Tamgu No.18 and inflatable boat. Surveys were conducted along the coastal line until a pod of dolphins was encountered (Figure 1). Photographs of the dolphins were taken to examine the color pattern and external morphology using DSLR cameras (Nikon D2Xs) with 17–55 mm and 80–200 mm lenses.

We obtained a male carcass (Registration No: CRI-001, Cetacean Research Institute). CRI-001 was taken incidentally by set net at Jongdal-ri of Jeju Island, Korea (Figure 1, 126°55′E, 33°31′N), 11 August 2008. Twenty-one external characters of CRI-001 were measured following Norris (1961), and rostrum width was additionally

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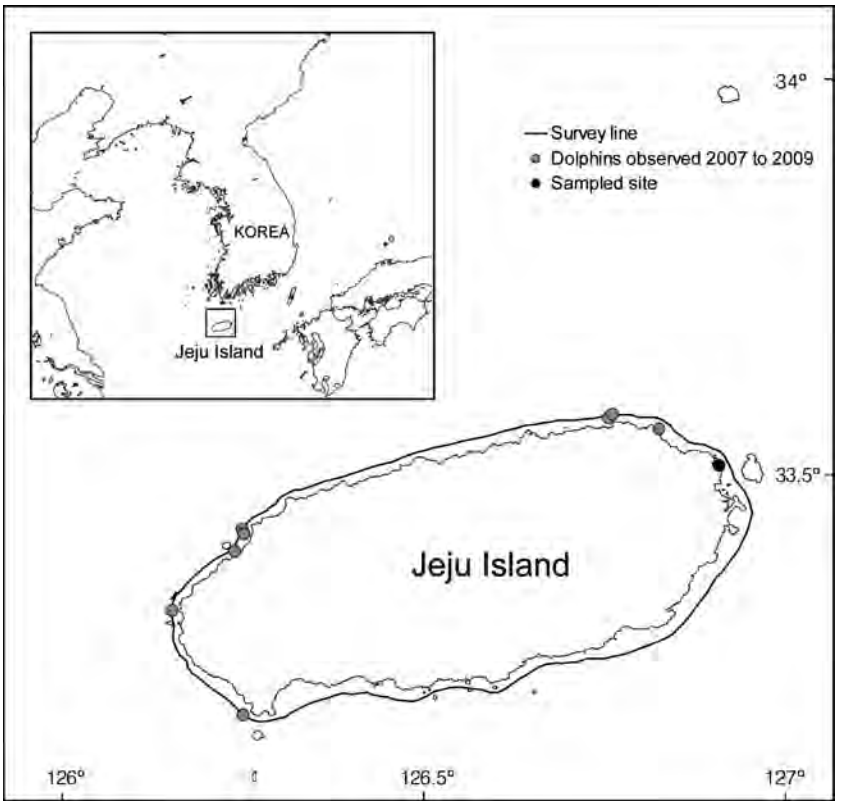

Figure 1. Sighting positions from boat survey, 2007 to 2009, and sampling site of the CRI-001 specimen (*Tursiops aduncus*) off Jeju Island, Korea.

measured. Specimen measurement was taken using a steel tape with a precision of 0.1 cm. Cranial characters of CRI-001 were measured as described by Perrin (1975) and Wang et al. (2000a) (Figure 2). All measurements were taken with vernier calipers to 0.01 mm. Dental and vertebral formulas were counted as meristic characters. The examined specimen was deposited in the Cetacean Research Institute, National Fisheries Research and Development Institute, Korea.

Systematic Accounts

Phylum Chordata
Class Mammalia
Order Cetacea
Family Delphinidae
Tursiops aduncus Ehrenberg, 1832
(New Korean name: Nam-bang-keun-dol-go-rae)
(Figures 3 and 4; Table 1)

Delphinus aduncus Ehrenberg, 1832 (type locality: Belhosse Island, Dahlak Archipelago, Ethiophia).
Tursiops truncatus: Ross and Cockcroft, 1990: 329 (Australian waters); Gao et al., 1995:121 (China).
Tursiops aduncus: Pilleri and Gihr, 1972: 95 (Pakistan); Ross, 1977: 135 (South African waters); Zhou and Qian, 1985: 16 (China); Wang et al., 2000a: 147, 2000b: 1157 (Penghu Islands, Taiwan) Shirakihara et al., 2003: 654 (Amakusa-Shimoshima Island, Japan).

Description. External morphology from field survey. Body streamlined and robust. Dark gray dorsal surface progressing to lighter gray on the flanks. Abdomen pale gray to white. Head gently rounded and slightly bulged. Dark gray line from the eyes to the forehead. Prominent snout. Lower jaw extends beyond tip of upper jaw. Slender flippers with pointed tips. Dorsal fin falcate or triangular with slightly concave in margin. Thick tail stock. Flukes concave edges and distinct notch in middle (Figure 3A). Ventral spots in flanks and abdominal part in some individuals (Figure 3B).

The external morphology of the specimen CRI-001 almost corresponded to that given above. Measurements of CRI-001 (cm): total body length 215.0, rostrum length 13.0, rostrum width 8.5, snout to gape 23.1, snout to blowhole 30.2, snout to eye 32, snout to external auditory meatus 40.5, snout to anterior insertion of flipper 53.5, snout to posterior dorsal fin 132.5, snout to umbilicus 97.8, snout to genital aperture 145.1, snout to anus 165.3, maximum width of dorsal fin 46.3, height of dorsal fin 23.2, anterior length of

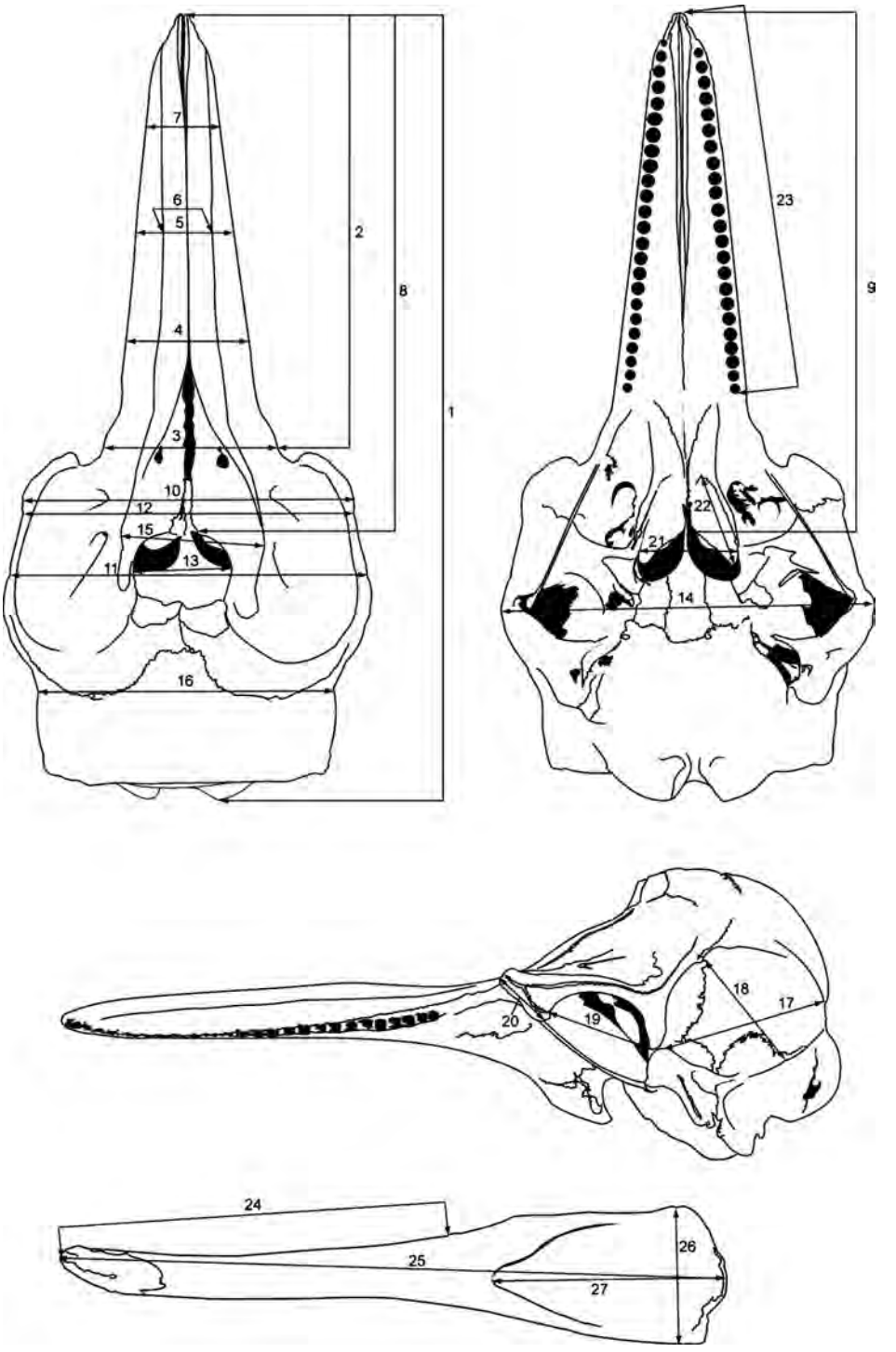

Figure 2. Measurements of *Tursiops aduncus*. 1, Condylobasal length. 2, Length of rostrum. 3, Width of rostrum at base. 4, Width of rostrum at 60 mm from base. 5, Width of rostrum at midlength. 6, Width of premaxillaries at midlength of rostrum. 7, Width of rostrum at 3/4 length. 8, Distance from tip of rostrum to external nares. 9, Distance from tip of rostrum to internal nares. 10, Greatest preorbital width. 11, Greatest postorbital width. 12, Least supraorbital width. 13, Greatest width of external nares. 14, Greatest width across zygomatic processes of squamosal. 15, Greatest width of premaxillaries. 16, Greatest parietal width. 17, Greatest length of left posttemporal fossa. 18, Greatest width of left posttemporal fossa. 19, Length of left orbit. 20, Length of antorbital process of left lacrimal. 21, Greatest width of internal nares. 22, Greatest length of left pterygoid. 23, Length of upper left tooth row. 24, Length of lower left tooth row. 25, Greatest length of left ramus. 26, Greatest height of left ramus. 27, Length of left mandibular fossa.

Figure 3. Indo-Pacific bottlenose dolphin (*Tursiops aduncus*), illustrating morphological and color pattern.(A) Lateral view. (B) Dark spotting on the front ventral region.

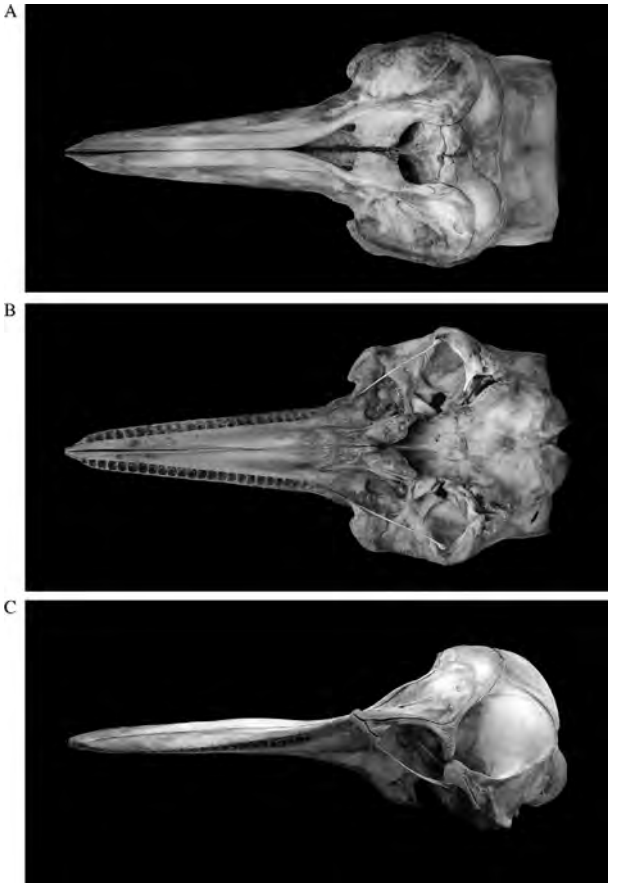

Figure 4. Skull of a *Tursiops aduncus* (CRI-001) bycaught in Jeju Island. (A) dorsal view; (B) ventral view; and (C) lateral view.

flipper 39.0, posterior length of flipper 27.5, maximum width of flipper 14.0, width of flukes 49.4, nearest point on anterior border of flukes to notch 18.9, girth on anus 125.6, girth on umbilicus 92.3.

Cranial and meristic characters of CRI-001 are shown in Table 1. In lateral view, the premaxillary convexity at approximately two-thirds distance from the tip was clear and also there was a narrowing of the premaxillae in the same region (Figure 4). The vertebral formula was C7, T12, L16, Cd24 with 13 chevrons. The first two cervical vertebrae were fused.

Measurements in ratio: tip of rostrum to the apex of the premaxillary convexity (TPC)/Condylobasal length (CBL) 0.365; TPC/Length of rostrum (LR) 0.640; TPC/Length of upper left tooth row (LUTR) 0.732; Greatest width of external nares (GWEN)/Greatest parietal width (GPW) 0.304.

Distribution. *T. aduncus* is distributed in the temperate and tropical coastal areas of the Indian and western Pacific oceans, from South Africa to central Japan and southeastern Australia (Wang and Yang 2009). Around the Korean waters, they are found off the Amami Islands and Amakusa-Shimoshima Island in Japan (Miyazaki and Nakayama 1989; Shirakihara et al. 2003) and Taiwan Strait (Wang et al. 1999, 2000a, 2000b). In Korea, the species is found in the inshore of Jeju Island (the present study).

Ecological notes. The specimen was collected by set net about 100 m apart from the coastal line. This species is

Table 1. Skeletal measurements and meristics of the *Tursiops aduncus* bycaught in Jeju Island compared with other stocks (%CBL, percentage of condylobasal length).

	Jeju Island (present study)		South African waters (Ross 1977, 1984)			Chinese waters (Wang et al. 2000a)		
	CRI-001	%CBL	*n*	Mean (range)	%CBL	*n*	Mean (range)	%CBL
(a) Cranial characters								
Condylobasal length	473.1		33	472.7 (433.0–507.1)		18	485.1 (450.7–529.1)	
Length of rostrum	270.1	57.1	33	271.9 (250.0–297.0)	57.5	18	282 (258.0–317.4)	58
Width of rostrum at base	103.98	22	33	112.3 (100.9–125.0)	23.8	19	115.8 (103.4–134.0)	23.9
Width of rostrum at 60 mm from base	70.07	14.8						
Width of rostrum at midlength	58.91	12.5	32	64.9 (56.0–74.9)	13.8	18	64.2 (56.3–71.3)	13.3
Width of premaxillaries at midlength of rostrum	30.38	6.4						
Width of rostrum at 3/4 length	44.42	9.4	33	48.8 (34.0–59.8)	10.3	17	50.3 (41.0–60.6)	10.5
Distance from tip of rostrum to external nares	319.45	67.5	33	316.9 (294.0–343.0)	67	14	328.5 (298.4–366.1)	66.9
Distance from tip of rostrum to internal nares	314.1	66.4						
Greatest preorbital width	194.89	41.2	32	203.4 (180.1–219.8)	43	18	201.9 (177.0–230.1)	41.6
Greatest postorbital width	217.29	45.9	32	230.2 (202.2–251.0)	48.7	14	223.4 (200.0–245.3)	46
Least supraorbital width	196.8	41.6	33	207.3 (187.1–225.0)	43.9	18	199.5 (175.3–226.3)	41.1
Greatest width of external nares	56.52	11.9	33	54.4 (50.0–61.0)	11.5	18	58.7 (54.0–70.3)	12.1
Greatest width across zygomatic processes of squamosal	218.66	46.2	30	229.6 (197.9–251.0)	48.5	13	230.6 (209.0–251–3)	47
Greatest width of premaxillaries	81.55	17.2	33	83.4 (76.8–90.1)	17.7	18	86.2 (77.1–100.0)	17.8
Greatest parietal width	186.04	39.3						
Greatest length of left posttemporal fossa	102.31	21.6						
Greatest width of left posttemporal fossa	75.77	16						
Length of left orbit	59.45	12.6						
Length of antorbital process of left lacrimal	43.66	9.2	21	44.8 (38.1–52.8)	9.52	14	46.1 (40.1–51.2)	9.4
Greatest width of internal nares	52.46	11.1						
Greatest length of left pterygoid	61.52	13						
Length of upper left tooth row	236.3	49.9	31	224.8 (208.0–245.0)	47.6	19	236.9 (209.4–265.9)	48.7
Length of lower left tooth row	234.15	49.5	30	226.9 (212.0–248.0)	48.2	18	243.9 (228.2–267.6)	50
Greatest length of left ramus	400.25	84.6	30	399.6 (372.8–422.0)	84.8	17	416 (385.9–460.9)	85.1
Greatest height of left ramus	81.42	17.2	30	83.2 (71.9–90.2)	17.7	17	82.6 (76.9–92.7)	16.9
Length of left mandibular fossa	141.27	29.9						

Table 1 (*Continued*)

	Jeju Island (present study)		South African waters (Ross 1977, 1984)			Chinese waters (Wang et al. 2000a)		
	CRI-001	%CBL	*n*	Mean (range)	%CBL	*n*	Mean (range)	%CBL
(b) Meristic characters								
No. teeth – upper left	26		33	25.8 (24–28)		20	25.2 (23–27)	
No. teeth – upper right	26		33	25.3 (24–28)		20	25.4 (24–28)	
No. teeth – lower left	27		29	25.9 (23–28)		19	25.7 (23–28)	
No. teeth – lower right	27		30	26.1 (23–29)		19	25.6 (24–28)	
Total No. teeth	106		29	102.9 (97–111)		19	102 (96–111)	
No. vertebrae	59		9	61 (59–62)		19	60.2 (59–62)	

mostly distributed in coastal waters (Shirakihara et al. 2002; Kogi et al. 2004). The forestomach contained half-digested cephalopods, various types of fish bones, 18 cephalopod beaks (10 upper and 8 lower) and 38 eye lenses of cephalopods and fish. Cephalopods were identified through their tentacles and beaks as common squid (*Todarodes pacificus*). Only one fish species, Largehead hairtail (*Trichiurus lepturus*), was identified from their premaxillae and mandibles. Total weight of stomach contents was 355 grams.

Remarks. Some individuals that were observed in the field presented a black line from the eye to the forehead and distinct ventral spots, which appears to be common for *T. aduncus* throughout its distribution (Ross 1977; Ross and Cockcroft 1990; Wang et al. 2000b; Shirakihara et al. 2003).

Wang et al. (2000b) found diagnostic differences in external morphology between *T. aduncus* and *T. truncatus*. The rostrum length (RL) as a proportion of the total body length (TBL) or the snout to eye length (SEY) revealed non-overlapping distribution for the species. The ratios of RL/TBL and RL/SEY for *T. aduncus* were 6.0 and 40.3, whereas those of *T. truncatus* were 3.9 and 28.8 respectively. The present specimen's measurements corresponded closely to those given in the previous measurements of *T. aduncus* (RL/TBL 6.0 and RL/SEY 40.8)

The premaxillary convexity and the narrowing in the premaxillae, shown in CRI-001, are one of the

Table 2. Osteological key to the identification of *Tursiops* sp. (Wang et al. 2000a).

Osteological key	CRI-001	*T. aduncus*	*T. truncatus*
Greatest width of external nares/ greatest parietal width	0.304	≥0.313	≤0.306
Tip of rostrum to the apex of the premaxillary convexity/ condylobasal length	0.365	≥0.352	≤0.346
Tip of rostrum to the apex of the premaxillary convexity/length of upper left tooth row	0.732	≥0.723	≤0.719
Tip of rostrum to the apex of the premaxillary convexity/length of rostrum	0.640	≥0.607	≤0.606

characteristics of the skull of *T. aduncus* in South Africa and China. The cranial and meristic measurements fell within the ranges of *T. aduncus* off South African waters and Chinese waters (Ross 1977, 1984; Wang et al. 2000a; Table 1). All keys of osteological ratios for identification, except external nares/greatest parietal width, were consistent with those of *T. aduncus* in Chinese waters suggested by Wang et al. (2000a; Table 2).

Numerous taxonomic characters strongly support the contention that the *Trusiops* sp. observed in Jeju Island can be identified as *T. aduncus*. We propose the new Korean name for the species as Nam-bang-keun-dol-go-rae.

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References

An YR, Kim ZG, Sohn H, Yang WS. 2004. By-catch of small cetaceans in the eastern coastal waters of Korea. J Korean Soc Fish Res. 6(2):163–172.

Gao A, Zhou K, Wang Y. 1995. Geographic variation in morphology of bottlenose dolphins (*Tursiops* sp.) in Chinese waters. Aquat Mamm. 21:121–135.

Hale PT, Barreto AS, Ross GJB. 2000. Comparative morphology and distribution of the *aduncus and truncatus* forms of bottlenose dolphin *Tursiops* in the Indian and Western Pacific Oceans. Aquat Mamm. 26(2):101–110.

Hemprich CG, Ehrenberg WF. 1832. Symbolae Physicae Mammalia, 2: footnote on last page of unpaginated fascicle headed *Herpestes leucurus* H. et E. Berlin, Germany.

Hershkovitz P. 1966. Catalog of living whales. US Nat Mus Bull. 246:1–259.

Jefferson TA, Leatherwood S, Webber MA. 1993. FAO species identification guide: Marine mammals of the world. Rome: FAO.

Kim ZG, Sohn H, An YR. 2005. Cruise report of the Korean whale sighting survey in the East Sea, August-September 2004. IWC/SC/57/NPM9 presented to the Intentional Whaling Commission.

Kim ZG, Choi SG, An YR, Kim HW, Park KJ. 2007. Whales, dolphins and porpoises off Korean Peninsula. NFRDI, p. 100–101.

Kogi K, Hishii T, Imamura A, Iwatani T, Dudzinski KM. 2004. Demographic parameters of Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) around Mikura Island, Japan. Mar Mamm Sci. 20(3):510–526.

Mead JG, Potter CW. 1995. Recognizing two populations of the bottlenose dolphin (*Tursiops truncates*) off the Atlantic coast of North America: morphological and ecologic considerations. IBI Rep. 5:31–44.

Miyazaki N, Nakayama K. 1989. Records of cetaceans in the waters of the Amami Islands. Mem Natl Sci Mus Tokyo 22:235–249.

Möller LM, Beheregaray LB. 2001. Coastal bottlenose dolphins from southeastern Australia are *Tursiops aduncus* according to sequences of the mitochondrial DNA control region. Mar Mamm Sci. 17(2):249–263.

Norris KS. 1961. Standardized methods for measuring and recording data on the smaller cetaceans. J Mammal. 42(4):471–476.

Perrin WF. 1975. Variation of spotted and spinner porpoise (genus *Stenella*) in the eastern tropical Pacific and Hawaii. Bull Scripps Inst Oceanogr. 21:1–206.

Pilleri G, Gihr M. 1972. Contribution to the knowledge of the cetaceans of Pakistan with particular reference to the genera *Neomeris*, *Sousa*, *Delphinus* and *Tursiops* and description of a new Chinese porpoise *Neomeris asiaeorientalis*. Invest Cetacea. 4:109–162.

Rice DW. 1998. Marine mammals of the world: systematic and distribution. Society for marine mammalogy, Special Publication No 4. Lawrence (KS): Allen Press.

Ross GJB. 1977. The taxonomy of bottlenosed dolphins *Tursiops* species in South African waters, with notes on their biology. Ann Cape Prov Mus Nat Hist. 11(9):135–194.

Ross GJB. 1984. The smaller cetaceans of the south east coast of southern Africa. Ann Cape Prov Mus Nat Hist. 15(2):173–410.

Ross GJB, Cockcroft VG. 1990. Comments on Australian bottlenose dolphins and taxonomic stock of *Tursiops aduncus* (Ehrenburg 1832). In: Leatherwood S, Reeves RR, editors, The bottlenose dolphin. San Diego (CA): Academic Press. p. 329–336.

Shirakihara M, Shirakihara K, Tomonaga J, Takatsuki M. 2002. A resident population of Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) in Amakusa, Western Kyushu, Japan. Mar Mamm Sci. 18(1):30–41.

Shirakihara M, Yoshida H, Shirakihara K. 2003. Indo-Pacific bottlenose dolphins *Tursiops aduncus* in Amakusa, western Kyushu, Japan. Fish Sci. 69(3):654–656.

Tomilin AG. 1957. Cetacea. In: Mammals of the U.S.S.R. and adjacent countries. Moscow: Nauk. S.S.S.R. p. 1–717. (English translation, 1967, Israel Program for Scientific Translations, Ltd. Jerusalem)

Wang JY, Chou LS, White BN. 1999. Mitochondrial DNA analysis of sympatric morphotypes of bottlenose dolphins (genus: *Tursiops*) in Chinese waters. Mol Ecol. 8(10):1603–1612.

Wang JY, Chou LS, White BN. 2000a. Osteological differences between two sympatric forms of bottlenose dolphins (genus *Tursiops*) in Chinese waters. J Zool. 252:147–162.

Wang JY, Chou LS, White BN. 2000b. Differences in the external morphology of two sympatric species of bottlenose dolphins (genus *Tursiops*) in the waters of China. J Mammal. 81:1157–1165.

Wang JY, Yang SC. 2009. Indo-Pacific bottlenose dolphin. In: Perrin WF, Würsig B, Thewissen JGM, editors, Encyclopedia of marine mammals. 2nd ed. San Diego: Academic Press. p. 602–608.

Yang G, Ji G, Ren W, Zhou K, Wei F. 2005. Pattern of genetic variation of bottlenose dolphins in Chinese waters. Raffles Bull Zool. 53:157–164.

Xiong Y, Brandley MC, Xu S, Zhou K, Yang G. 2009. Seven new dolphin mitochondrial genomes and a time-calibrated phylogeny of whales. BMC Evol Biol. 9:1–13.