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SURFACE AND DIVE TIMES OF FINLESS PORPOISES IN HONG KONG'S COASTAL WATERS

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ABSTRACT. – We studied the surface and dive times of finless porpoises (*Neophocaena phocaenoides*) in Hong Kong from three land-based survey sites in winter/spring 2000, to allow the estimation of the trackline detection probability [g(0)] for helicopter line transect surveys in Hong Kong. We determined that groups of finless porpoises in Hong Kong spend on average about 60% of their time at or near the surface, and 40% of their time on a long dive (30 sec. or greater). Surface times apparently increase in larger groups. We conclude that finless porpoises in Hong Kong, while being challenging targets for sighting surveys, are apparently available at the surface to be seen for a higher proportion of time than are harbour porpoises in some deeper water habitats.

KEY WORDS. – Finless porpoise, *Neophocaena phocaenoides,* Hong Kong, surface and dive times, line transect assumptions.

INTRODUCTION

The finless porpoise (*Neophocaena phocaenoides*) is endemic to southern and eastern Asia. It is distributed patchily throughout the Indo-Pacific, from southern Japan in the east to the Arabian Gulf area in the west (Reeves et al., 1997; Kasuya, 1999). Although some behavioural studies have been conducted on free-ranging animals (Pilleri & Pilleri, 1979; Chen et al., 1979; Zhou et al., 1979, 1980; Liu et al., 1986) and in captivity (Kataoka, 1977; Yoshie et al., 1994; Yoshie, 1995), detailed behaviour studies are still rare. Recently, some tagging and tracking work has been done with Yangtze finless porpoises, allowing certain dive and surfacing parameters to be calculated (Zhang et al., 1996; Würsig et al., 2000).

Research focussing on estimating abundance of small cetaceans in Hong Kong using vessel- and helicopter-based line transect surveys began in 1995 (Jefferson & Leatherwood, 1997; Jefferson & Braulik, 1999; Jefferson, 2000). One of the main problems in obtaining accurate estimates of abundance for cetaceans, which spend much time underwater, has been to obtain an unbiased estimate of the probability of detecting trackline groups (g[0] - see Buckland et al., 1993). Previously, many studies have made the assumption that g(0)=1, but this is not likely to be true for most cetaceans, which dive for long periods between surfacings. Acoustic detection data from a towed porpoise click detector (POD) have been used to make an estimate of this parameter for vessel surveys (see Jefferson et al., 2002). However, for estimates from helicopter surveys, no such data were available for estimating its value. Surface and dive time data have been used by Barlow et al. (1988) and Laake et al. (1997) to calculate values of g(0) for harbour porpoises (*Phocoena phocoena*). The main objectives of this study were to estimate surface and dive times and their variation (and obtain data for estimating g[0] for helicopter surveys).

METHODS

Data Collection. – We collected data between 13 January and 25 March 2000 from three land-based sites (Fig. 1) overlooking coastal waters of Hong Kong known to be frequented by finless porpoises (see Jefferson & Braulik, 1999). Observations from the Chi Ma Wan Peninsula, Lantau Island, were conducted from a hillside above the Sea Ranch housing estate, approximately 54 m above sea level. Observations were also undertaken from a cliff above Mong Tung Wan Bay, Lantau Island, approximately 48 m above sea level. These two observation stations provided unobstructed views overlooking coastal waters surrounding Cheung Chau, the Soko Islands, and Fan Lau (see Fig. 1). Both sites were characterized by typically calm weather conditions. Some observations were also undertaken from the Ha Mei Tsui Peninsula, on Lamma Island. That observation station was 64 m above sea level and provided a 180° unobstructed view over western Lamma coastal waters and out to Cheung Chau. The site was generally exposed to the wind, and due to this, the number of surveys there was limited.

During the observation period, a single observer (occasionally up to three) scanned the water surrounding the observation point. Binoculars and naked eye were used alternately for periods of 20 min. When multiple observers were present, they would rotate search duties. A pair of *Fujinon* 10X binoculars were used to locate animals and follow their movements and behaviour. Observations were normally undertaken in Beaufort 1-3 conditions, although some Beaufort 4 data were collected. Once a group was located, a *Sony* dictaphone was used to record porpoise surface/dive times and behaviour notes. Groups were only included in the final analysis if they were sighted in calm conditions (Beaufort 0 to 2) and all surfacings of every porpoise in the group were believed to have been observed.

A record of all boats in the area was kept. The categories were: small speed boat, high speed ferry, passenger boat, sampan, research boat, fishing boat, tanker and marine police boat. Once a porpoise group was sighted, data were also recorded on the presence of boats within an estimated 200 m of the closest porpoise and associated behaviour of the porpoise group.

Definitions and Analyses. – A 'group' was defined as any cluster of porpoises (an aggregation of individuals or a solitary animal) observed in apparent association, moving in the same direction and often, but not always, engaged in the same activity (Shane, 1990). A subgroup was defined as a separate group if it was more than an estimated 500 m away from other porpoises and not in apparent association, as defined above. A new 'group' was designated when the number of animals in the group changed, or when the animals reappeared after being out of sight for more than 20 min.

Finless porpoises generally exhibited long surface times followed by a very occasional dive of 30 sec. or longer. We defined surface and dive times for groups, not individuals, following Laake et al. (1997). We could not identify individuals, and it was actually group dive parameters that we were interested in (since groups, not individuals, are the targets of line transect surveys - see Jefferson et al., 2002). We calculated two surfacing/dive parameters as follows:

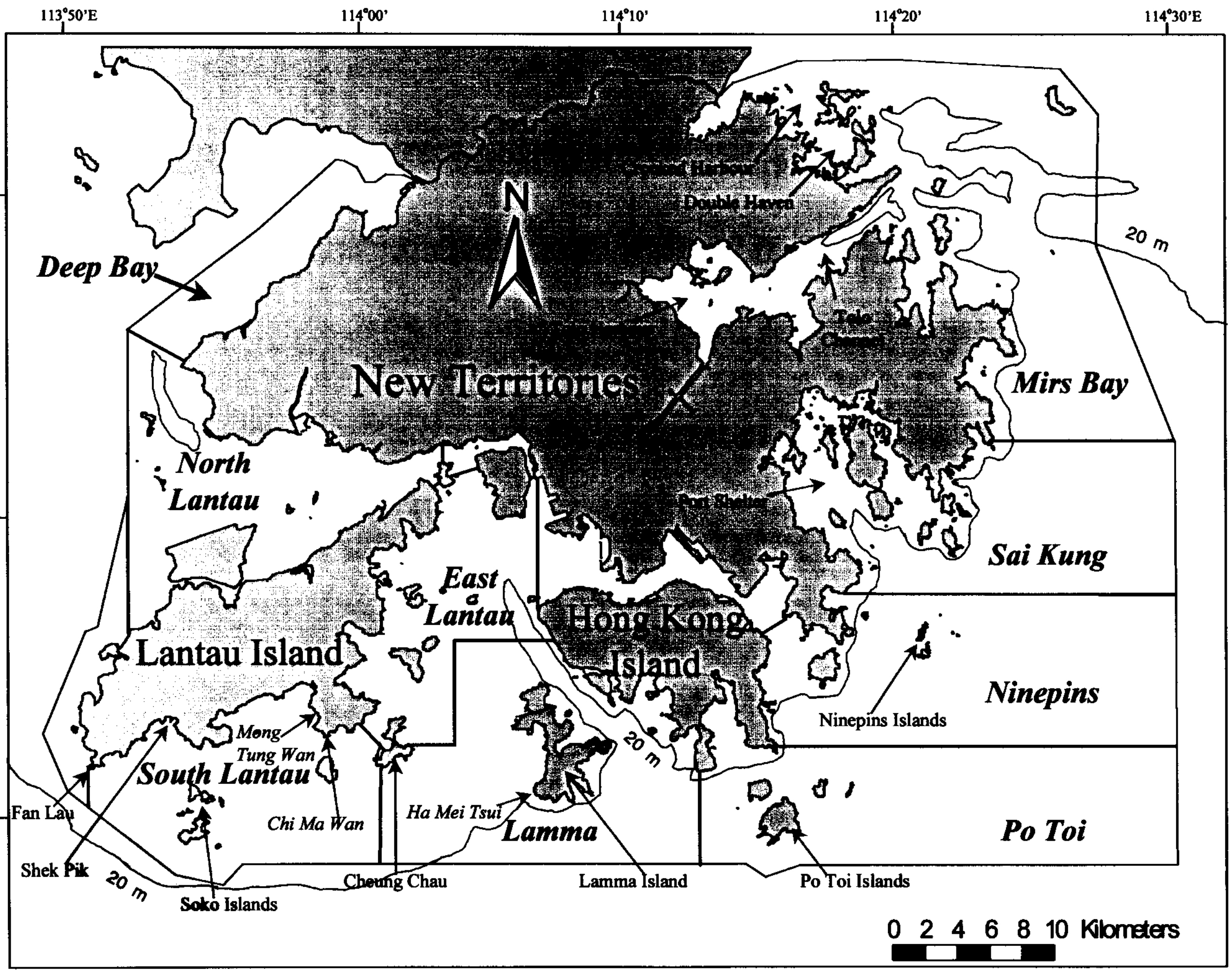

Fig. 1. Map of the study area, showing the locations of the three land-based survey sites, and place names mentioned in the text. The 20 meter depth contour is also shown. The subarea boundaries shown are those used for vessel and helicopter surveys. For detailed information on the vessel and helicopter transect lines, see Jefferson et al. (2002).

Surface time: Periods in which at least one porpoise in the group was present at the surface, or all porpoises were underwater for no longer than 29 sec. This can be interpreted as the time that porpoises are 'at or near' the surface.

Dive time: Periods in which the entire group of porpoises was underwater for 30 sec. or longer. In other words, dive times were only recorded as beginning 30 sec. after the last porpoise had disappeared (however, these 30 sec. were then included in the dive time).

Thus our surface time and dive time correspond to the surface/surfacing interval and dive interval of Laake et al. (1997).

Data were analyzed using SPSS statistical and EXCEL database software. All measures of variance are reported as ± 1 standard deviation, and all statistical tests were conducted at the alpha = 0.05 level.

RESULTS

Group Surface and Dive Times. – A total of 19.54 hr. of surface/dive time data were gathered on 22 days, from a total of 57 groups. After those periods in which incomplete surface times were excluded, this left 10.06 hr. of surface/dive time data. Of this, 6.06 hr. consisted of surface times. This resulted in an estimate of porpoises being at or near the surface 60.2% of the time and down on a long dive (30 sec. or longer) for 39.8% of the time (this was based on 241 complete surface times and 288 complete dive times from 40 groups).

Forty-eight groups made at least one dive of 31 sec. or longer, and most dives were between 31 and 80 sec. (Fig. 2). Mean group surface time was 90.5 ± 213.38 sec. (median = 38 sec., range = 1-2,212 sec., n = 241). Mean dive time was 50.1 ± 22.61 sec. (median = 43 sec., range = 30-225 sec., n = 288).

Individual Surface and Dive Times. – There were five sightings of single animals, from which we were able to record surface and dive times for individual porpoises (52.91 min.). This resulted in an estimate of individual porpoises being at or near the surface 42.7% of the time and on a long dive for 57.4% of the time. The mean individual porpoise surface time was 49.5 ± 53.62 sec. (range 11-171, n = 14). The mean porpoise dive time was 62.1 ± 28.26 sec. (range 32-139, n = 15).

During the observation period, long calf dives were infrequent, with a maximum dive time of 68 sec. A sighting of an adult and newborn calf at Chi Ma Wan on 16 February 2000 resulted in the only observed instance of a porpoise logging at the surface. While the mother was down on a long dive, the calf remained relatively motionless on the

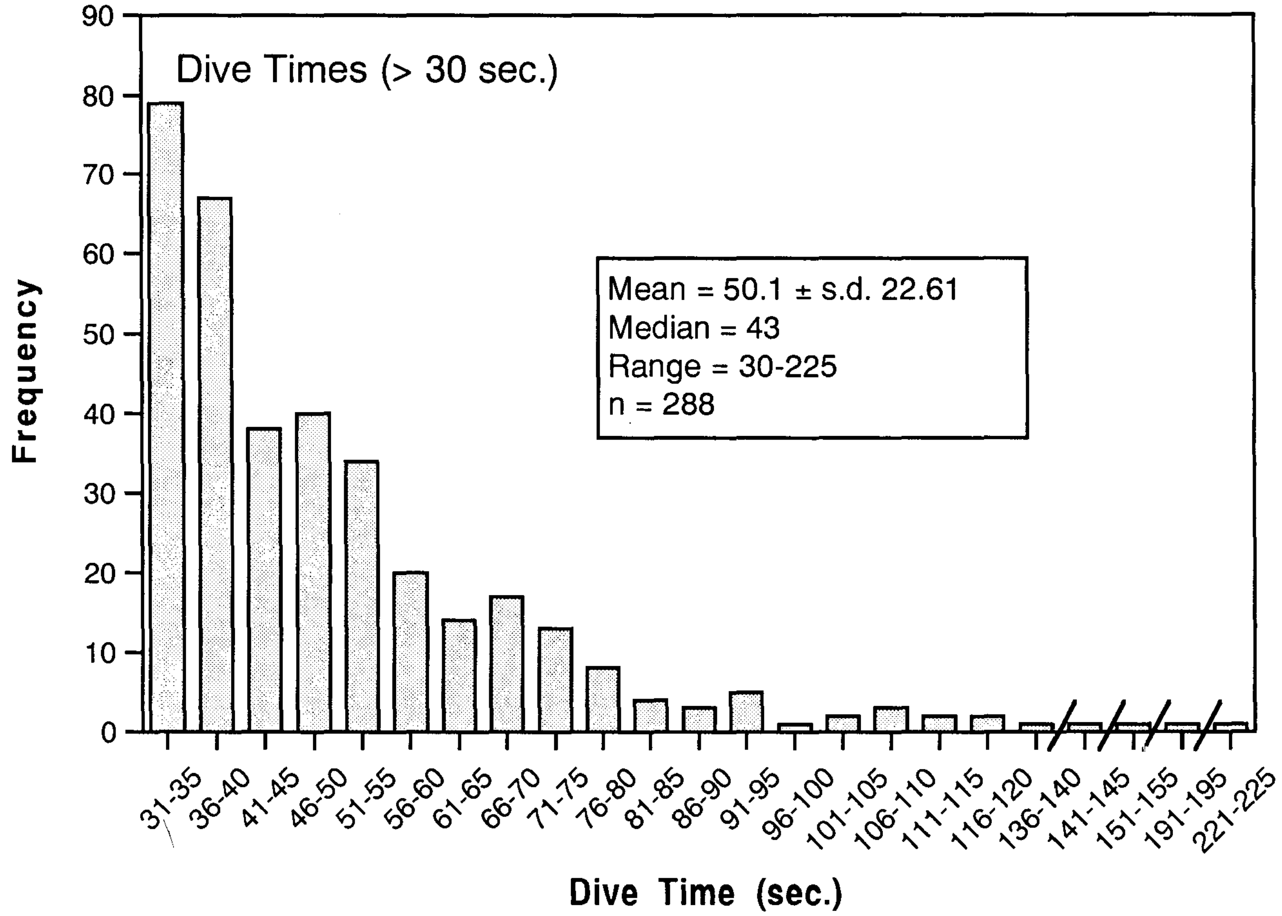

Fig. 2. Distribution of dive times (> 30 sec.) among groups of finless porpoises in Hong Kong.

surface for periods of 5-10 sec. Once the adult resurfaced, the calf would continue surfacing in synchrony with the adult again, until the next dive.

Factors Affecting Surface and Dive Times. – We examined the effect of group size on surface and dive parameters. As group size increased the average surface time also increased (Fig. 3a). There was no clear overall increasing or decreasing trend for the average dive time data. However, there did appear to be a reduction in average dive time with group sizes of larger than 10 (Fig. 3b).

Due to insufficient sample sizes to test each particular boat type, all boat data were pooled. Mean surface time with no boats present was 94.2 ± 224.65 sec. (range = 1-2,212, n = 213), and when boats were present was 62.5 ± 86.69 sec. (range = 1-384, n = 28). However, the difference was not significant (Mann Whitney test, Z = -0.427, $p > 0.05$). Average dive time with no boats was 49.8 ± 22.37 sec. (range = 30-225, n = 256), and with boats present was 52.6 ± 24.67 sec. (range = 30-155, n = 32) a non-significant difference (Mann Whitney test, Z = -0.832, $p > 0.05$).

DISCUSSION

Radio-tracking studies in the Yangtze River of China (Zhang et al., 1996; Würsig et al., 2000) have shown that the animals tended to make 2-6 surfacings at short intervals between long dives of up to just over 4 min. However, their data are not comparable to ours, since they collected records on individual dive and surface times and our data were obtained from groups.

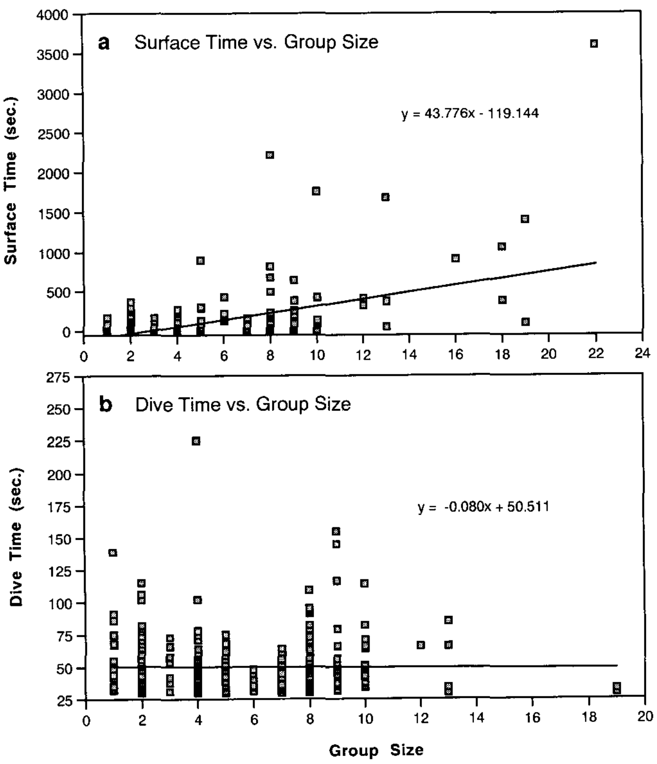

Fig. 3. Scatterplot of surface times in relation to group size (a), and dive times in relation to group size (b).

Recent vessel and helicopter surveys using line transect methods have been designed to assess finless porpoise abundance and distribution (Jefferson et al., 2002). In estimating abundance, one of the basic assumptions of line transect theory is that all animals on and near the transect line are seen (i.e., that the trackline detection probability [g(0)] = 1 - see Buckland et al., 1993). As a result of the cryptic nature of finless porpoise groups, it seems unlikely that the assumption of detection unity along the trackline is valid for finless porpoises in Hong Kong. That being the case, it is important to estimate the trackline detection probability, and then to factor it into the line transect equation. Recently, we have used an acoustic porpoise click detector (POD) to estimate trackline detection probability for vessel surveys (Jefferson et al., 2002).

Estimates of abundance from helicopter surveys are more problematic, because we can not use data from the click detector (which is specific to the vessel surveys) to estimate the trackline detection probability. Instead, Jefferson et al. (2002) used data on surface/dive times from the present study in the equation presented in Laake et al. (1997), and derived an estimate of the trackline detection probability for helicopter surveys in Hong Kong of 0.65. This is much higher than estimates of g(0) for aerial surveys of harbour porpoises - 0.31 for the west coast of the U.S. (Barlow et al., 1988) and 0.079-0.292 for the inshore waters of Washington State (Laake et al., 1997). However, it should be noted that there were some differences in field and analysis techniques that may complicate direct comparisons among these studies. In light of such differences, we suggest that g(0) should be estimated independently for each population in future studies.

Nonetheless, Hong Kong finless porpoises appear to spend significantly more time at or near the surface than do harbour porpoises in the eastern North Pacific. Harbour porpoises along the west coast of the U.S. have an average surface time of 30 sec., an average dive time of 96 sec., and spend about 23.9% of their time 'at or near' the surface (Barlow et al., 1988). The corresponding values for Washington State harbour porpoises are 36 sec. surface time, 127 sec. dive time, and they spend about 23.1% of their time 'at or near' the surface (Laake et al., 1997). This is in contrast to our data for finless porpoises in Hong Kong: average surface time of 90 sec., average dive time of 50 sec., and 60% of time at or near the surface. We suggest that this may be due to the differences in habitat between the finless porpoise and harbour porpoise studies. Our data on finless porpoises were collected in waters no more than 30 m deep (most less than 10 m deep). Data in Laake et al. (1997) were collected in waters between about 50 and 200 m depth (J. Laake, pers. comm.), and at least some of the sightings from the study of Barlow et al. (1988) were collected in water as deep as about 70 m. The shallow water inhabited by finless porpoises in Hong Kong may eliminate the need for them to dive deeply (and thus for long periods) to obtain food. Whatever the reason, it appears that they are spending more of their time at or near the surface of the water than are harbour porpoises (at least in the above study areas), thus making them more available for detection during visual surveys. Thus, although

Hong Kong finless porpoises are somewhat difficult to spot during vessel and aerial surveys, other characteristics of their behaviour may make them relatively good subjects for line transect surveys.

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LITERATURE CITED

Barlow, J., C. W. Oliver, T. D. Jackson & B. L. Taylor, 1988. Harbor porpoise, *Phocoena phocoena*, abundance estimation for California, Oregon, and Washington. II. Aerial surveys. *Fish. Bull.*, **86**: 433-444.

Buckland, S. T., D. R. Anderson, K. P. Burnham & J. L. Laake, 1993. *Distance Sampling: Estimating Abundance of Biological Populations*. Chapman and Hall, 446 pp.

Chen, P., P. Liu, R. Liu, K. Lin & G. Pilleri, 1979. Distribution, ecology, behavior and conservation of the dolphins of the middle reaches of Changjiang (Yangtze) River (Wuhan-Yueyang). *Invest. Cetacea*, **10**: 87-103.

Jefferson, T. A., 2000. Population biology of the Indo-Pacific hump-backed dolphin in Hong Kong waters. *Wildl. Monogr.*, **144**, 65 pp.

Jefferson, T. A. & G. T. Braulik, 1999. Preliminary report on the ecology of the finless porpoise in Hong Kong waters. *IBI Rep.*, **9**: 41-54.

Jefferson, T. A. & S. Leatherwood, 1997. Distribution and abundance of Indo-Pacifichump-backed dolphins (*Sousa chinensis* Osbeck, 1765) in Hong Kong waters. *Asian Mar. Biol.*, **14**: 93-110.

Jefferson, T. A., S. K. Hung, L. Law, M. Torey & N. Tregenza, 2002. Distribution and abundance of finless porpoises in waters of Hong Kong andadjacent areas of China. *Raffles. Bull. Zool.*, Supplement **10**: 43-55.

Kasuya, T., 1999. Finless porpoise *Neophocaena phocaenoides* (G. Cuvier, 1829). In: Ridgway, S. H. & R. Harrsion (ed.), *Handbook of Marine Mammals, Vol. 6: The Second Book of Dolphins and the Porpoises*. Pp. 411-442. Academic Press.

Kataoka, T. (ed.), 1977. *Report on the Rearing and Behavior of Finless Porpoise* (Neophocaena phocaenoides) *in Toba Aquarium*. Toba Aquarium, Japan, 65 pp.

Laake, J. L., J. Calambokidis, S. D. Osmeck & D. J. Rugh, 1997. Probability of detecting harbor porpoise from aerial surveys: estimating g(0). *J. Wildl. Manage.*, **61**: 63-75.

Liu, R., M. Klinowska & R. J. Harrison, 1986. The behaviour of *Lipotes vexillifer* and *Neophocaena phocaenoides* in the Changjiang River and in captivity in China. In: M. M. Bryden & R. Harrison (eds.), *Research on Dolphins*. Pp. 433-439. Oxford University Press.

Pilleri, G. & O. Pilleri, 1979. Observations on the dolphins in the Indus Delta (*Sousa plumbea* and *Neophocaena phocaenoides*) in winter 1978-1979. *Invest. Cetacea*, **10**: 129-135.

Reeves, R. R., J. Y. Wang & S. Leatherwood, 1997. The finless porpoise, *Neophocaena phocaenoides* (G. Cuvier 1829): a summary of current knowledge and recommendations for conservation action. *Asian Mar. Biol.*, **14**: 111-143.

Shane, S. H., 1990. Comparison of bottlenose dolphin behavior in Texas and Florida,with a critique of methods for studying dolphin behavior. In: S. Leatherwood & R. R. Reeves (ed.), *The Bottlenose Dolphin*. Pp. 541-558. Academic Press.

Würsig, B., D. Wang & X. Zhang, 2000. Radio tracking finless porpoises (*Neophocaena phocaenoides*): Preliminary evaluation of a potential technique, with cautions. In: Reeves, R. R., B. D. Smith & T. Kasuya (ed.), *Biology and Conservation of Freshwater Cetaceans in Asia*. Pp. 116-121. Occasional Paper of the IUCN Species Survival Commission.

Yoshie, K., H. Taishaku, S. Sakamoto, S. Mitani, M. Yano, T. Moritaki & N. Okumura, 1994. Chasing behavior of finless porpoise *Neophocaena phocaenoides* in captivity at Toba Aquarium. *Ann. Rep. Toba Aquarium*, **5**: 69-74.

Yoshie, K., 1995. On the behavior of captive finless porpoise *Neophocaena phocaenoides* during feeding time. *Ann. Rep. Toba Aquarium*, **6**: 53-59.

Zhang, X., D. Wang, J. Yang, Z. Wei, K. Wang & B. Würsig, 1996. Study on radio-tracking finless porpoise *Neophocaena phocaenoides*, at the Yangtze River. *Acta Ecolog. Sinica*, **16**: 490-496.

Zhou, K., G. Pilleri & Y. Li, 1979. Observations on the baiji (*Lipotes vexillifer*) and the finless porpoise (*Neophocaena asiaeorientalis*) in the Changjiang(Yangtze) River between Nanjing and Taiyangzhou, with remarks on some physiological adaptations of the baiji to its environment. *Invest. Cetacea* **10**: 109-120.

Zhou, K., G. Pilleri & Y. Li, 1980. Observations on baiji (*Lipotes vexillifer*) and finless porpoise (*Neophocaena asiaorientalis*) in the lower reaches of the Chang River. *Scientia Sinica*, **23**: 785-793.