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Position at Birth and Possible Effects on Calf Survival in Finless Porpoises (*Neophocaena asiaeorientalis*)

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Abstract

Odontocetes are usually reported giving birth to calves in breech position (fluke-first). Cephalic position (head-first) is less frequently observed and, therefore, is considered to be abnormal for the parturition. However, the influence of the calf position at birth on the parturition process and calf survival has not been thoroughly studied. More information is needed to improve the captive breeding success of odontocetes—especially for endangered species such as finless porpoises (*Neophocaena asiaeorientalis*). In this study, we observed the labor of eight captive finless porpoises (*N. asiaeorientalis asiaeorientalis* and *N. a. sunameri*). The duration of parturition and the time of particular events in the parturition process were recorded for both breech and cephalic births. Cephalic births were shorter than breech births, and the calf position at birth did not seem to have a negative effect on its survival. The results presented herein could be used as recommendations to improve the management of future parturitions of captive finless porpoises by ensuring the safety of both cows and calves, potentially increasing the survival rate of calves. Better management of the parturition process could facilitate the improvement of the captive breeding success of these endangered species.

Key Words: cetacean birth, fetus presentation, calf survivorship, Yangtze finless porpoise, East Asian finless porpoise

Introduction

Odontocetes are widely observed giving birth in fluke-first presentation (Reidenberg & Laitman, 2008; Gol'din, 2011). These cetaceans differ in this regard from their closest phylogenetical relatives, the terrestrial cetartiodactyla, who give birth to calves with head-first delivery and in which, without human intervention, abnormal birth positions often lead to calf death (Holland et al., 1993).

Births of several odontocete species have been reported in captivity (Joseph et al., 1987; Zani et al., 2008; Foley et al., 2011), but only a few mentioned calf position at birth (Essapian, 1963; Duffield et al., 1995; Robeck et al., 2005); the fluke-first calf presentation at birth was reported more frequently than the head-first presentation. A study of three bottlenose dolphins (*Tursiops truncatus*) suggested that calf positions that were not fluke-first induced abnormal behaviors in the mother and a shorter duration of the delivery process (Essapian, 1963). Knowledge about calf position and its effect on the parturition process and calf survival at birth are still scarce. This kind of information could be valuable for the management of parturition events to improve the success of captive odontocete births and the survival rate of calves, especially for endangered species whose captive breeding is crucial (Sweeney et al., 2010; Baumgartner et al., 2018).

There are two distinct subspecies of the narrow-ridged finless porpoise (*Neophocaena asiaeorientalis*) in Chinese waters: (1) the Yangtze finless porpoise (*N. a. asiaeorientalis*) (YFP) and (2) the Eastern-Asian finless porpoise (*N. a. sunameri*) (EFP). The YFP is a freshwater species and is endemic to the Yangtze River and its adjoining lakes. This species has been identified as "Critically Endangered" under the criteria of the International Union for Conservation of Nature's (IUCN) (2013) *Red List of Threatened Species*. The EFP is a marine species, which is distributed in the narrow strip of shallow coastal water in the East Sea, Yellow Sea, and Bohai Sea in China (Wang et al., 2010). The EFP is classified as "Endangered" by the IUCN (2013). Because of their small body size and their constant avoidance of humans, observing the reproductive behaviors and parturition events in wild finless porpoises is hard, and almost no information is available on those topics.

Captive breeding has been considered to be a complement to *in situ* conservation for the YFP

(Wang et al., 2005). Therefore, a captive breeding program was launched in 1996 in the only facility keeping these animals under human care: the Yangtze Cetacean Breeding and Research Center (YCBRC). The first birth occurred in 2005, resulting in a live and healthy calf who is now a healthy adult male (Wang et al., 2005). However, the following births that occurred in YCBRC failed, with all calves dying in a short lapse of time (3 to 50 d) after birth until, in 2018, we had another successful birth resulting in a healthy calf (YCBRC, unpub. data, 2007-2018). More than 50 EFPs are kept under human care in privately owned aquariums in China (Zhang et al., 2012). Histology and morphology of EFPs have been previously studied (Zhang, 1992; Gao & Zhou, 1993; Chang & Zhou, 1995; Lee et al., 2013; Zeng et al., 2015), and there are some births that occurred without published reports (T. Robeck, pers. comm., 2018). Only a few studies investigated the reproductive behavior of finless porpoises, including studies of mating and nursing in captive individuals (Zhang, 1992; Yang et al., 1998; Wang et al., 2005; Xian et al., 2012; Zhang et al., 2012). Some studies reported the calf position at birth and the parturition process (Masami et al., 1976; Yang et al., 1998); however, data remain scarce, and the impact of the calf position on the parturition process and the calf's survival was never discussed in detail. An analysis of finless porpoises' birth data might provide useful information, especially about parturition duration, which could be a tool to help decide if human intervention is needed for the success of the birth.

In this study, parturition observations of captive YFPs and EFPs were conducted. Herein, we combined the data we collected and the data obtained from the Toba Aquarium (Masami et al., 1976) and the Enoshima Aquarium (Yang et al., 1998). The two subspecies were compared to investigate the impact of the calf position on the parturition process and calf survivorship at birth. This study aims to further understand the delivery process and to improve management and husbandry practices at the crucial moment of parturition in captive finless porpoises.

Methods

Animals and Management

Twelve births of captive YFPs were observed from 2005 to 2018. Eleven births occurred in YCBRC, and one occurred in the Tian-E-Zhou Natural Ex-Situ Reserve (TEZR). Three births of captive EFPs were also observed in Shandong Quancheng Polar World (SQPW) from 2016 to 2017. The basic information about the cows and calves is presented in Table 1.

Five pregnant females, Jing Jing, Ying Ying, Yang Yang, F7, and F9, were kept in the YCBRC. Jing Jing and Ying Ying were always kept together in a kidney-shaped pool (20 m long × 7.5 m wide × 3.5 m deep) during their parturitions. F9 was

Table 1. Basic information of observed finless porpoises (*Neophocaena asiaeorientalis*) at labor and the health status of calves

Animal name	Species	Facility	Initial age estimated	Age at labor	P/M (number)	Labor date (d/mo/y)	Calf position (F/H)	Survival time of calf
Jing Jing	YFP	YCBRC	1999-02 (2 y)	8	P	5/7/2005	F	Alive
				10	M (*n* = 2)	2/6/2007	F	50 d
Ying Ying	YFP	YCBRC	1996-03 (2 y)	10	P	5/7/2008	F	6 d
				11	M (*n* = 2)	11/8/2009	F	0 d
F9	YFP	YCBRC	2011-03 (2 y)	7	P	31/5/2016	F	3 d
				9	M (*n* = 2)	19/5/2018	F	26 d
Yang Yang	YFP	YCBRC	2009-03 (2 y)	11	P	11/6/2018	F	10 d
F7	YFP	YCBRC	2011-03 (2 y)	9	P	2/6/2018	F	Alive
EE	YFP	TEZR	2010-10 (2 y)	8	P	22/5/2016	F	Alive
SD1	EFP	SQPW	Unknown	--	P	13/6/2016	H	2 y
SD2	EFP	SQPW	Unknown	--	P	26/4/2017	F	5 d
SD3	EFP	SQPW	Unknown	--	M (*n* = 2)	28/4/2017	F	0 d

YCBRC = Yangtze Cetacean Breeding and Research Center, SQPW = Shangdong Quancheng Polar World, P = primiparous, M = multiparous, TEZR = Tian-E-Zhou Reserve, F = fluke-first, and H = head-first kept alone in the kidney-shaped pool during its first parturition and with Yang Yang for its second birth. Yang Yang was held alone in the same pool during its parturition. F7 was kept alone and gave birth in a circular pool (15 m in diameter × 3.5 m deep). All three pools use one closed life-support system for water filtration and disinfection, and the water temperature is maintained at 24°C during summer (from June to September), which is the period during which births usually occur. The finless porpoises were fed four to five times a day. Following the knowledge about their diet in the wild, the food was a mixture of thawed crucian carp (*Carassius auratus*), common carp (*Cyprinus carpio*), and white semi-knife carp (*Hemiculter leucisculus*). The daily consumption was about 3 to 4 kg and was adjusted seasonally according to the appetite and reproductive status of the animals.

One pregnant female, EE, was kept in a net-cage (10 m long × 10 m wide × 7 m deep) in the open water of the Tian-e-Zhou Reserve. A rescued male was kept with EE and moved away in her late pregnancy. The water temperature was mediated by a sun shelter above the net-cage and a deep-water-exchange system and ranged from 6 to 32°C. EE was fed frozen white semi-knife carp (6 to 8% of body weight) and could forage for live fish in the net-cage.

For the EFPs, SD1 was kept alone in a square pool (3 m long × 5 m wide × 3 m deep) during her pregnancy. The other two pregnant females, SD2 and SD3, were originally kept together in a maternity pool (12 m long × 8.5 m wide × 2.9 m deep). After SD2's delivery, SD3 immediately swam forward to the calf, inducing the separation of SD2 and her calf. The calf was then transferred to a square pool after 9 min. Meanwhile, the water in the maternity pool was drained off to move SD3. SD3 was transferred to the square pool 368 min after the birth, and the calf was moved back to the maternity pool with SD2. All of these cows were fed around 3 kg of frozen mackerel (*Pneumatophorus japonicus*) and Japanese Spanish mackerel (*Scomberomorus niphonius*) per day.

Observation and Data Collection

Continuous direct observations were conducted through the underwater windows of the kidney-shaped pool, and two underwater cameras connected to a CCTV screen were used for observation of the circular pool in YCBRC. The parturition process of EE in the semi-natural reserve could only be observed from the water surface because of the turbidity of the water.

In SQPW, the labor process of SD1 was recorded continuously through an underwater window using a camera (Panasonic Lumix HC-V270) and a voice recorder. Direct continuous observations of SD2 and SD3 were conducted on a deck above the pool since there were no underwater windows in the pool.

The exact time of major events during each parturition was recorded, including the sighting of the first part of the calf's body (fluke or head), peduncle expulsion, calf expulsion, and placenta release. The delivery was categorized as cephalic or breech birth depending on the calf position. The cephalic position was when the calf was born with the head coming out first, and the breech position was with the fluke coming out first. Following Blanchet et al. (2009), we divided the delivery process into two stages; however, because no uterine contractions and allantochorion expulsion were noticed, we modified the definitions. Stage I started with the dilatation of the cervix or appearance of the first part of the calf's body, and Stage II was recognized as the period from the calf expulsion to the fetal placenta release. The complete parturition resulting in a live calf was considered to be successful, whereas the birth of a dead calf was recorded as a stillbirth.

In the data obtained from Toba Aquarium, for the 12 births, only eight delivery durations were recorded; and the data obtained from the Enoshima Aquarium contained the delivery duration of one birth. For the data coming from other facilities, Stage II duration was never recorded. We combined and analyzed the delivery duration (Stage I) of these nine births together with the data we collected during this study.

Statistical Analysis

We used *SPSS 19.0* to compare the durations of Stage I and Stage II within YFP, the breech birth durations of Stage I between YFP and EFP, and the Stage I duration between cephalic and breech births in EFP. These were also compared using independent-samples t test; the confidence interval was 0.95. The Spearman rank correlation test was used to compare the duration of Stage I and Stage II in YFP. Due to small or no samples, the duration of Stage I and Stage II in EFP, the breech birth durations of Stage II between YFP and EFP, the duration of Stage II between cephalic and breech births in EFP, and the duration of different stages of the stillbirth were excluded from the statistical analysis.

Results

Twenty-one parturition cases were analyzed, including 12 cases observed by the author and nine cases from other facilities' reports (Masami et al., 1976; Yang et al., 1998). Among all the births, nine were YFPs and 12 were EFPs. The nine YFP calves were all fluke-first births (breech position) and included eight successfully born calves and one stillbirth (11.1% of YFP births). For the 12 EFP births, nine were born in breech position, including eight successfully born calves and one stillbirth (8.3% of EFP births). Among these 12 EFP births, three calves were successfully born in head-first position (cephalic position), which accounts for 25% of total births in EFPs (Tables 1 & 2).

Cephalic births were only recorded in the EFPs. Duration of Stage I was significantly shorter in cephalic births than in breech births ($p = 0.003$). The only recorded Stage II duration of the cephalic birth was 551 min. The total duration of the delivery process was 561 min, which is quite similar to the breech births (560 min).

For successful breech births, there was no significant difference in the duration of Stage I between YFPs and EFPs ($p = 0.85$). The duration of Stage I ranged from 73 to 130 min (mean ± SD =108.75 ± 21.1; $n = 8$) for the YFPs, while it ranged from 43 to 153 min (105.75 ± 38.6; $n = 8$) for the EFPs. The duration of Stage II ranged from 341 to 480 min (418.57 ± 45.9 min; $n = 7$) in the YFPs; and in the EFPs, this duration was 414 min for the only birth that was recorded. The durations of Stages I and II for YFPs were not significantly different ($p = 0.76$). The total duration of the parturition was 524.29 ± 43.1 min for YFPs (range: 463 to 583 min; $n = 7$) and 560 min for the only EFP birth where Stage II duration was recorded. For the two stillbirths, Stages I and II lasted 187 and 52 min, respectively (239 min in total), for the YFP calf and 29 and 54 min, respectively (83 min in total), for the EFP one (Tables 3 & 4).

Discussion

For 18 cases of parturition in this study, three were cephalic and 15 were breech births. The three calves born head-first were alive at birth. Among the breech-born calves, 13 were alive and two were stillborn. In odontocetes, cephalic births are less frequently reported than breech births (Duffield et al., 1995; Robeck et al., 2001); however, even if not frequent, this kind of birth has been observed in various odontocete species. In captivity, for instance, two beluga whales (*Delphinapterus leucas*; Robeck et al., 2005), two killer whales (*Orcinus orca*; Duffield et al., 1995), a Commerson's dolphin (*Cephalorhynchus commersonii*; Joseph et al., 1987), and two bottlenose dolphins (Essapian, 1963; P. Martelli, pers. comm., 17 January 2018) were reported delivering calves in the cephalic position. In the wild, a pygmy sperm whale (*Kogia breviceps*) was observed giving birth to a live, head-first calf before they were found stranded (Huckstadt & Antezana, 2001). A harbor porpoise (*Phocoena phocoena*; Gol'din, 2011), several beluga whales (Vladykov, 1944; Doan & Douglas, 1953; Kleinenberg et al., 1964), and a white-beaked dolphin (*Lagenorhynchus albirostris*; Hart & van der Kemp, 1999) were also found stranded with cephalic-presented calves in the uterus. To our knowledge, no evidence strongly suggested the cephalic position induced the death in the stranded cases.

Besides the stranded cases in which the cause of death is unknown, the cephalic births in captivity and in the wild mentioned above all resulted in live calves, and the three EFP calves born in cephalic position in this study were all alive. Gol'din (2011) pointed out that cephalic presentation might be a natural variation rather than a pathology. In our study, the cephalic presentation

Table 2. Parturition information of EFPs adopted from literature (Masami et al., 1976; Yang et al., 1998)

Calf position	Facility	Animal number	Labor date (d/mo/y)	Duration of Stage I (min)
Head-first	Toba Aquarium	1	2/4/1982	19
		2	23/5/2008	5
Fluke-first	Toba Aquarium	1	17/4/1976	110
		2	9/5/1977	87
		3	1/5/1979	73
		4	19/7/19989	139
		5	27/3/2008	43
		6	2/5/2013	95
	Enoshima Aquarium	7	10/4/1993	153

Table 3. Time of parturition events of observed finless porpoises

		Time of each event during parturition (hh:mm)											
	Birth event	SD1-16*	SD2-17	SD3-17+	JJ-05	JJ-07	YY-08	YY-09+	F9-16	F9-18	YYa-18	F7-18	EE-16
Stage I	Fluke/Head visible	21:09	10:50	10:37	22:05	12:25	07:20	20:26	07:00	05:07	12:45	--	1:20
	Head emergence	21:17	--	--	--	--	--	--	--	--	--	--	--
	Both flukes out	--	11:34	10:40	--	13:27	--	--	07:06	5:30	13:01	5:03	--
	Peduncle visible	--	11:40	10:40	22:43	13:29	--	--	08:27	5:58	13:02	5:16	2:00
	Calf expulsed	21:19	13:16	11:06	23:49	14:24	08:33	23:33	08:57	07:11	14:47	6:24	3:30
	Duration (min)	10	146	29	104	119	73	187	117	124	122	81	130
Stage II	Placenta expulsed	6:30	20:10	0:00	07:05	21:20	15:20	00:25+1	15:28	14:50	20:28	14:24	Unknown
	Duration (min)	551	414	54	436	416	407	52	391	459	341	480	--
Total duration		561	560	83	540	535	480	239	508	583	463	561	Unknown

SD1, SD2, and SD3 are the EFPs observed in 2016 in SQPW, and *SD1 is the only head-first birth observed in this study. JJ, YY, YYa, F7, and F9 were the YFPs in YCBRC, and EE is the female YFP in the holding net-cage in the Tian-E-Zhou Reserve. $^{+}$The animals with this superscript demonstrate stillbirth of the calf; +1 is the next day.

Table 4. The average parturition durations (mean ± SD) of the two stages in finless porpoises with different calf positions and birth results

		Average duration(min)		
Result of birth	Parturition stage	YFP (Fluke-first)	EFP (Fluke-first)	EFP (Head-first)
Live birth	Stage I	108.75 (*n* = 8)	105.7538.6 (*n* = 8)	11.37.1 (*n* = 3)
	Stage II	418.5745.9 (*n* = 7)	414 (*n* = 1)	551 (*n* = 1)
	Total duration	524.2943.1 (*n* = 7)	560 (*n* = 1)	561 (*n* = 1)
Stillbirth	Stage I	187 (*n* = 1)	29 (*n* = 1)	--
	Stage II	52	54	--
	Total duration	239	83	--

seemed to have no influence on the success of the birth for the cow nor on the calf's survival at birth. It might suggest that the cephalic position is not a problem for the success of births in finless porpoises and that it does not induce higher chances of stillbirths than the fluke-first position.

In our study, we found that the average delivery duration (Stage I) of successful cephalic births was shorter than that of breech births in EFP. In other odontocete species, the duration of Stage I is variable. For instance, bottlenose dolphins take an average of 94.3 min (range: 45 to 240 min) to give birth to live calves, killer whales take 60 to 240 min, and beluga whales take 392 min (range: 136 to 870 min) (Robeck et al., 2001). Three parturition cases of captive bottlenose dolphins were reported with one cephalic birth spending only 22 min to expel the fetus, and the other two breech births spending 50 and 60 min, respectively (Essapian, 1963). Another case of cephalic birth of a bottlenose dolphin in Hongkong Ocean Park took approximately 20 min (P. Martelli, pers. comm., 17 January 2018). These observations are congruent with our results, suggesting that calves coming out head-first take less time to be expelled than those coming out fluke-first. When calves are born fluke-first, the fluke and peduncle remain exposed to the water, which causes no harm to the calf, allowing the complete delivery to last longer (Essapian, 1963). When the calf is in the cephalic position, the blowhole is exposed to the water. In this case, the delivery is quicker to make sure the calf is expelled, facilitating a breath as soon as possible, which might prevent the calf from drowning. Additionally, the fusiform shape of finless porpoises with a greater girth of the head than the fluke might help the mother to expel the calf rapidly during a cephalic birth (Reidenberg & Laitman, 2008). These observations and hypotheses suggest that the calf position influences the parturition process (at least in terms of duration) and that these changes in the process ensure the success of the birth (the birth of a live calf).

The durations highlighted in this study might be used as references in future parturitions of the finless porpoise. In a breech birth, when the parturition lasts longer than the average time in Stage I or when the placenta is expelled earlier than these references or is taking too long compared to it, artificial assistance might be needed to help the mother give birth to a healthy calf and to ensure the mother's safety.

The stillbirths of Ying Ying and S3 were both breech births. Ying Ying spent time in Stage I like the successful births, but pieces of its placenta were out as soon as the labor started, and the whole placenta was fully expelled 52 min after the calf was born. S3 spent less time to deliver her stillborn calf than the EFPs' successful breech births, and the placenta was expelled 54 min after the calf was born. The reasons that caused the stillbirths are unclear. A placental rupture could have induced Ying Ying's stillbirth. For S3, she was transferred to another pool 2 d before her labor, and this transport during late pregnancy might have been a strong stressor that initiated early labor and might have caused the stillbirth.

Considering parturitions were observed by several observers in several facilities, and some data analyzed herein were recorded decades ago, some parameters were lacking, such as Stage II duration of cephalic and breech birth for finless porpoises, which made it hard to compare the whole parturition process between different calf presentations. In addition, contraction, which might be one of the most important parturition events, was not documented by the different observers. This might have affected the precise determination of the beginning of labor. On the other hand, the stillbirth rates and associated calf positions in odontocete species are unclear, and the duration of two calf presentations is lacking, making the comparison with other species difficult.

In conclusion, the average duration of the successful births highlighted in this study might help in the management of future parturition of finless porpoises and, thus, in the success of captive breeding, which is crucial for these endangered subspecies. Although odontocetes normally give birth in the breech position, the cephalic position is likely to be a natural phenomenon that has no relationship with stillbirth in finless porpoises but only affects the duration of the birth. More information about breech and cephalic births in finless porpoises and in other odontocete species is required in future studies for a better understanding and improvement of the management of the parturition process to ensure the health status of both the cow and calf to finally increase captive breeding success.

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