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An attempt on rearing a dugong calf (*Dugong dugon*) and its behaviors

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ABSTRACT
Within one month, a female dugong calf (*Dugong dugon*) of 107 cm long had twice been stranded at Paklok sub-district, Phuket province, on 3 February 2004 and 2 March 2004. Firstly, it was released back to the sea and secondly transferred to be reared at Phuket Marine Biological Center. The calf carried a large wound on its muzzle and the wound completely healed after medical care within 2 months. Milk, in a concentration of 15-30 g of powdered milk made up to 100 cc in volume, had been offered to the calf 4-5 times a day, starting from 100 cc and then gradually increasing to 500 cc. Its behaviors were intensively observed 24 hours, 4 times during 15-30 March 2004. It was found that the minimum breathing interval times were 1 second in 24 hours during daytime (06.00-17.59) and 2 seconds during nighttime (18.00-05.59) while the maximum was 559 seconds (24 hours and nighttime). The minimum: maximum numbers of diving time, per hour were 29:97 (24 hours and daytime) and 30:82 (nighttime). It seemed that in a weak condition, the calf frequently surfaced to breath and could not dive for long period as in a normal condition. The gastrointestinal tract and lungs of the calf were severly infected by bacteria and it died after 79 days of the keeping period.

KEYWORDS: **dugong, calf, rearing, behavior, breathing**

INTRODUCTION

Dugongs (*Dugong dugon*) are the large herbivorous marine mammal in the tropical-subtropical areas of the Indo-Pacific. Adult dugongs typically range between 2.4-3 m in length and 250-420 kg in weight, with females slightly larger than males. Size at birth is quite variable, with neonates ranging from 1.1-1.2 m in length and 20-35 kg in weight. Calves begin to consume some seagrasses soon after birth but continue to suckle from their mothers for at least 18 months (Nishiwaki and Marsh, 1985). Throughout their geographical distribution, attempts to hand-rear dugongs have met very limited success, and it has been reported that among the dependent juveniles that had been taken into human care, only one was known to have survived to weaning age (Blanshard, 2000). Since 1960s, several aquariums, zoos, or institutions in Asia have tried to keep dugongs, with an exception for a few cases elsewhere, most of the attempts were not successful (Kataoka *et al*., 1995). Phuket Marine Biological Center (PMBC), Thailand, had been trying to rear 9 dugongs since 1979 and the longest keeping period was 200 days (Boonprakob *et al*., 1983; Adulyanukosol and Patiyasaevee, 1993; Boonyanate, 1994; Adulyanukosol, 2002). Two of those were released back to the sea after 15 days of rearing; one at Yon Bay (near PMBC) in 1989 and another one at Chaomai district, Trang province, in 1993 (Boonyanate, 1994).

Dugongs are very delicate animals, susceptible to diseases and difficult to keep in captivity. In the beginning of March 2004, we got the injured calf from the northern Phuket Island. There was only a small chance of success in raising this calf, but worthwhile information could be obtained irrespective of the outcome.

MATERIALS AND METHODS

About the calf

A female dugong calf had twice beenstranded at Paklok sub-district, Talang district, the north of Phuket province (Fig.1). First, it was stranded on 3 February 2004 and then it was released back to the sea in the same day. Later, on 2 March 2004, she became stranded again at the river mouth close to the first place and local people had brought her to the Phuket Coastal Fisheries Research and Development Center where she was kept until she was transferred to the Phuket Marine Biological Center (PMBC) on 5 March 2004 (Fig.1). She was 107 cm in length and 27 kg in weight and carried a large wound (10 cm long and 4-5 cm deep) on her muzzle with some small scars

scattered on her skin (Fig. 2a, 2b). The calf was emaciated with a deep groove on the midline of her ventral side. On arrival, her vagina was slightly bleeding. Nothing was known about the circumstances in which she had separated from her mother.

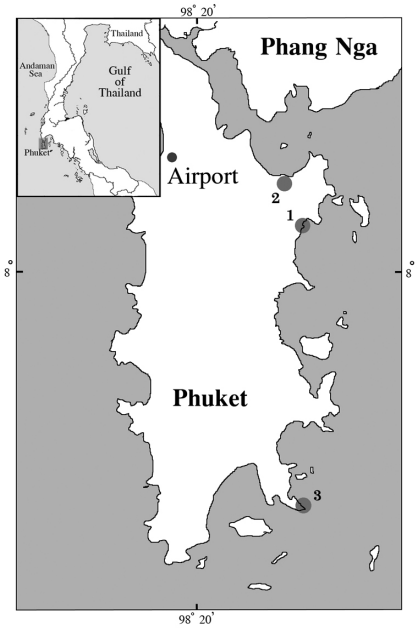

Figure 1. Map of Phuket Island shows the stranding area in the north at Paklok sub-district (1), the first keeping place at Phuket Coastal Fisheries Research and Development Center (2), the rearing place at Phuket Marine Biological Center in the south of the island (3).

General care and water system

Two different pools had been used to house the calf. First, on 5 March 2004, the calf was held in a circular fiberglass pool 3 m in diameter and with a wall height of 1 m, which allowed her about 0.75 m of water depth. Sea water was running through the UV system, about 3 tons of sea water per hour, for 24 hours. On 13 April 2004, this was replaced by 5*2.5*1 m concrete tank, which allowed her the same 0.75 m of water depth. The water system of the concrete tank was running through high rate sand filter tank (Cristal-flo^{TM}, 1 kw). Sea water from the filter tank was then separated into 2 pipes; the first pipe directly flowed into the rearing tank and the second pipe flowed through the UV system before entering the rearing tank.

Generally, milk had been offered to the calf 4-5 times a day outside the tank. After feeding in the morning, the wound on her muzzle was cleaned with 10% H_2O_2 solution, the dead tissue scraped off, cleaned with 1.2% Betadine solution followed by normal saline and then Bogela was applied. The calf was weighed daily and her length was measured 4 times during the keeping period. In total, approximately 25-30 minutes were spent for feeding, wound treatment, and weighing. The tank was drained and cleaned daily in the late afternoon (about 20 minutes around 17:30-18:00 hr). Detritus, seagrasss, and stool on the bottom of the tank were regularly removed. Water was drained out about 30% in case the calf has defecated. The bottom of the tank was provided with excess seagrasses attached onto the rubber sheets (seagrass plates); one plate for the circular tank and 4 plates for the rectangular tank (Fig. 2c). The floating seagrasses were taken out of the tank every 2-3 hours, except from midnight until early morning.

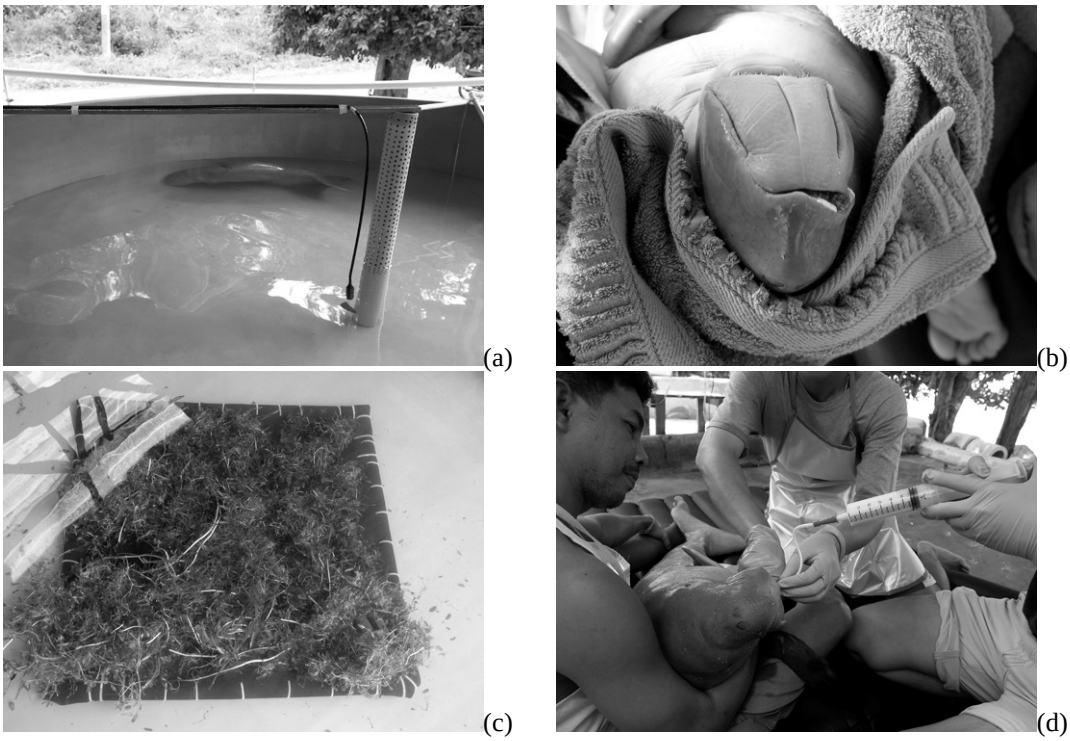

Figure 2. a) a female dugong calf 107 cm long in a circular fiberglass tank, b) the large wound on its muzzle, c) the seagrass attached onto a rubber sheet (a seagrass plate), d) feeding apparatus; 60 cc syringe and suction tube.

Food

It is important to raise a metabolically normal calf by feeding the calf frequency such as two-hourly, 24 hours a day as the recommendation of Miami Seaquarium in Florida (Blanshard, 2000). To follow this suggestion, Esbilac (milk for pup) which contains medium chained fatty acid and a high concentration of milk, was first selected for the calf. But our calf accepted a lesser quantity of milk each time and it seemed like she did not digest this kind of milk very well at the beginning of the arrival. The second kind of powered milk is Pan-enteral (milk for premature birth). Pan-enteral containes short chained fatty acid and a low concentration of milk, which can easily be digested and absorbed by the calf. Then Pan-enteral powdered milk was used instead of Esbilac brand (Appendix 1).

Before milk preparation, the rubber bed was cleaned with Dettol solution and laid on the floor as a feeding bed. Wet towel covered the calf body during feeding. The staffs ensured the hygiene of their body using Batadine Scrub particularly for hands, legs and feet. Powdered milk was mixed well with warm water and the volume adjusted with drinking water in a ratio of 30 g of milk powder made up 100 cc in volume. In the first few days after arrival, milk had been fed to the calf 100 cc each time. Later, it had gradually increased up to 500 cc. The calf did not accept the different kinds of feeding apparatus which were tested *i.e.* a nipple for calf, a rubber cast made from a nipple of mature female dugong, and a nipple applied from gloves, therefore, she had been fed by force-feeding for the whole experiment. Force-feeding was conducted by filling the milk into a 60 cc syringe equipped with a suction tube (3.5 mm in diameter and 50 cm long) (Fig. 2d). The tip of the suction tube was covered with a small amount of KY gel. The staff wore gloves (the nitrite powdered examination gloves) and gradually inserted the suction tube into the mouth of the calf until it reached her stomach (approximately 37 cm from the tip of her mouth). All feeding apparatuses were cleaned, except the suction tube which was soaked in the Chlohexidine solution for 15 minutes and then sterile solution for 1 hour. Comprehensive information of the timetable of caring for the calf is available in Appendix 1.

Medicinal treatment

Analysis of a stool had been made when the calf's condition was weak *i.e.* inactive, frequently surfaced, poor digestion or constipation. On arrival, she was suspected to have an infection of the digestive tract, however, it was later diagnosed as an infection of both lungs and digestive tract. The medical treatment was applied to the calf under the

recommendations of pediatricians and veterinarians. An antibiotic was applied through muscle tissue while an antiseptic was fed together with milk (Appendix 1).

Observation on behavior

General behaviors had been observed during day time in the keeping period of 79 days. However, the 24 hours observation on her behaviors had been conducted 4 times on 15-16, 22-23, 25-26, and 29-30 March 2004 from 09:00 am.-09:00 am the next day.

RESULTS

Food

Water quality in the rearing tank was quite clean for the calf. It was not necessary to control the water temperature by putting the heater in the tank due to the high flow rate of sea water. The calf seemed to have good acceptance to the force-feeding because she did not move her body during feeding and often closed her eyes (Fig. 3a). Regarding to the Sea World Formula of milk for manatee, one component is canola oil; at 4 ml/100 g formula (Townsend *et al.*, 2001). A small amount of canola oil was added to the milk in the first few days of her arrival but she could not digest the oil. Milk was given to the calf 4-5 times per day. The maximum volume of milk had been accepted by the calf was 500 cc each time (Appendix 1). The excessive seagrasses had been provided on the seagrass plate(s), but the calf fed only a little amount of these seagrasses.

(a)

(b)

Figure 3. a) a calf often closed her eyes while feeding milk, b) the wound almost healed after about 2 months of the treatment.

Medicinal treatment

Unexpectedly, the large wound on the muzzle recovered after about 2 months of the treatment (Fig. 3b). The behaviors of the calf in good condition are; easy swimming and diving, rubbing her flippers on the chest, suckling on the flipper(s), and rolling the body. The behaviors of uncomfortable condition or sickness are; always floating on the water surface, seldom swimming, and frequent breathing including rare diving. The calf often had constipation or diarrhea. Many kinds of medicine, both injection and oral feeding, were applied to the calf (Appendix 1). Results obtained from the stool and urine analysis have suggested that she was infected by bacteria in the gastrointestinal tract. Although after offering some doses of medicines, the calf's condition had shown that she recovered from the disease, but after about a week she was in an uncomfortable condition again. On 9 May 2004, fungi were found in the stool, it could have occured because of a prolong period of antibiotic usage. Before she died on 20 May 2004, she still fed very well without any sign of severe health condition.

The calf gained 5 cm in length and 3 kg in weight after 78 days of rearing. Her length slightly increased after about one month of keeping period and reached 112 cm while the weight fluctuated after her arrival and reached 30 kg at the end of the experiment (Fig. 4).

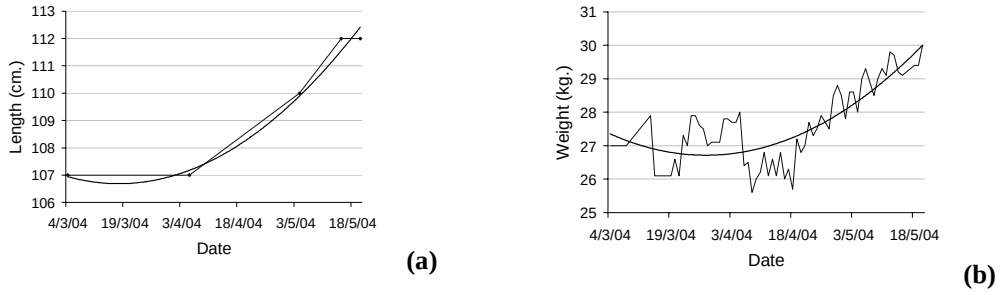

Figure 4. Growth curve of the calf in captivity during 4 March-19 May 2004, a) the relationship between the length (cm) and date, b) the relationship between the weight (kg) and date

Observation on behavior

General activities of the calf were milk feeding, seagrass chewing, surfacing, breathing and resting (always at the bottom and seldom surfacing). From 24 hours observation for 4 times (15-16, 22-23, 25-26 and 29-30 March 2004), it was found that the minimum breathing interval was 1 second in 24 hours during daytime (06.00-17.59 hr) and 2 seconds during nighttime (18.00-05.59 hr). The maximum breathing interval was 559 seconds in 24 hours and nighttime. The number of minimum: maximum of diving times per hour were 29:97 (whole day and daytime), 30:82 (nighttime) (Table 1). The mean values of the breathing time (min-max) and mean values of surface breathing per hour are shown in Table 1.

Table 1. The breathing interval (diving time) and the number of surface breathing of the calf per hour from 24 hours observation for 4 days (15-16, 22-23, 25-26 and 29-30 March 2004).

Period	Min(sec)	Max(sec)	Mean±SD
breathing interval (diving time)			
Whole day	1	559	61.18±57.58
Daytime (06.00-17.59)	1	420	57.00±51.06
Nighttime (18.00-05.59)	2	559	66.04±63.81
surface breathing per hour			
Whole day	29	97	58±15.07
Daytime (06.00-17.59)	29	97	62±16.93
Nighttime (18.00-05.59)	30	82	54±12.32

Regarding to the patterns of average rate of the calf breathing per hour, in 24 hours, for 4 times observation (15-16, 22-23, 25-26, and 29-30 March 2004) in Fig. 5, it was noticed that the active activities occurred during daytime and inactive activities was during nighttime. Besides, the rate of average breathing per hour was higher in the daytime than the nighttime, particularly on 29-30 March 2004.

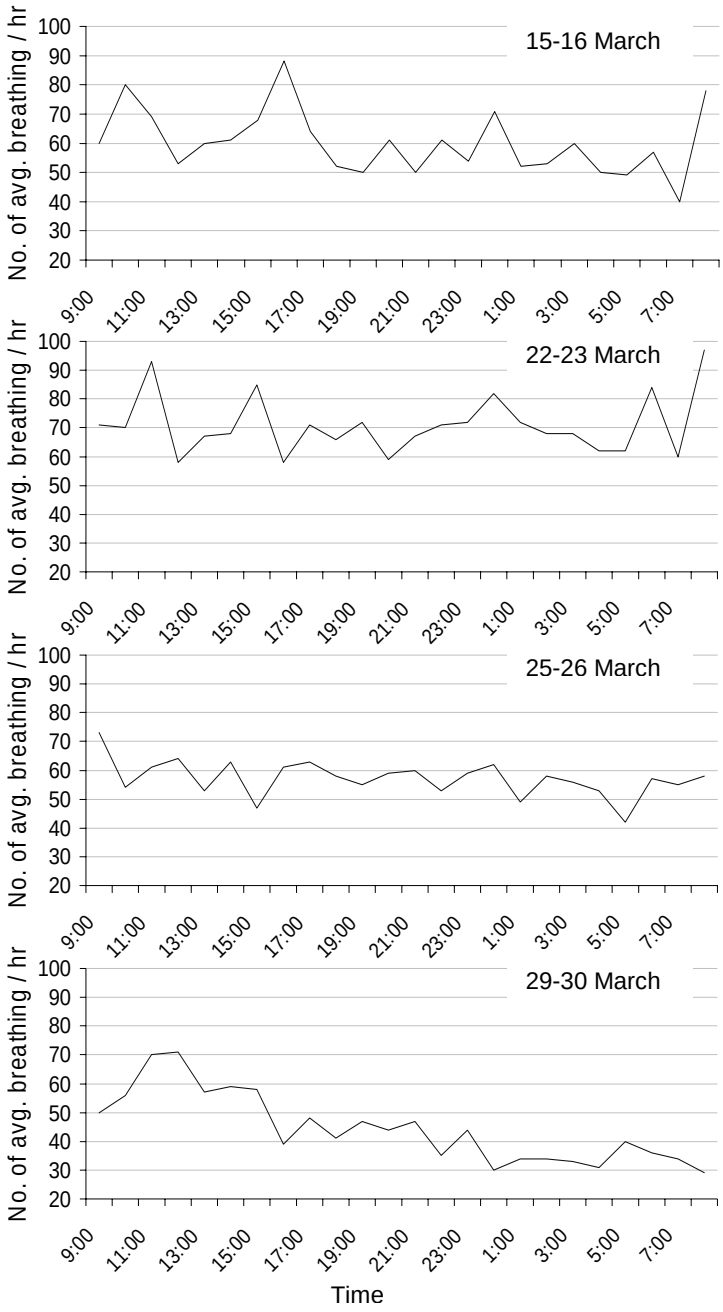

Figure 5. Graphs show the rate of average breathing per hour of the calf, in 24 hours, for 4 times observation (15-16, 22-23, 25-26, and 29-30 March 2004).


(c)

(d)

Figure 6. a) the nasal valves opened while surface breathing, b) a calf always lay at the bottom of the tank during nighttime.

About one hour duration after milk feeding, the calf surfaced for breathe more often and had shorter breathing interval times than usual (Fig. 5 and Appendix 1). Generally, the calf opened the nasal valves only once each surfacing (Fig 6a). In addition in the first month of rearing the calf often made calls (vocalize) especially when people came close to her or around the rearing tank. She generally produced calls while feeding on the seagrass plate, wound treatment, or in constipation condition. Sometimes she called during force-feeding outside the tank. The resting behavior occurred during nighttime (Fig. 6b).

DISCUSSION

We have realized that dugongs are very delicate animals, susceptible to diseases and hard to keep in captivity. We had released the female calf back to the nature on the first arrival. The calf was expected to have got lost from her mother and might have had an opportunity to meet her mother soon after releasing. Unfortunately a month later, the same calf, carrying a bad injury on her muzzle, became stranded again at the river mount close to the first location. Thus, we could not deny rearing this orphan calf on this arrival. We had been worried about the large wound of 10 cm long and 4-5 cm deep and the emaciation. This calf was of very young age, 107 cm in length and weighed 27 kg on arrival on 5 March 2004. The indications of very young calf included the deep hole of her navel, very short bristles on her facial disc, absence of calluses on the underside of the tips of her pectoral flippers, and unstrained horny plates in top and bottom jaws (Blanshard, 2000; Adulyanukosol, 2004). Food and therapeutic drugs had been used on the calf according to the recommendations of the pediatricians and veterinarians. Although, there was a large wound on her muzzle together with emaciation, her behaviors seemed to be normal *i.e.* always swimming around the tank, upside down swimming *etc.* The calf gained only 5 cm and 3 kg after 78 days of rearing.

Food

Kataoka *et al.* (1995) have suggested that in the case of a young calf approximately 5-8 months old, human infant milk formula should be given. In order to give substitute milk, a nipple resembling a natural one (2.6 cm in diameter) proved effective. Nutritional and dietary supplements were given as the situation required. Important points to watch include amount of milk and seagrass consumed, signs of constipation or poor digestion. It is also important to respond quickly to problems before the individual weakens. Furthermore, Blanshard (2000) has assumed that the gastrointestinal tract of most young herbivores was inoculated with useful bacteria accidentally (or in the case of koalas, deliberate) ingestion of adult faeces, it seemed reasonable to suppose that a neonatal dugong raised away from its normal seagrass-meadow environment may not harbor the appropriate gut flora.

Observation on behavior

The age of the dugong and the health condition might be one of the factors involved in its behaviors. Kataoka *et al.* (1995) have observed daily activities of 2 dugongs of 9 and 17 years old in Toba Aquarium. It was determined that the resting or inactive periods of the captive dugongs were concentrated in the stretch from late night to early morning (this includes sleeping). In this study, the calf of less than 5-6 months old had active behaviors during daytime and inactive during nighttime. The maximum breathing interval in this study was 559 seconds. Adulyanukosol (1996) reported

that the maximum breathing interval of a calf (119 cm in length) was 480 seconds while it was 506 seconds in the study on Kenny (1967) (cited from Nishiwaki and Marsh (1985)).

Dugong in Captivity

Since 1960s, about 49 dugongs have been kept at 17 institutions in 10 countries around the world (Table 2). Most of the attempts to keep dugongs in captivity were short-lived and only 13 had lived longer than 6 months (number 13 are from: 11 individuals from Marsh (1991) plus 2 individuals from Table 2; one from Sea World, Australia, in 1998 and another one from Underwater World, Singapore, in 1998). In recent years, a handful of dugongs had been maintained in captivity around the world, notably at Toba Aquarium in Japan, Jaya Ancol Aquarium in Indonesia, Sea world in Australia and Underwater World in Singapore (Marsh 1991, Kataoka *et al*., 1995, Table 2).

Table 2. Keeping record of dugongs in the world at present (as of November 2004).

Date	Keeping place	No of dugong (ind)	Longest term (y/mo/d or week)	Food supply	Original location of dugong
1955	Steinhart Aquarium, USA	1	1mo/ 15days	nf	Palau Is., Micronesia
1959-70	Central Marine Fisheries Institute, India	2	10y	seagrass	India
1965, 1966	Yangon (Rangoon) Zoo, Myanmar	2	?	seagrass	Myanmar
1966,1978	Cairns Oceanarium Australia	2	3mo	*Zostera* sp., milk	Australia
1996, 1997, 1998	Sea World, Australia	3	4-5.5 weeks/ 3y and rehabilitation	seagrass, mik	Australia [1]
?	Noumea Aquarium, New Caledonia	1	4mo?	*Halophila*, *Cymodocea*	New Caledonea
1975, 1981-83, 1978-89	Jaya Anchol Aquarium, Indonesia	8	4y/ 9mo	*Halophila*, *Syringodium*	Indonesia
1976-?	Surabaya Zoo, Indonesia	3>	?	seagrass	Indonesia
1968	Oita Marine Place, Japan	1	17days	Vegetable juice, milk	Australia
1975, 1992-93	Okinawa Expo Aquarium, Japan	3	22days/ 9mo	*Thalassia*, *Cymodocea*, *Syringodium*, *Ipomoea*	Indonesia, Okinawa, Japan
1979	Okinawa Marine Park	1		*Zostera*, *Syringodium*	Okinawa, Japan
1977, 1979,1987	Toba Aquarium, Japan	4	2dugongs *still alive*	*Zostera*, *Syringodium*, milk	Philippines [2]
1992-2004	Pawikan Conservation Project, WWF-Philippines	5	15 days-6 mo	Milk, seagrass	Philippines [3]
1998	Underwater World, Singapore	1	*still alive*	Seagrass, milk	Singapore [3]
1979-2004 (include this study)	Phuket Marine Biological Center, Thailand	10	20days/ 6mo	*Halophila*, milk	Thailand [4]
	Fishery Station/ Fisherman	2	?/ 15 days and released	seagrass	

<u>Remarks:</u> The main information derived from Kataoka et al. (1995) and additional data were from [1] Blanshard (2000) and www.seaworld.com.au, [2] Romeo B. Trono (personal communication) [3] www. underwaterworld.com.sg, and [4] Adulyanukosol (2002) including this study.

It is hard to determine the precise cause of its death. It may come from various causes *i.e.* injury during catching and transportation, nutrition, stress, being sensitive to medicine, sickness etc. (Boonprakob *et al.*, 1983, Adulyanukosol and Patiyasaevee, 1994, Boonyanate, 1994). Except for maintaining the water quality and the space of rearing tank, the nutrition seems to be the most important factor for the survival of dugongs in captivity. Although complete details are unknown, dugongs are especially susceptible to different

types of chemical. Deaths due to copper sulphate ($CuSo_4$) and DDT have been reported. (Blanshard, 2000). After the calf had died on 20 May 2004, about 2-3 liters of water was found in her body cavity and the infection was noticed on her lungs and gastrointestinal tract**.**

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Appendix 1. Time table of all information on milk feeding and general care including the medicinal treatment of the calf during 4 March–20 May 2004. In general milk concentration was 15-30 g of powdered milk made up to 100 cc. (Fl= Floxidin vet 10%, CA= Catosol10%, CF= Ceftriaxone, AM= Amoxycilin+clav (curam), MT= Metronidazole, OF= Ofloxin, FZ= Fluzoral), mixed Multi-Vitamin Syrup with cod liver oil (Seven Seas brand) 5 cc once a day in the morning together with milk.

Date	Milk feeding time (volume in gram)										% Milk		Medicine	Remarks
	4:00	8:00	11:00	12:00	15:00	17:00	18:00	20:00	22:00	24:00	Esbilac	Pan-enteral		
4 Mar									15		100		FL 2ml,CA 4ml	Constipation, medicine applied at 18:00 pm
5		30		30		30					100		FL 2ml	constipation
6	75	75		75		75					100		FL 2ml	constipation
7				60		60		60			100		FL 2ml	found undigested milk
8		75		75	75			75		75	100		FL 2ml	stool check, occult blood in stool, undigested milk
9		75		75		75		75		75	100		FL 2ml	undigested milk
10		75		90		90		30		75	100		FL 2ml	diarrhea
11		45		45	90			90	90		100		FL 2ml	diarrhea
12		30									100			floating, rarely dive
13							8					100		
14		8		8								100		
15		8		45	45			45				100		
16		60		60	60		60		60		50	50		
17		60		60	60		60		60		44	56		
18		60		60	60		60		60		33	67		
19		75		75	75		75		75		40	60		
20		75		75	75		75		75		40	60		
21		75		75	75		75		75		35	65	CF 3ml	diarrhea; medicine applied at 22:00 pm
22		120		75				105				100	CF 3ml	
23		90		60	90		75	90				100	CF 3ml	
24		90		75			75		90			100	CF 3ml	occult blood in stool
25		105	90		75		90		90			100	CF 3ml	
26		120	75		105		75		105			100	CF 3ml	yellowish green stool (from seagrass)
27		105	75		75		75		75			100		

Appendix 1. cont.

Date	Milk feeding time (volume in gram)										% Milk		Medicine	Remarks
	4:00	8:00	11:00	12:00	15:00	17:00	18:00	20:00	22:00	24:00	Esbilac	Pan-enteral		
28 Mar		105	75		75		90		90		7	93		
29		90	90		90			90			4	96		constipation
30		90		90	90		90		90	90		100		constipation
31		90			90				45			100		constipation
1 Apr		90	45		45		45		45			100		constipation
2					45		45	45	45	45		100		constipation
3		45	45		45		45		45			100		floating, rarely dive, constipation
4		45	45									100	CF 3ml	medicine applied at 14:00 pm
5													CF 3.5ml	
6													CF 3.5ml	
7			75		75			75				100	CF 3.5ml	
8		75			75		15		75			100	CF 3.5ml	defecate
9		75	75		75			90				100	CF 3.5ml	stool and urine-check found bacteria infection on intestine and urinary system
10		90			90			90			5	95	CF 3.5ml	
11		75		90				90			12	88	CF 3.5ml	diarrhea
12		90		90			75		90		13	87	CF 3.5ml	
13		90		90	90			90			17	83		diarrhea
14		90						45			11	89		diarrhea, saline feed instead of milk
15		45		45		45		45				100		
16		45		45			45		60			100		
17		60		75	75			75				100		stool-check found more infection in the intestine
18		75		75	75			75				100		
19		75		90	90			90				100		
20		90		90	120			90				100		diarrhea stop
21		90		90	90			105				100		
22		105		105		105		105				100		
23		105		105		105		105				100		

Appendix 1. cont.

Date	Milk feeding time (volume in gram)										% Milk		Medicine	Remarks
	4:00	8:00	11:00	12:00	15:00	17:00	18:00	20:00	22:00	24:00	Esbilac	Pan-enteral		
24 Apr		105		105		105		105				100		
25		105		105		105		105				100		
26		105		105		105		105				100		
27		105		105		105		105				100		
28		105		105				105				100		much protozoa found in stool and urine-check found infection on intestine including dehydration
29		105		105		105		105				100		floating, rarely dive
30		105		105		105						100	CF 5ml, AM 500mg	
1 May		105		105		105		105				100	CF 5ml, AM 500mg	medicine applied at 16:00 pm
2		105		105		105		105				100	CF 5ml, AM 250mg	
3		105		105		105		105				100		
4		105		105		105		105				100	MT 900mg, OF 200mg	medicine oral applied
5		105		105		105		105				100	MT 900mg, OF 200mg	
6		120		120		120		120				100	MT 900mg, OF 200mg	
7		120		120		120		120				100	MT 900mg, OF 100mg	
8		120		120		120		120				100		
9		120		120		120		120				100		stool-check found fungi
10		120		120		120		120				100		urine-check still has bacterial infection
11		120		120		120		120				100		
12		120		120		120						100		defecate mixed with some mucus
13		120		120		120		120				100		
14		135										100	FZ 100mg	medicine oral applied
15						60		60				100	FZ 100mg	
16		120		120		120		120				100	FZ 100mg	
17		120		120		135		135				100	FZ 100mg	
18		135		135	135	135		135				100	FZ 100mg	
19		135		135		135		135				100		
20											-	-		died at 07:00 am, gastrointestinal tract and lungs