Chapter 4

Discussion

1. Present status of dolphin and porpoise in the Inner Gulf of Thailand

There are five species of porpoise and dolphins, *Neophocaena phocaenoides* (finless porpoise), *Orcaella brevirostris* (Irrawaddy dolphin), *Sousa chinensis* (Indo-Pacific humpback dolphin), *Tursiops truncatus* (bottlenose dolphin) and *Stenella longirostris* (spinner dolphin). However, only the first four species are common while spinner dolphin seemed to have very small population at present if this species is still remaining in this area.

1.1. *Neophocaena phocaenoides*, finless porpoise

Although, finless porpoise is seen localized by nearshore fishermen at the same time it can also be seen in deeper water as well. In the Inner Gulf of Thailand, finless porpoise were commonly seen in coastal water quite far from the estuary and was unknown in the freshwater at all. This is the only one species of porpoise found in Thai waters and noted to be one of the most common species. The distribution of the finless porpoise is almost the same as that of the Irrawaddy dolphin but differs slightly. The Inner part of the Gulf seems to have less population of finless porpoise than the east and west part of the Gulf. It was found along the west part but the eastern most of the range extended only to Pattaya where the depth, salinity and boat traffic are higher. This is similar to reports from other areas but contradicted to reports concerning its freshwater intrusion. Klinowska (1991) refered to Mitchell (1975 a and b), Pilleri and Gihr (1972 and 1974), Leatherwood and Reeves(1983), Tadjalli-Pour (1976), Zhuge (1982) and Wang (1984) reported, that this species was found in the middle and lower reaches of Yangtze (Changjiang) river in China as far as Yichang

and in the adjacent lakes such as Dongtinghu and Boyanhu. Pilleri (1974) and Jefferson (1994) reported that finless porpoise are very shy to boat. Hence, it would not be possible to swim through the crowded traffic around the four major rivermouths of this study.

This species had commonly been found entangled by various types of fishing gears. However, it can not be concluded that this is the most abundant species in this area beacuse only high quantity of bycatch can not be interpreted as such and the other dolphins may be able to escape the fishing net better than this species. Eventhough finless porpoise is still common at present, the incedental take of this species is most frequently reported. Therefore the urgent study is needed to reduce the entanglement of this species.

1.2. *Orcaella brevirostris*, Irrawaddy dolphin

Irrawaddy dolphin showed that its population would have particular local habitats and usually limited their distribution to shallow water. They are common in specific localities. This is opposite to wider distribution patterns of bottlenose and humpback dolphin. Irrawaddy has narrow range of distribution. This species prefers shallow, brackish, riverine water. It was found close to the shore of northern and western part of the Inner Gulf especially near the mangrove swamp. On the east coast its distribution was limited around Pattaya and the lower part of the Inner Gulf. Irrawaddy dolphins are also found in brackish estuaries and coastal waters in many Asian countries, including Thailand,(Baird and Moungsuphom, 1994). This possibly cause of the unoccurrence of Irrawaddy dolphin in the lower part of the Gulf where there is no major runoff.

At present, Irrawaddy dolphin is occasionally found about few kilometers from Bang Pakong river mouth while in the past, it was known to be the best in freshwater intrusion into Chao Phraya and Bang Pakong Rivers. Anderson (1879) and U Tin Thein (1977) reported the presence of this dolphin at Bhamo (Burma) about 1300 km.

up the Irrawaddy River. Baird and Moungsuphom., (1994) reported sighting Irrawaddy dolphins in the Mekong River. The reason for not having Irrawaddy dolphin in the lower part of the Gulf might be from not having major freshwater runoff.

This species was commented by most fishermen that it was less influenced by fishing activities. Irrawaddy dolphin inhabited mainly in the shallow waters where only small scale fishery was conducted. It was only unharmed by local people, the local people also reported to be friendly with Irrawaddy dolphin.

1.3. *Sousa chinensis*, Indo-Pacific humpback dolphin

Indo-Pacific humpback dolphin is well known by most coastal inhabitants of the Inner Gulf. It seems to permanently inhabit around all rivermouths and extend along the coast to the depth of about 20 m. This is coincided to the report of Jefferson (1994) that it is the inhabitant of tropical to warm temperate coastal water and they enter rivers, estuaries and mangroves. Ross, et al. (1994) also stated that humpback dolphin occur in shallow water less than 20 m deep throughout their distrbution. The saline and often turbid channels into mangrove and between sand banks so typical deltas form prime habitat of humpback dolphin, and appear to support considerable population. Some interviewees in this study confirmed their occurences at Ko Sichang and Ko Kram where the depth is slightly more than 20m. The behavior when they were closely followed was very different to that of the bottlenoses which had also been observed in this study. Bottlenose dolphin at Ko Mai Ton, Phuket, the constant compactness of the school, even in flight, was very characteristic. If approached too close, the whole school dived at the same moment and changed direction in compact formation away from the object that was threatening them while in the Indo-Pacific humpback dolphins, they split a large school into smaller.

Indo-Pacific humpback dolphin is currently the only one species found to intrude few kilometers from the mouth of most rivers. Ross, et al. (1994) coincide

with this study in their work that the southern China humpback dolphin which may swim up river for several kilometers.

Though Indo-Pacific humpback dolphin was reported to have low density population, it was very popular for people along the coast of the Inner Gulf. Most fishermen believed that this dolphin was the dolphin of angle and very few people dare to harm Indo-Pacific humpback dolphin. Some fisherman leader necessarily shot this dolphin when it scrambles for the caught fish in their nets.

1.4. *Tursiops truncatus*, bottlenose dolphin

Up to present, bottlenose dolphin is well known to many people. They were from time to time spotted by fishermen. Bottlenose dolphin is also not shy for boats. It prefers to ride the bow or following the ferries and this impresses all observers. Although this species could sometimes be found nearshore, it is commonly in deeper water, more than 15-20 m. Bottlenose dolphin is the most typical dolphin worldwide, including Thailand. They were found along the Inner Gulf particulary around the islands in the lower part of the eastcoast. Sylvestre (1995) reported that it was usually a coastal animal, but it could also be found very far out at sea. Bottlenose dolphin possibly has widest range in distribution. Klinowska (1991) suggested their inshore range included river mouths, bays, lagoons, esturine complexes and virtually any shallow water of marine region, 0.5-20 m. Passes between open ocean and enclosed bays or lagoons are often centres of abundance, and the dolphins use intra coastal waterways and otherdeep channels to gain access to productive shallows.

Except Klinowska (1991) reported that the inshore form of bottlenose dolphin was occasionally reported in freshwater rivers. Although these are most likely to be vagrants or temporary visitors, no other papers reported the fresh water intrusion of this species. In this study, the old specimens of bottlenose dolphin were surprisingly found at about 30 km away from Chao Phraya river mouth. This can be one of few evidences in freshwater intrusion of bottlenose dolphin in Thailand.

The incidental catch of this species is very rare. Most fishing gears used in the study area are of small scale which could not entrap this high speed dolphin.

1.5. *Stenella longirostris*, spinner dolphin

Only two sighting records of spinner dolphin come from the lower part of the both east and west coast of the Inner Gulf. Iot can be concluded that this species is not a resident in the study area and it is not common to find spinner dolphin in the Inner Gulf of Thailand. Perrin, et al. (1989) reported to collect ten specimens of this species 1970-1971 from Samut Sakorn, large fish landing port. but most fishing vessels landed there usually covered the area rather far, to the south of Thailand or even international waters. However the rich of undated taxidermic specimens of spinner dolphin kept around the study area can concluded that this species might once been common in the study area but becomes rare in present.

From the five species present, four dolphins seem of be more of the coastal species while bottlenose dolphin distributed further into the deeper water. The distinct color of Indo-Pacific humpback dolphin and the acrobatic behavior of bottlenose dolphin could attract more attention than other species. Irrawaddy dolphin is commonly found inhabited in the brackish and shallow water while Indo-Pacific humpback dolphin also prefers the estuarine of Ta Chin and Mae Klong rivers and found intruded only few kilometers into those rivers. There is no record of the other species intruded into these two rivers. Irrawaddy dolphin was reported by the elderly local local people that they were commonly found intrude into the Chao Phraya and Bang Pakong rivers while the intrusion of bottlenose dolphin was recorded only in Chao Phraya river. All these informations correspond to those reported by many authors with the exception of the freshwater intrusion ability of finless porpoise which can not be found in this study.

2. Specimens studied

Although the bycatch dolphin is not good for conservation, it is the best specimen for research. Good information gather from fresh bycatch or stranded samples are necessary for studying intensive biology. Furthermore, it is very troublesome and difficult to study these animals in their natural habitat. This is partly due to the difficulties inherent in observing free-ranging cetaceans. The old taxidermic and skeletal specimens have to be used for this study. Particularly, the old taxidermic and skeletal specimens of Indo-Pacific humpback and bottlenose dolphin are to be used since no new sample could be obtained.

To preserve an animal for exhibition, taxidermy can present the external characteristic similar to living animal but the proportion could be shrunk. This taxidermic specimen could loose all important data which could be obtained from skeleton measurement. At present, museums are trying to preserve the skeletons of dolphin instead of taxidermy. Collecting all of dolphin's bones is a very tedious work but valuable data of osteology is still remained.

3. External and internal morphological data

3.1. *Neophocaena phocaenoides*, finless porpoise

3.1.1. External morphological data

Body shape, head shape, dorsal ridge, fluke and flpper are analogous to those described by other authors with an exception of light reddish color on the ventral side, especially around the throat and thorac. The tooth count on upper/lower on each side are 15-21/14-21, wider range than those of other four species. The external morphology of porpoise with higher and lower tooth numbers are not distinguishable.

The upper teeth of juvenile porpoise have erupted before the lower teeth. No other authors refered to this character of this species earlier.

3.1.2. Comparision between adult and juvenile porpoise

The external proportion of adult and juvenile *N. phocaenoides* is shown in Fig. 45. The persentage of body girdle and blubber thickness/bodylength of juvenile are much higher than those of adult (Table 31). Furthermore, head and flipper proportion in juvenile makes its body seemed less slender than its adult. Cockcroft and Ross (1990) studied the early development of a bottlenose dolphin calf and reported that at birth the proportion of blubber to total mass is greater than that of muscle. A calf was noticably thin, with lean flanks and a large head in relation to the body. Moreover, these proportion are similar to those in striped dolphin, *Stenella coeruleoalba* as studied by Sinclair, 1967 (Perrin,1975).

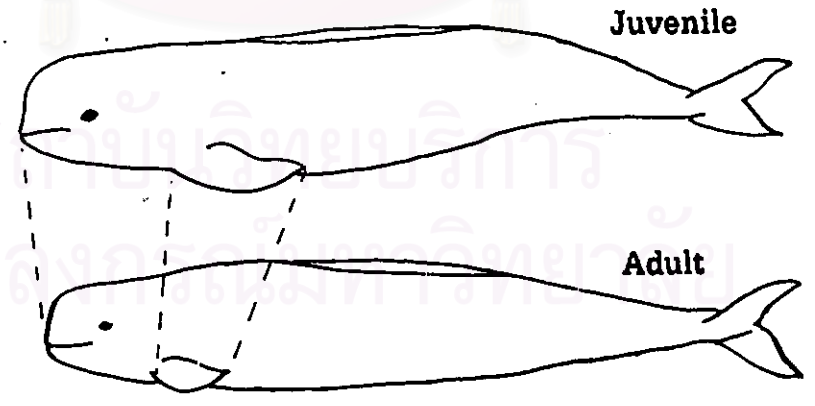

Fig. 45 External proportion of adult and juvenile finless porpoise

3.1.3. Internal anatomy

3.1.3.1. Organs

Weights of liver, heart and kidneys are similar to those reported by Kasuya (in press). They did not report the weights of lung and pancrease which are 3.27- 3.46% and 0.11-0.29% of body weight in this study. It should be focused also on the trachae. Two porpoises, MSCU005 and BIMS019, were observed and confirmed by veterinarian to have double trachae which never been reported before. Most studies on respiratory tract would focuss on the bronchus, only one report of trachae by Tinker (1988). Tinker described that the trachae of all mammals divided into two branches upon entering the thorax ; the larger of these two branches supplies the right lung and the other branch supplies the left lung. However, in some whales, a third branch arises to supply the apical (anterior) part of the right lung. This is probably because he observed only external morphology of the trachae. The double trachae could be observed only when it was cut in cross section. From out side, double trachae will be observed as only one trachae which will be divided into three branches when actuallly the treachae is already divided internally into two.

3.1.3.2. Stomach contents

The stomach contents of finless porpoise composed of cephalopods, crustaceans and fishes. This resemble to those reported by Sylvestre (1993), Kasuya (in press) and Jefferson, et al. (1994). These can indicate that finless porpoise feed on both pelagic and bethic fauna. Although one side of bivalve mollusk was found, it can be considered as incedent material and may function as stones to help griding up material consumed, such as fish bone or exoskeleton of crustacea.

3.1.3.3. Internal parasite

Nematode is one of parasites found in finless porpoise (Kasuya, in press). He also reported that trematodes, nematodes and cestodes were found in finless porpoise. This study, however, found only nematodes in the lung of juvenile porpoise.

3.1.3.4. Skeleton

Cranium

The skull of finless porpoise is smaller than other four species found in the study area. The mandible is comparatively smaller than that of another beakless species, Irrawaddy dolphin. The external nare is also slightly smaller than that of Irrawaddy dolphin or about 14.13% of CBL. Amano, et al.(1992) compared the skull measurement of physically mature finless porpoise from the Indian Ocean, Yangtze River and Japan. They concluded that the condylobasal length (CBL) of this porpoise was greatest in Japanese waters and smallest in the Indian Ocean. In this study, MSCU001 is the only one physically mature male. When skull of MSCU001 was compared with the others, it showed the smallest proportion with the exception of the width of rostrum at base(WRB) which was wider than that of Yangtze River population(Table 27). This can be noted that the skull of finless porpoise in Gulf of Thailand is smaller than other skulls reported from other parts of the world the same as the dwarf spinner dolphin, *Stenella longirostris*, and the small form of Brydes' whale, *Balaenoptera edeni*.

Postcranial skeleton

Vertebrae

The vertebral formula is in the range of Japanese population reported by Kasuya (in press). He also reported that the first three of seven cervical vertebrae are fused together with the exception of one individual having four fused cervicals reported by Mizue, et al. (1965). All of Thai porpoises have the first three fused cervical vertebrae.

Ribs

The numbers of single-headed ribs, two-headed rib, sternal ribs and floating ribs are similar to those described by Kasuya (in press) and Shirakihara, et al.(1994).

Table 31 Skull measurements (mm) of physically mature finless porpoises from the Indian Ocean, Yangtz River, Japan and Thailand

Measurement\regions	Indian Ocean	Yangtze River		Japan				Thailand
	BMNH	USNM	USNM	NSMT	NSMT	NSMT	HA	MSCU
	1889-8-6-1	240001	240002	M24659	M24908	M24955	19	001
CBL	205.0	212.0	227.0	234.5	248.4	245.1	239.6.153.1	194.0
ZW	138.0	141.0	143.0	156.7	157.4	153.3	153.1	135.0
LR	76.0	83.0	86.0	86.5	98.0	90.1	90.5	66.40
TE	106.0	115.0	122.0	121.1	137.8	128.3	125.8	105.0
WRB	74.3	66.2	68.0	72.4	73.8	77.1	69.6	71.60
WRH	53.8	53.3	52.0	56.4	58.2	57.0	53.5	51.80
LUTR	65.9	67.7	70.3	69.5	81.9	102.4	76.0	64.30
LAR	149.0	153.0	153.0	165.7	177.3	170.0	171.5	141.50

Abbreviations : NSMT, National Science Museum ; Tokyo ; HA, Himeji City Aquarium ; USNM, United States National Museum of Natural History ; BMNH, British Museum (Natural History) ; MSCU, Dept. of Marine Science, Chulalongkorn Univ. ; CBL, condylobasal length ; ZW, zygomatic width ; LR, length of rostrum ; TE, distance from tip of rostrum to external nares ; WRB, width of rostrum at base ; WRH, width of rostrum at midlength ; LUTR, length of upper left toothrow ; LRA, length of left mandible

3.1.3.5. Comparison between adult and juvenile

The growth pattern of scapula and sternum can be evaluated by the change of proportion from juvenile to adult. The width of scapula and sternum of juvenile show the higher proportion than those of adult. This can indicated that growth of scapula and sternum occur in length more than in width. This will pave the way to study on width/length ratio of scapula and sternum in the long run. They might be used in the future as one bone which can roughly determine the age of this species.

On the other hand, typanic bulla and periotic bone of juvenile are as long as those of adult. This show that they have not grown any more. Furthermore, tympanic bulla of juvenile seemed thicker while adult's one seemed more slender. This can possibly mean that the hearing capability of adult and juvenile are not different but more study on this apparatus should be tested.

3.1.3.6. Sexual dimorphism on skeleton

Sexual dimorphism was observed in greatest length of sternum along midline together with the size and shape of pelvic bones. Male with the total length of 141 cm and 133 cm female were compared. Male pelvic is longer, broader and thicker than that of female. This bone had also been used on sex determination in many dolphins, porpoises and dugong as well. This character was also observed in Japanese *N. phocaenoidess* by Yoshida, et al. (1994). Furthermore, this pelvic bone had been used to determine sex in the dugon, *Dugong dugon*, by Domning (1991). The obvious difference size of male and female sternum can be used to determine sex. Sternum of male, MSCU001, is only 6.65 cm long but female, MSCU003, has sternum of 7.63 cm long although she is not physically mature yet.

3.1.3.7. First record on life history of finless porpoise in Thailand

In this study, the biggest male, MSCU001, is only 141 cm. long and the mean weight of testis is 310 g. This male has already been both sexually and physically mature. This corresponds to the work of Shirakihara, et al. (1993) which repored the male porpoise with the age of four to six years or 138.5 cm body length and 58.0-862.5 g testis is already sexually mature. Furthermore, they reported that an individual age 14 yr shows fusion in all the vertebrae, but epiphysial sutures are still visible in the thoracic and lumbar vertebrae. Two porpoises aged 23 yr (a 174.5 cm long male and a 148.5 cm female) had no visible sutures. Follow this report and refer to Thai porpoise, MSCU001, it should be in the range between 14-23 yr old.

The biggest female, MSCU003, is 133 cm long with active mammary gland but thoracic vertebrae and their epiphyses are not fused together yet. This can be concluded that she was sexually mature but not physically mature. The record of this female incorresponded to the work of Shirakihara, et al. (1993) which reported that all females of 145 cm or over are sexully mature and all females of 134 cm or less are sexully immature. They suggested that female seem to attain sexual maturity at body length of 135-145 cm. Female at the age of 4 yr or less are immature and those of 7 yr or over are sexually mature. They considered female probably attain sexuall maturity at ages of 6-9 yr. Yoshida, et al. (1994) reported that an individual finless porpoise showed fusion in all vertebrae at an age of 14 yr. From all these reports, the Thai female porpoise, MSCU003, would attain sexual maturity quicker than Japanese female with the age of 7-14 yr.

The smallest taxidermic specimen, ZMKU006, is only 62.5 cm long but the actual size might be longer. The smallest new specimen, MSCU005, is 74.5 cm long. In many part of the continent, the smallest neonate of Chanjian River, China is 60 cm (Howell, 1927 refered by Kasuya, in press) while Shirakihara, et al. (1993) reported the body length of neonatal Nagasaki specimens ranged from 71.5 to 84.0 cm with a mean of 78.2 cm (n=12). Although ZMKU006 is possibly a neonate, its external

morpholoy can not be well obserbed to confirm whether it is the Thai neonate. MSCU005, the smallest new sample in this study is not a neonate but its size and its empty stomach can be assumed as the suckling calf with the possible age of less than 15 months following the work of Kasuya (in press). He reported an usual suckling period of about 7 months with a possible range of 6 to 15 months. This study, however, suggest that Thai neonate should be shorter than 74.5 cm.

3.2. *Orcaella brevirostris*, Irrawaddy dolphin

3.2.1. External morphological data

This is one of the two beakless cetaceans found in this region. The another species is finless porpoise. Both species are called " Pla Loma Hau Batr" in Thai. Irrawaddy dolphin, however, can be distinguished from finless porpoise by its bigger size and the present of a small dorsal fin.

The important character is the different positions of the blowhole and eyes. Its blowhole is located at more anterior part than other four species. In finless porpoise, it has positions of blowhole and eyes at similar distance from the head tip. In Indo-Pacific humpback and spinner dolphins, they all have their blowhole set far back from the eyes.

Most external morphology is similar to those described from other parts of its distribution as reported by Pilleri (1974) with the exception of the tooth count. This study found the tooth count on the upper/lower jaws ranged from 14-17/12-14 on each side. This agree with Sylvestre (1993) but disagree with Marsh, et al. (1989) and Jefferson (1994). Sylvestre reported without sample that Irrwaddy dolphin has tooth count on each side of upper/lower jaw as 15-17/12-14, while Jefferson (1994) floatingly reported 17-20/15-18. Marsh, et al. (1989) reported about Irrawaddy dolphin from Townsville, Australia when examined visually that the number of teeth in a single

upper jaw quandrant was found to vary from 17-20, while the corresponding number of lower teeth varied from 15-18. The authors also described by referring to Lloze (unpublished thesis, 1973) that the tooth count range from 19-19/15-15. Furthermore, the variation on tooth count has been one of the characters which Pilleri (1974) tried to use to separate Irrawaddy dolphin as two species, *O. brevirostris* and *O. fluminalis*. He suggested that *O. brevirostris* had teeth 12-16/9-16 while *O. fluminalis* had teeth 15-19/13/14.

However, numbers of teeth are overlapped and most cranium measurement are not so different that can separate *O. fluminalis* as another species of *Orcaella*. The variation of *O. brevirostris* needs further study immediately.

3.2.2. Internal anatomy

There is no any Irrawaddy dolphin carcass dissected in this study. Only osteology could be conducted.

3.2.2.1. Skeleton

Both examined skeletons are not complete. The ribs and vertebral formula could not be described. The skull is similar to finless porpoise but the lack of bony bosses and the pointed tip of Irrawaddy rostrum will impossibly misidentify this species. The shape of Irrawaddy's rostrum is more triangular than that of *N. phocaenoides*. The another important feature is the mandible. Its mandible is much longer and broader than of finless porpoise, with proportions of 82.85% and 26.95% of CBL but the length of tooth row are similar. The position of external nares is 16.87%. The preorbial width is 62.71%. They are much longer than those of finless porpoise.

Most cranium characters are similar to those reported by Pilleri (1974) and he attemped to split *Orcaella* to two species as *O. brevirostris* and *O. fluminalis*. However, most characters are not so different that they should be separated (Table 28).

Table 32 Skull measurements (mm) of *orcaella* from several source, * are data from this study, the others from Pilleri (1974)

Species	O. b	O. b	O. b	O. b	O. b	O. b	O. f	O. f	O. b*	O. b*	O. b*
Locality	Songkhla T563	Songkhla	Baram River (Borneo)	Borneo	Singapore	Penang	Irrawaddy	Irrawaddy Anderson 1878	Chao Phraya MSCU002	Mae Klong EN062	Mae Kong Lao
CBL	294	300	291	267	300	279	320	309	298	272	315
Length of rostrum	121	120	122	108	150	120	137	127	125.4	107	128
Width of rostrum at base	109	105	105	102	106	94	117	118	115.8	109.8	106
Width of rostrum at midlength	62	90	61	80	74	73	-	51	63	73	68.4
Zygomatic width	194	205	198	202	197	184	214	207	210.4	207	200
Parietal width	159	160	150	150	148	150	163	145	150.6	151.5	147
Maxilla width of premaxilla	82	80	75	83	83	80	-	-	89	88.5	80.7
Length of upper left tooth row	95	97	79	-	110	85	-	-	106.2	79.3	94
Length of left mandible	225	225	218	-	228	213	-	-	244	228	-
Height of mandible	73	75	67	-	72	67	-	-	79.5	74	-

CBL= Concylobasal length, O. b= *Orcaella brevirostris* and O. f= *Orcaella fluminalis* which were refered by Pilleri(1974)

Postcranium

The first two cervical vertebrae are fused the same as those reported by Pilleri (1974). The shape of acromion is thin and slender but in the Indo-Pacific humpback, bottlenose and spinner dolphin, they all have large and oval acromions. Acromion of finless is similar to Irrawaddy's but size can be well distinguished. Therefore the acromion of Irrawaddy dolphin can be used to identify it from other four dolphins in the Inner Gulf. (Fig. 46)

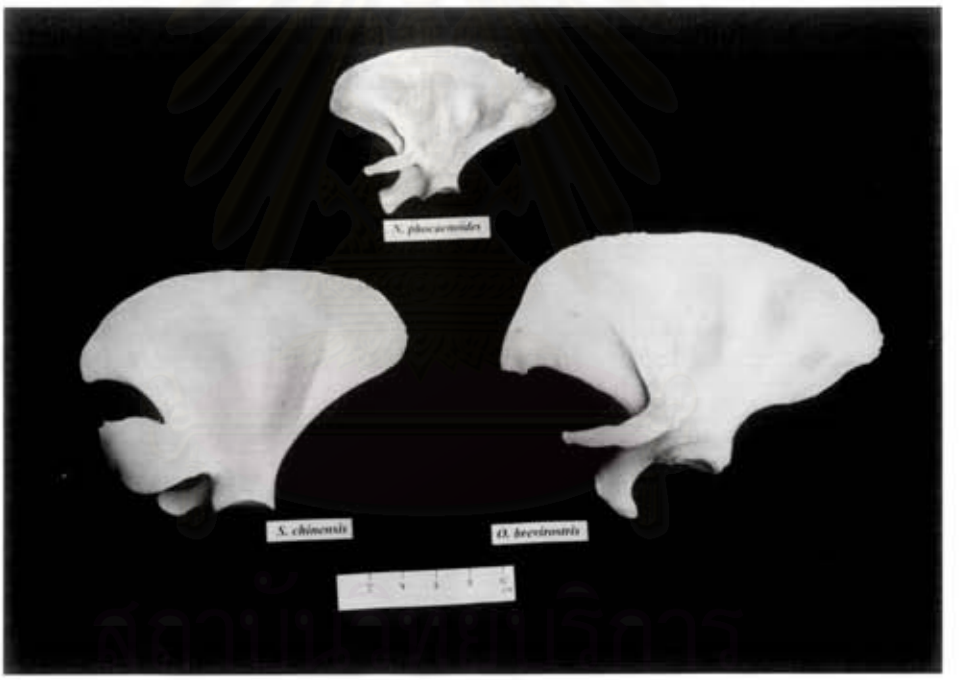

Fig. 46 Scapula of finless porpoise, Irrawaddy and Indo-Pacific humpback dolphin

3.3. *Sousa chinensis*, Indo-Pacific humpback dolphin

3.3.1. External morphology

This dolphin is commonly called "Pla Loma Phuak" in Thai because of its pale pink color. Although pink is the principle body color of this species in the study area, the color pattern is individually vary. The variation of body color with age in some ares which have been reported by Jefferson (1994) can not be concluded in this area. External morphology and number of teeth correspond to those described by Jefferson (1994), Ross, et al. (1994) and Sylvestre (1995).

The worldwide conflict on *S. chinensis* character is the hump on its back. Ross, et al. (1994) separated *S. plumblea* from *S. chinensis* based on the hump and dorsal fin. *S. plumblea* with a distinct hump inhabits in the Indian Ocean while the hump of Pacific form, *S. chinensis* appears to be absent. In this case, Gulf of Thailand is in the center of these two habitats and *Sousa* is undetermined as *S. plumblea* or *S. chinensis* by (Ross, et al. 1994), an expert team of *Sousa spp.*. Jefferson (1994), Sylvestre (1994), Klinowska (1991) and most authors include *Sousa* from South Africa , Indian Ocean through Pacific and Northern Australia as single species, *S. chinensis*.

S. chinensis was observed during the intensive survey at Bang Pakong estuary. Pictures from Bang Pakong, Chao Phraya and Mae Klong estuaries including the specimen study of MSCU004 were carefully compared in this study. It is evidenced that the hump on the back of *Sousa* is not quite absent because when an animal archs its back to begin diving, the hump on the back will obviously present. However when *Sousa* is swimming normally, it resembles *S. chinensis* which has no distinct hump. This possibly can be concluded that Thai *Sousa* is *S. chinensis* although further study should be necessarily carried out.

3.3.2. Internal anotomy

The internal organ of MSCU004 is not complete enough to study, so the internal anatomy is focused only on the skeleton.

3.3.2.1. Skeleton

Cranium

The skull of Indo-Pacific humpback dolphin has the most slender rostrum among 4 species of dolphins found although spinner dolphin has very long narrow rostrum as well.

Cranium in this study has the proportion not so much different from those of South Africa, West Indian Ocean and Australia to be able to sesregate this local Sousa from *S. chinensis*. Thai *S. chinensis*, however, has longest CBL but shortest rostrum while Australian *S. chinensis* has shortest CBL and lowest no. of teeth. (Table 29)

Postcranial skeleton

The vertebral formula is similar to those reported by Ross, et al. 1994. First two cervical vertebrae are fused.

TABLE 33 Skull measurement of humpback dolphin from South Africa, West Indian Ocean, Australia(Ross,et.al., 1994) and Thailand (This study)

Measurement	South Africa			W. Indian Ocean			Australia			Inner Gulf of Thailand		
	mean	range	n	mean	range	n	mean	range	n	mean	range	n
CBL	509	402-564	31	521	456-575	2	489	403-556	19	54.25	51-57.75	3
LR	61.2	57.5-62.7	31	61.9	57.8-67.7	2	60.6	58.2-63.3	18	58.88	57.06-60.56	3
WRB	21.3	19.1-21.5	31	19.9	18.4-22.5	20	22.9	20.0-24.2	18	20.64	20.14-21.04	3
WRH	8.9	8.2-10.0	31	9.5	7.7-10.9	19	9.2	8.3-9.7	18	7.28	5.15-8.10	3
PRO	36.4	35.3-38.7	31	34.8	32.3-38.4	20	36.4	33.7-39.2	18	34.67	33.59-35.47	3
PSO	41.2	39.1-42.8	30	39.0	33.9-43.6	19	41.8	40.0-44.4	19	39.25	37.75-40.74	3
ZW	39.6	38.9-42.7	31	39.1	36.0-41.4	21	41.7	40.0-44.7	19	39.43	37.40-41.48	3
MAXP	15.8	14.9-18.5	31	15.5	13.9-17.2	21	15.7	14.5-16.9	18	14.61	13.84-15.59	3
LUTR	53.3	50.9-54.7	31	55.5	55.1-56	2	53.6	51.9-55.9	17	53.53	52.64-54.63	3
LLTR	51.4	48.0-53.0	31	53.4	53-54.3	2	53.6	50.6-57.0	17	52.80	50.21-54.26	3
LRA	85.9	83.6-87.7	31	84.0	82.1-87.9	7	85.9	83.40-89.0	17	81.89	48.79-83.73	3
HRA	16.7	15.2-17.8	31	16.20	14.9-17.5	15	17.0	16.1-18.2	16	16.07	15.36-16.86	3
UT	35.5	33-38	24	36.5	31-38	15	32.5	30-35	17	36	33-39	5
LT	32.9	30-37	32	34.4	37-38	18	32.5	31-34	18	35	34-38	5

Abbreviation : PRO, Pre-orbital width ; PSO, Post-orbital width ; MAXP, maximum width of premaxilla ; HRA, hight of mandible ; UT, no. of teeth in each upper jaw ; LT, no. of teeth in each lower jaw ; other abbreviation the same as table 31 .

3.4. *Tursiops truncatus*, bottlenose dolphin

3.4.1. External morpholoy

All of external morphology correspond to those of many authors. Pilleri (1974) distinguished *T. aduncus* from *T. truncatus* from many cranium and postcranial skeletons, although they were slightly different ; for example, he suggested that in the *T. aduncus* average no. of teeth in the upper and lower jaw is higher, 24-25/25, than in *T. truncatus*, 22/21-22. Jefferson (1994) reported single species, *T. truncatus* to have 18 to 26 pairs of teeth in each jaw, covering the two species of Pilleri's report. From this study, *T. truncatus* should remains as single species until more resonable characters will be discovered.

3.4.2. Internal anatomy

Only skeletons were studied.

3.4.2.1. Skeleton

Bottlenose dolphin has shorter skull proportion than those of spinner and humpback dolphin. However, bottlenose dolphin has the broadest rostrum, with 22.27% of CBL. Among these three species of dolphins, bottlenose dolphin has the highest proportion in external nares, preorbital width, lenght of orbit and braincase 5, 16, 9 and 23. The first two cervicals are fused (n=6). An acromion on scapula is in paddle shape.

Pilleri (1974) used many cranium and postcranial characters to separate *T. aduncus* from *T. truncatus*. In this study, all data gather from old specimens which the postcranial were not all properly collected. Therefore the ribs and vertebral formula can not determined. In this study, most *Tursiops* in the collections are labeled as *T. aduncus* and the craniums are similar to those compared by Pilleri (1974) as

T. aduncus, such as the number of teeth but these two species were treated as a single species of *T. truncatus* by Ross & Cockroft (1990), Jefferson (1994) Klinowska (1993) and Sylvestre (1995).

3.5. *Stenella longirostris*, Spinner dolphin

3.5.1. External morphology

This study could gathered only old taxidermic specimens, so the three color pattern of spinner dolphin, dark grey cape, ligth grey side and white belly, can not be detected. Its long beak, shape, proportion and many pointed tiny teeth can suggest that it is the spinner dolphin. Perrin, et al. (1989) studied ten specimens of Thai spinner dolphin and reported a dwarf form of spinner dolphin in The Gulf of Thailand to be differed from specimens of this species collected elsewhere in body size and shape. He suggested that the Gulf of Thailand specimens are morphologically separable from all other specimens, but it is to be expected that when larger samples are available there will be some overlapped. Eight old taxidermic specimens in this study which were not studied by Perrin have smaller size than dwarf form of spinner dolphin. CRDF003 and CUMZ005, have less total length, 78 and 88 cm., than others including dwarf spinner dolphin reported by Perrin.

Table 34 Range of selected external measurement(in cm) between *S. longiroatris* around the world (from Perrin, 1989) and this study

Measurement	Thailand		Indopacific		E. Pacific		Atlantic		N. australia		This study	
	range	n	range	n	range	n	range	n	maximum	n	range	n
Total length	129-137	4	172-209	17	152-235	2309	173-208	34	158	41	78-129.5	7
Snout to melon	14	3	15-19	9	11-17	91	13-20	32	-	-	8.3-15	7
Snout to blowhole	22-27	4	32-38	8	25-36	90	30-39	32	-	-	18-28.5	7
Snout to eye	25	4	29-35	10	26-35	86	30-36	34	31	40	18-28.5	7
Snout to ant. base of flipper	33-34	4	42-50	8	37-47	92	41-53	35	46	40	26-38.5	7
Ant. length of flipper	22-23	4	19-27	10	-	-	25-38	34	27	40	17-21	7
Post. length of flipper	17-18	4	-	-	16-22	83	-	-	21	40	9.8-15	7
Breadth of flipper	8	4	9	1	-	-	8-11	34	11	40	5.5-7.8	7
Breadth of fluke	28-38	4	38-46	9	31-45	84	36-53	33	42	39	25-32	5
Height of dorsal fin	13-16	4	17	1	-	-	15-25	34	18	41	9-17.5	5

3.5.2. Internal anatomy

New speimens of this species could not be obtained and seemed to have no population in the Inner Gulf of Thailand. All internal anatomy had to study from only two old skeletons.

3.5.2.1. Skeleton

The length of tooth row is almost equal to that of humpback dolphin. The mandible length of three species, spinner dolphin, Indo-Pacific hump back dolphin and bottlenose dolphin are similar but spinner dolphin has lesser width than others. Every points of skeletons measurement have extremely smaller proportion than those of spinner dolphin reported by Perrin, et al. (1989) with the exception of dwarf form which has slightly smaller proportion. The vertebral formula and ribs can not determined from old skeletons because some may be lost.

Spinner dolphin in this study, however, just have smaller proportion of both external and internal characters, it can be the same case as *T. truncatus* and *T. aduncus* discussed earlier. The most important point is the number of their teeth which differ from the case of *Tursiops*. The teeth of Thai samples have already completely erupted although the vertebrae and epiphyses could not be examined to confirm their maturity. The no. of teeth, 37-46/36-45, is less than those reported by every authors. The obvious difference of their teeth suggested that this dolphin should not be lumped as *S. longirostris*. They have to be intensively studied to place in precise taxonomic status.

Table. 31 Skull measurement of *S. longilostris* from around the world and this study

Meas.	Thailand			Indian Ocean			Western Pacific		
	mean	range	n	mean	range	n	mean	range	n
CBL	342.5	335-352	4	409.2	394-430	7	420.1	411-431	7
LR	219.8	215-224	4	264.9	250-281	7	272.1	262-281	7
WRB	61.0	57-66	4	74.0	71-76	7	78.3	73-84	7
WRH	35.0	33-37	4	43.3	42-45	7	47.9	44-54	7
PRO	115.5	111-120	4	141.6	135-146	7	144.6	140-150-	5
PSO	128.3	124-131	4	155.4	153-160	7	160.8	155-169	6
ENAW	34.3	33-36	4	39.6	38-42	7	42.8	40-45	5
ZW	125.8	121-130	4	154.0	151-160	7	156.2	152-161	5
PRMW	52.3	49-55	4	61.4	59-64	7	62.2	60-65	5
PW	104.8	103-108	4	128.7	122-133	7	127.6	125-131	5
OBW	38.8	38-40	4	42.3	40-44	7	43.0	40-46	5
INAW	34.8	34-35	4	42.0	39-45	7	44.6	42-47	5
LUTR	192.8	185-198	4	232.3	224-242	7	237.2	219-246	6
LRA	293.3	287-303	4	352.0	336-370	7	366.3	360-371	7
HRA	46.3	45-47	4	55.9	55-57	7	55.8	55-57	6

Abbreviation : ENAW, Greatest width of external nares ; PRMW, Greatest width of premaxiila ; PW, Parietal width ; OBW, Orbital width ; other abbreviations are the same as table 27.

Table 31 (continued)

Meas.	Central Pacific			Atlantic			This study		
	mean	range	n	mean	range	n	mean	range	n
CBL	436.9	417-464	24	427.0	395-458	41	342.5	335-350	2
LR	282.6	263-304-	24	276.8	251-304	41	216.5	213-220	2
WRB	79.3	74-86	24	76.6	68-83	42	65.5	64.4-66.6	2
WRH	47.0	42-56	24	44.4	41-50	41	40.75	36.0-45.5	2
PRO	150.8	140-158	24	145.6	137-153	42	118.55	118.1-119	2
PSO	165.2	158-172	25	161.1	152-169	41	130.3	129.4-131.2	2
ENAW	42.5	39-47	25	41.8	38-45	38	32.2	31.7-32.7	2
ZW	163.5	154-171	25	159.2	150-167	40	133.5	132-135	2
PRMW	66.1	62-70	24	64.8	60-71	42	52.4	52.2-52.6	2
PW	131.4	122-140	25	130.5	121-140	41	114	111.4-116.6	2
OBW	42.8	40-47	25	41.8	39-50	39	39.55	39.1-40	2
INAW	44.1	39-48	25	46.5	42-53	37	33.9	33.6-34.2	2
LUTR	245.6	224-263	24	243.5	221-265	41	184	181-187	2
LRA	372.4	352-399	23	368.4	343-399	40	282	280-284	2
HRA	58.4	53-64	23	56.4	51-61	41	45.35	44.7-46.0	2

Abbreviation : ENAW, Greatest width of external nares ; PRMW, Greatest width of premaxiila ; PW, Parietal width ; OBW, Orbital width ; other abbreviations are the same as table 27.

Table 32 No. of Teeth of *S. longirostris* from around the world (Perrin, 1989) and this study

Sources	Number of Teeth (on each side)					
	Upper			Lower		
	Mean	range	n	mean	range	n
Thailand	46.3	43-48	9	45	42-49	8
Indian Ocean	52.9	49-59	15	50.6	45-58	15
W. Pacific	53.3	48-61	12	51.4	47-60	14
C. Pacific	55	50-62	29	52.5	48-57	29
Atlantic	55.4	48-64	41	53.9	47-62	42
This study	42.27	37-45	18	42.18	36-45	17