SPECIES, DISTRIBUTION AND STATUS OF DOLPHINS IN THE INNER GULF OF THAILAND

Mr. Somchai Mahakunlayanakul

A Thesis Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Science
Department of Marine Science
Graduate School
Chulalongkorn University
Academic Year 1996

ISBN 974-636-833-8

An 69

โครงการวิจัยองค์ความรู้และศึกษานโยบายการจัดการทรัพยากรชีวภาพในประเทศไทย
ชุดโครงการวิจัยเพื่อการจัดการความหลากหลายทางชีวภาพ
สำนักงานพัฒนาวิทยาศาสตร์และเทคโนโลยีแห่งชาติ
73/1 ถนนพระรามที่ 6 เขตราชเทวี
กรุงเทพฯ 10400

ชนิด การกระจาย และสถานภาพของโลมาในอ่าวไทยตอนใน

นายสมชาย มหากัลยาณกุล

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต
ภาควิชาวิทยาศาสตร์ทางทะเล
บัณฑิตวิทยาลัย จุฬาลงกรณ์มหาวิทยาลัย
ปีการศึกษา 2539
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Thesis Title	Species Distribution and Status of Dolphin in the Inner Gulf of Thailand
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สมชาย มหากัลยาณกุล : ชนิด การกระจาย และสถานภาพของโลมาในอ่าวไทยตอนใน (SPEICES, DISTRIBUTION AND STATUS OF DOLPHINS IN THE INNER GULF OF THAILAND) อ.ที่ปรึกษา : ผศ.ดร. สุรพล สุดารา, 130 หน้า. ISBN 974-636-833-8.

จากการศึกษาโลมาในอ่าวไทยตอนใน รูปตัว ก ในปัจจุบันพบโลมา 4 ชนิด คือ โลมาหัวบาตรหลังเรียบ, *Neophocaena phocaenoides*, โลมาหัวบาตร : *Orcaella brevirostris*, โลมาเผือก, *Sousa chinensis* และ โลมาปากขวด, *Tursiops truncatus* โลมาหัวบาตรมักอาศัยอยู่บริเวณน้ำกร่อยใกล้ชายฝั่ง แต่โลมาหัวบาตรหลังเรียบมักพบบริเวณที่ห่างจากปากแม่น้ำมากกว่า โลมาเผือกเป็นโลมาที่สามารถพบเห็นได้บ่อยบริเวณปากแม่น้ำ แต่ก็สามารถพบไกลฝั่งออกไปเช่นเดียวกัน โลมาอีกชนิดหนึ่งคือโลมาปากขวด มักอาศัยไกลฝั่งออกไป โดยเฉพาะบริเวณเกาะต่างๆ จากการศึกษาความสามารถในการว่ายเข้าแม่น้ำของโลมา ในอดีตพบว่ามีผู้พบเห็นโลมาหัวบาตรว่ายเข้าไปในแม่น้ำเจ้าพระยาได้ถึง 85 กิโลเมตร ที่บริเวณเกาะเกร็ด จังหวัดนนทบุรี และสามารถเข้าแม่น้ำบางปะกงได้ถึง 60 กิโลเมตร บริเวณ ตลาดอำเภอเมือง จังหวัดฉะเชิงเทรา นอกจากนี้ยังพบโลมาปากขวดเข้ามาในแม่น้ำเจ้าพระยาถึง 30 กิโลเมตรซึ่งถูกยิงตายและยังคงมีซากเก็บไว้ แต่ในปัจจุบันไม่มีการพบเห็นโลมาในแม่น้ำอีกนอกจาก การเข้าแม่น้ำเพียง 2-3 กิโลเมตรของโลมาเผือก และเป็นโลมาเพียงชนิดเดียวที่พบว่าสามารถว่ายเข้าไปในแม่น้ำท่าจีนและแม่กลอง โลมาอีกชนิดหนึ่งที่ไม่สามารถพบได้ในปัจจุบัน หรือ อาจมีประชากรอยู่น้อยมากในบริเวณอ่าวไทยตอนในคือโลมากระโดดเนื่องจากแทบจะไม่มีผู้พบเห็นโลมาชนิดนี้เลยในปัจจุบันแต่มีซากสตัฟฟ์เป็นจำนวนมากในแถบนี้ โลมาหัวบาตรหลังเรียบเป็นโลมาที่ได้ทำการศึกษาซากใหม่มากที่สุด โลมาหัวบาตรหลังเรียบเพศผู้ขนาดใหญ่ที่สุดในการศึกษาครั้งนี้พบว่ามีความยาว 141 เซนติเมตร และพบว่าโลมาเพศเมียยาว 133 เซนติเมตรกำลังอยู่ในช่วงการให้นมลูก อาหารของโลมาหัวบาตรหลังเรียบที่พบในกระเพาะอาหาร คือ ปลาหมึก ปลาและกุ้ง จากการศึกษาเรื่องโลมาของนักวิทยาศาสตร์ชาวต่างประเทศหลายท่านที่พยายามจะแยกชนิดของโลมาทั้ง 5ชนิดให้เป็นชนิดใหม่ จากการศึกษาในครั้งนี้พบว่าโลมากระโดดแบบแคระเพียงชนิดเดียวที่ควรจะแยกเป็นชนิดใหม่จากโลมากระโดดที่พบที่แหล่งอื่นๆของโลก เนื่องจากมีสัดส่วนต่างๆเล็กมากและที่สำคัญ มีจำนวนฟันน้อยกว่าโลมากระโดดจากที่อื่นๆอย่างเห็นได้ชัด

ภาควิชา วิทยาศาสตร์ทางทะเล ลายมือชื่อนิสิต สมชาย มหากัลยาณกุล

สาขาวิชา วิทยาศาสตร์ทางทะเล ลายมือชื่ออาจารย์ที่ปรึกษา [illegible]

ปีการศึกษา 2539 ลายมือชื่ออาจารย์ที่ปรึกษาร่วม .....

C625869 MAJOR MARINE SCIENCE
KEY WORD: DOLPHIN / PORPOISE / TRIBUTARIES INTRUSION / MORPHOLOGY / GULF OF THAILAND

SOMCHAI MAHAKUNLAYANAKUL : SPEICES, DISTRIBUTION AND STATUS OF DOLPHINS IN THE INNER GULF OF THAILAND. THESIS ADVISOR : ASSIST. PROF. SURAPHOL SUDARA, Ph.D. 130 PP. ISBN 974-636-833-8.

In the Inner Gulf of Thailand there are four species of porpoise and dolphins, one species of porpoise, *Neophocaena phocaenoides* ; finless porpoise and three species of dolphins *Orcaella brevirostris* ; Irrawaddy dolphin, *Sousa chinensis* ; Indo-Pacific humpback dolphin and *Tursiops truncatus* ; bottlenose dolphin. *O. brevirostris* inhabited only shallow and brackish water, while *N. phocaenoides* prefered away from estuaries. Both can be found along the coast of the Inner Gulf of Thailand except Pattaya and the lower part of the east coast. *S. chinensis* was commonly found almost all estuaries although it could sometimes be seen offshore. *T. truncatus* usually found offshore, around every islands but sometimes found along the coastline. Intrusion of *O. brevirostris* in Chao Phraya River were recorded at Ko Kret, 85 km from river mouth thirty years ago while *T. truncatus* were found only 30 km. *O. brevirostris* found to get in 60 km. from Bang Pakong river mouth in 1967. At present, *S. chinensis* is seen almost every rivers about travel only few km from the mouth and it is only one species found in the Mae Klong and Ta Chin River. *S. longirostris* has very small population if not gone from the study area. The largest male *N. phocaenoides* was 141 cm in length and 133 cm for largest female which was in lactation period were caught in August. Cephalopods, crustaceans and fishes were found to be food of finless porpoise. Exception for *S. longirostris*, the others four species could not be separated as new species as suggested by some authors because their differences were not distinctively different enough. Spinner dolphin in the Gulf of Thailand should not be considered as *S. longirostris* because it possesses differences in morphological proportion and obvious less number of teeth.

ภาควิชา วิทยาศาสตร์ทางทะเล ลายมือชื่อนิสิต Somchai Mahakunlayanakul

สาขาวิชา วิทยาศาสตร์ทางทะเล ลายมือชื่ออาจารย์ที่ปรึกษา Suraphol Sudara

ปีการศึกษา 2539 ลายมือชื่ออาจารย์ที่ปรึกษาร่วม .....

Acknowledgements

I am extremely grateful to the Thai-Denish Marine Mammal Research cooperation which arranging me to attend marine mammalogy course at the Zoological Museum, University of Copenhagen, Denmark in 1996. My special thanks to Mr. Michael Andersen and Dr. Carl Chr. Kinze for providing me with suggestions and assisting me. My sincere thanks to Dr. Ajcharaporn Piamsomboon, Dr. Kumthorn Theerakup and Mr Jonathan Murray for their kind suggestions and help correcting this thesis. I am very grateful for the help of Prof. Jerzy Rokicki, University of Gdan 'sk, Poland in identifying the internal parasite. I am grateful for the beautiful drawing of figures no. 2, 4, 5, 6 and 7 by Mr. Bamroongsak Kongsuk.

I wish to express my appreciation to the Aquatic Resource Research Institute, SV Marine Co.ltd. and JSPS core university cooperative research programme which allow me to be on their ship during their cruises to do my surveys. My special thanks to the following institutes which allow me to study their collections : Natural History Museum and Faculty of Veterinary of Chulalongkorn University, Department of Zoology, Faculty of Science and Faculty of Fishery of Kasetsart University, Thailand Institute of Scientific and Technological Research, Science Center for Education, the Crocodile Farm, Swangkaniwas Fish Farm and the Oceanic Fishery Division, Samutprakarn, Bangsaen Institute of Marine Science, Chonburi and Phuket Marine Biological Center.

This work was supported by Biodiversity Research and Training Program, a joint program supported by the Thailand Research Fund and National Center for Genetic Engineering and Biotechnology. Furthermore this work was also supported by National Science and Development Agency and Marine Mammal of Thailand Research Project, MAMAMTH (Thai-Danish). I also acknowledge gratefully.

Lastly, thanks to all of my friends who always lent me their hands to make it possible to carry this work and always encourage me to do a good job.

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Chapter 1

Introduction

Dolphin is a marvelous animal. Its splendid body, its miracle intelligence and its acrobatic behavior interest every observers including the author. Although it can not be easily found in the sea as most marine animals, marine mammologist still want to divulge its mysterious life.

Cetacean watching in the sea has been promoted as commercial tourism in many parts of the world such as New Zealand, Australia, Canada and the United States of America. This creates the best avenue for public to appreciate the real life of cetaceans in nature. Careful watching will not disturb the animals but will introduce the cooperative life of both man and dolphin peacefully.

On the other hand, their normal behavior and quick-learning abilities, dolphins and porpoise have been taken from their normal habitat for many aquaria world-wide, including a few dolphinaria in Thailand. Condition in some dolphinaria or aquaria are unacceptable. They usually are reluctant to provide information for researchers and reporters. The number of dolphins died in these dolphinaria remains unknown.

Furthermore, the incidental catch may now be a bigger problem for cetaceans worldwide than directed catch even though cetacean flesh consumption is still common in some countries such as Japan and Vietnam. A particular concern in recent years is large scale monofilament pelagic driftnetting which are still being used by some countries. This driftnet is causing many dolphin incidentally entangled. This fishing methods has been employed in coastal waters, and cetaceans become more accidentally caught. Other types of gears, particularly set net of various types, are more dangerous than others. Researchers have now been trying to find some means to deter cetaceans from such gears, without affecting the fishing effiency. Due to the little status of dolphins in Thailand causes extreme difficulty to protect or conserve them effectively.

The Gulf of Thailand, where the four major rivers, Chao Phraya, Ta Chin, Mae Klong and Bangpakong drained into, is the most productive area of Thai waters. This area has been considered as one of the rich fishery resources in the world together with a rich diversity of dolphins. However, the fisheries development in the Gulf had grown unsystematically and unmanagably. Overfishing condition had severely affected marine wildlife and dolphins as well. Furthermore, habitat degradation, incidental catch, pollution and dolphinaria supply can effect dolphin population. All these factors are now prevalented in many countries around the world.

So far, knowledge of cetaceans in Thai waters is still very preliminary. Reports of small cetaceans in Thai waters from Pilleri & Gihr (1974), Lekagul & McNeely (1977), Humphrey & Bain (1990), Sudara (1990), Andersen & Kinze (1991), Kowitwatee (1991) and Chantrapornsil, et al. (in press), are not supportive and contradicted to one another.

Up to present, very few studies on the numbers of small cetacean species and their distributions had been carried out in Thai waters. Irrawaddy dolphins had been reported in many great rivers of Asia. Lekagul & McNeely (1977) reported that the Irrawaddy dolphin was previously known to enter the Chao Phraya river. This compels the author to search for more evidence to confirm the presence of Irrawaddy dolphin and the others in the four major rivers open to the Inner Gulf of Thailand.

The interview data is needed to scan the basic information of dolphin in the area. Study on old specimens may indicate the status of dolphin in the past. The morphological and biological study on the new specimens will help to evaluate the present status of dolphin. Therefore this integrated study is carried out and expected to gather some information on the ecological and biological aspects of dolphins and porpoises. It is intended in providing more information as the basis to find ways to conserve them in our waters.

Objectives

1. To study species composition and external morphology of dolphins and porpoises in the Inner Gulf of Thailand.

2. To study the distribution of dolphins and porpoises in the Inner Gulf of Thailand, including the four major tributaries.

3. To study some biological aspects and determine the status of dolphins and porpoises in the current environment of Inner Gulf of Thailand.

Expected Results

1. Gather additional information and knowledge of dolphins and porpoises in the Inner Gulf of Thailand.

2. Estimate the changes of status of dolphins and porpoises from the past to present.

3. The study on morphology in details would aid in the identification to species in dolphins and porpoises. This may lead to the discovery new species.

Literature review

Cetaceans are mammals which spend their lives in water, and have evolved many adaptations to this way of life. The body is streamlined, with no hindlimbs, reduced forelimbs to form flippers and a powerful horizontal tail for propulsion. The nostrils have become blow holes at the top of the head to facilitate respiration while travelling through the water. The marine mammal order Cetacea includes 2 Suborders : The Mysticeti or moustached whales, including 11 living species of baleen or whalebone whales; and the Odontoceti or toothed whales, including

dolphins, porpoises and whales with teeth but no baleen. Delphinidae is one family of the suborder Odontoceti. They are the group of oceanic dolphins, including the biggest, 10 m., Killer whales and the smallest, 1.5 m., Heaviside's dolphin. The Phocoenidae is the another family of Odontoceti which consists of 6 species of porpoises which seperated from delphinids by the difference of their teeth. Phocoenids have teeth blunt with expanded crowns, and all have extremely short or non existent beak. On the other hand, Delphinids have conical and sharply pointed teeth; only some of them have no beak. Member in smalll size of both families are called " Pla loma " in Thai.

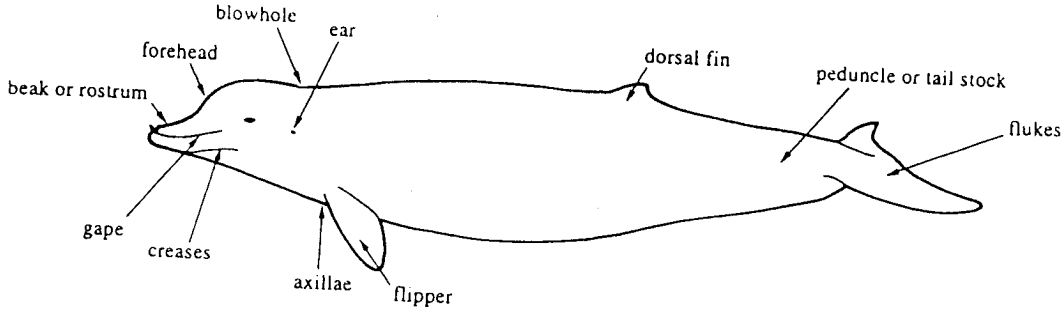

Fig.1 External morphology of dolphin (from Jefferson, et al., 1993)

Pilleri & Gihr (1974) reported on seven species of cetacean in Thai waters. Lekagul & McNelly (1977), reported eight species of dolphins, *Sotalia plumbea*, *S. borneensis*, *S. chinensis*, *Steno bredanensis*, *Stellnella malayana*, *Delphinus delphis*, *Tursiops aduncus* and *Orcaella brevirostris* and 1 species of porpoise, *Neophocaena phocaenoides*. Some of the species reported are now concidered as synnonyms of others. Sudara (1990), reviewed the above paper and recognized one more species of dolphin, *Stenella longirostris*. Humphrey and Bain (1990) reported 9 small cetacean in

Thai waters. Kowitwatee (1991) reported 10 species of tooth whales and dolphins on the east and west coast of the Gulf of Thailand.

Sixteen species of small cetaceans, *Kogia breviceps* (de blainville 1838), *Kogia simus* Owen 1866, *Mesoplodon gingodens* Nishiwaki and Kamiya 1958, *Peponocephala electra* (Gray 1846), *Pseudorca crassidens* (Owen 1846), *Globicephala macrôrhynchus* Gray 1846, *Orcinus orca* (Linnaeus 1758), *Orcaella brevirostris* (Gray 1866), *Steno bredanensis* (Lesson 1828), *Sousa chinensis* (Osbeck 1765), *Tursiops aduncus* (Ehrenberg 1833), *Delphinus delphis* Linnaeus 1758, *Stenella attenuata* (Gray 1846), *Stenella coeruleoalba* (Meyen 1833), *Stenella longirostris* (Gray 1829) and *Neophocaena phocaenoides* (Cuvier 1829) had been reported in Thai waters (Andersen & Kinze, 1995 and Chantrapornsil et al., 1996). Recently, the two more species *Ferasa attenuata* Gray 1875 and *Lagenodelphis hosei* Fraser 1956, are to be reported further from the Andaman Sea (Chantrapornsil , personal communication).

***Neophocaena phocaenoides*, finless porpoise**

Neophocaena phocaenoides (Cuvier, 1829), finless porpoise, is found in warm rivers and coastal waters from the Persian Gulf, through the Indian subcontinent to southeast Asia and north to China, the Korean peninsula and Japan. They are found in the middle and lower reaches of the Yangze (Changjianj) river in China, as far as Yichang, and in the adjacent lakes, such as Dongtinghu and Boyanghu. Elsewhere they are reported from mangrove areas, estuaries, deltas and fresh water lakes connected to rivers. They are found in all major rivers is this area (Klinowska, 1991).

Finless porpoises have no dorsal fin, and this is their most distinctive characteristic. In some way, they resemble small, slender white whales. The head is beakless; the rounded forehead rises steeply from the snout tip. The body shape, in general, is more slender than in other porpoises. The finless porpoise is soft and mushy, and the neck is very flexible. Instead of dorsal fin, the finless porpoise has an area of small bumps or tubercles on its back, running from just forward of midback to

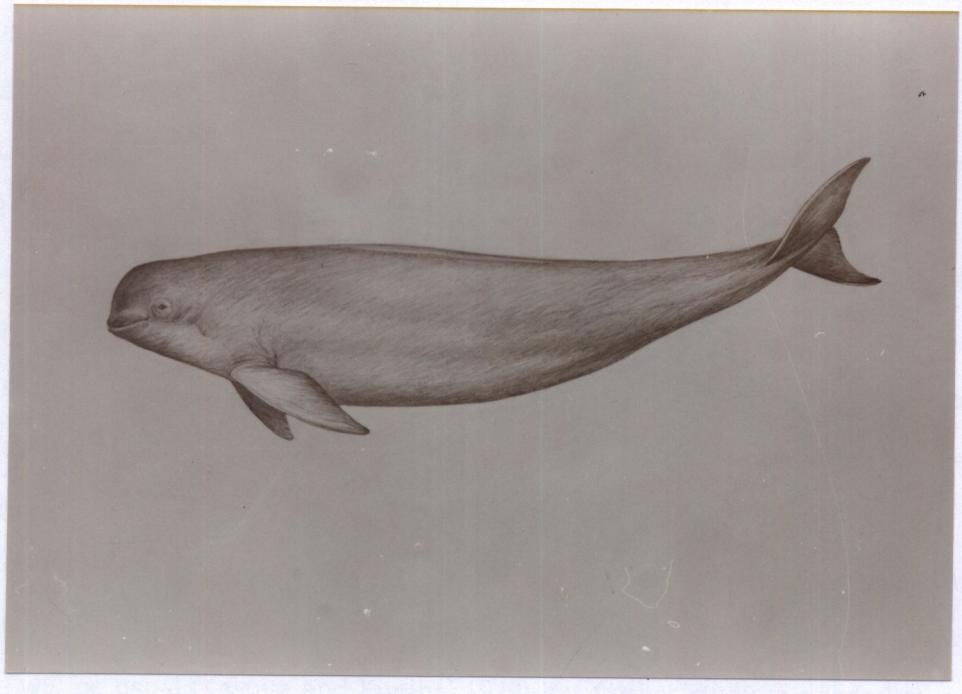

Fig. 2 *Neophocaena phocaenoides*, finless porpoise

the tail stock. The trailing edge of the flukes is concave and the flippers are large, ending in rounded tips. Regional differences in body size and morphology have been documented, with Yangze River animals apparently representing a separate stock. In most areas, finless porpoises are grey in color, with lighter areas on the throat and around the genitals. Older animals are gennerally lighter grey than juveniles. In the Yangze river population, they are very dark grey, nearly black. Tooth counts ranges from 13 to 22 in each tooth row. Finless porpoises are apparently about 70 to 80 cm. at birth (Jefferson, et al., 1993). The geographical differences and available information on distribution implies that the finless porpoises in western Kyushu constitute a local population (Shirakihra et al., 1993)

In the Changjiang River, body lengths of the smallest neonate and the largest fetus ranged between 60.0 cm. and 73.35 cm. (Kasuya, in press, quoted in Howell, 1927 and Chen et.al., 1982). Adults of this species have a significant geographical variation in their growth. A male finless porpoise increases from the smallest in the Indian Ocean (150 cm.) to the largest in the Yellow Sea/Bohai area (201 cm.). The maximum body length of females changes from the smallest in the Indian Ocean (155 cm.) to the largest in the Yellow Sea/Bohai area (200 cm.) (Kasuya, in press).

The information on the season of mating and parturition suggests that peaks of mating and parturition of finless porpoises are more diffused and problably later in the southern habitat. The northern populations are problably adapted for calves to switch their major source of nutrition from milk to solid food during the most productive summer months by clustering births, as the newborn calves can endure the cold climate in the spring. The weaning and calving interval, including a 11 month's gestation and a uniformly short nursing period, suggests that a two year cycle will be usual (Kasuya and Kureha, 1979) but further study is needed to arrive at a firm conclusion because the sample composition reflects mortality which may be dependent on age and reproductive status (Kasuya, in press).

Shirakihra et al. (1993) studied finless porpoises in the coastal waters of western Kyushu, Japan. They reported that both males and females grew to around 140 cm. by 5 yr. of age. Females probably attain sexual maturity at ages of 6-9 yr and at body lengths of 135-145 cm.. Males probably mature sexually at ages of 4-6 yr and at body lengths of 135-140 cm. and at weight of testis of 40-150 g.. The weight of testis increased with body length as well. Spermatozoa in the epididymis were abuntdant for 11 mature males taken in autumn to winter (September-January) and less abundant for 3 males taken in summer (June-July), inspite of the presence of spermatozoa in the seminiferous tubules. However, a seasonal change in testis weight and diameter of seminiferous tubules was inconclusive because of the small sample size. Parturition in western Kyushu was estimated to be prolonged from autumn to

spring, whereas in the Inland Sea and Pacific waters it was restricted from spring to summer with a peak in April.

The skeleton of finless porpoises in coastal water of western Kyushu, Japan, have been well studied by Yoshida, et al. (1994). Skulls ceased growing by the fourth year. Postcranial skeletons ceased increasing in size at an age older than 11years. Fusion between vertebral centra and the epiphyses progressed gradually with age (Fig. 3). Neonates have no epiphyses fused with centra. Fusion was observed first in the cervical vertebrae. Fusion progressed in a posterior direction in the cervical vertebrae and in anterior direction in the caudal vertebrae. An individual age 14 yr showed fusion in all the vertebrae, but epiphysial sutures were still visible in the thoracic and lumbar vertebrae.

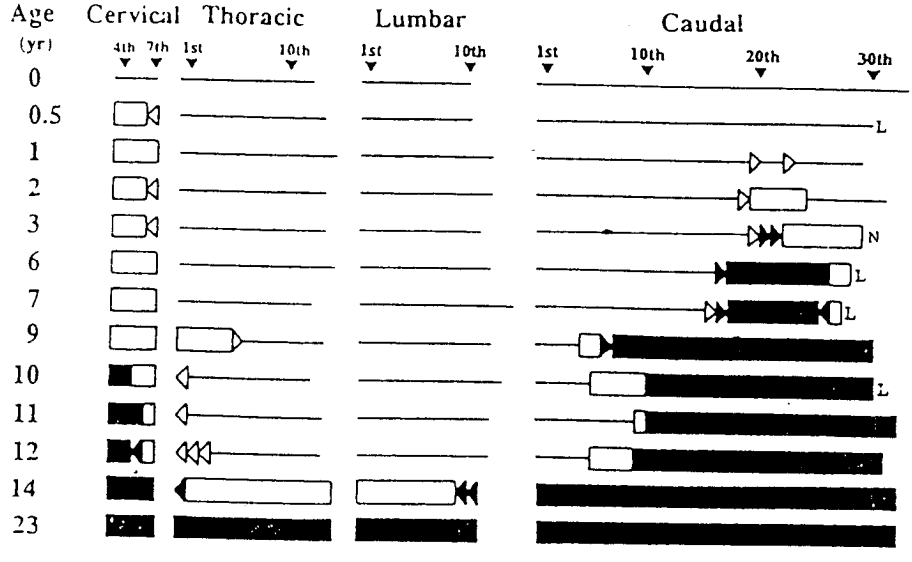

Figure 3 A typical pattern of fusion between vertebral centra and epiphyses. —, Both sides free; ◁, anterior side fused but suture visible; ▷, posterior side fused but suture visible; □, both sides fused but suture visible; ◀, anterior suture invisible but posterior visible; ▶, posterior suture invisible but anterior visible; ■, both sutures invisible; L, posterior caudals were lost; N, posterior caudals were too small to be examined. For animals aged 0 and 0.5 yr, in which lumbar and caudal vertebrae were combined, the first 10 lumbar + caudal vertebrae are shown as lumbars for simplicity.

From Yoshida (1994)

Sexual dimorphism was not detectable in most of the cranial characters but detected in more than half of the postcranium characters. Females tended to show larger values of poscranial characters. The shape of pelvic bone was obviously difference between male and female. Thus, a discriminant function was proposed to determine sex using measurements of this bone.

***Orcaella brevirostris*, Irrawaddy dolphin**

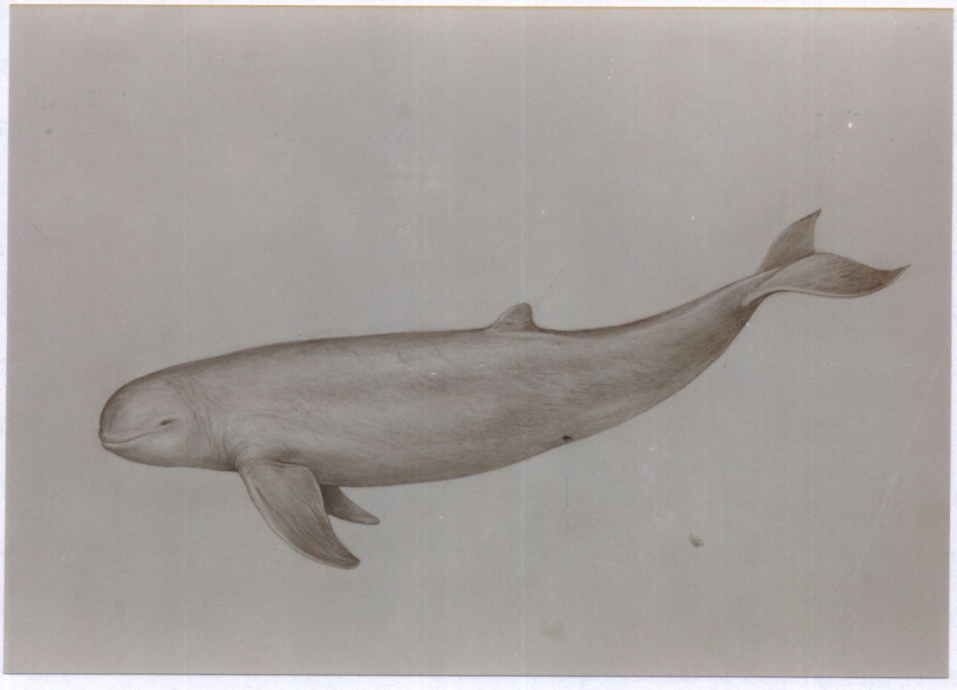

Fig. 4 *Orcaella brevirostris*, Irrawaddy dolphin

Orcaella brevirostris (Gray, 1866), the Irrawaddy dolphin, resembles the finless porpoise, *Neophocaena phocaenoides*, but unlike that species, it has dorsal fin. The fin is small and triangular, with abluntly rounded tip, and is set just behind midback. The large flipper have curved leadind edge and rounded tips. The head is blunt, with no beak; the mouthline is straight, and there may be a visible neck crease. The U-

shaped blowhole is open toward the front, the reverse of the situation in most dolphin species. The back and sides of Irrawaddy dolphins are grey to bluish grey; the belly is somewhat lighter. Tooth counts are 17 to 20 (upper) and 15 to 18 (lower) in each row. The teeth have slightly expanded crowns. Adults range from 2 to 2.75 m.. Scant evidence indicates that the length at birth is about 1 m.(Jefferson, et al.,1993).

Irrawaddy dolphin is found in the Bay of Bengal and throughout the Indo-Malay Archipelago to northern Australia, particularly in the major rivers, such as the Ganges, Mekong and Irrawaddy, and frequently in warm shallow water. (Klinowska, 1991). Freshwater intrusion of Irrawaddy dolphins have been reported in many areas. They are apparently riverrine, estuarine, and coastal inhabitants. There are some populations which are restricted to freshwater, and it is doubtful whether they venture very far offshore. Animals are found long distance from the sea in some of the great rivers of Asia, including the Irrawaddy and Mekong (Marsh et al.,1989). They also refer to records of Anderson (1879) and U Tin Thein (1977) reporting the presence of the dolphins at Bhamo (Burma) about 1300 km. up the Irrawaddy River. Furthermore Baird and Mounsouphom, (1994) reported that Irrawaddy dolphins were sighted by them in the Mekong River. Sightings during the survey and reports from villagers indicate that there are two main areas in Lao PDR inhabited by Irrawaddy dolphins. The first is in the southern-most section of the Mekong River in Champasak Province, along the Cambodian border. The other is in the Sekong River, a tributary of Mekong, and some of its larger tributaries in the provinces of Sekong and Attapeu. Lao and Cambodian villagers have also reported that dolphins inhabited the Cambodian part of the Sekong River and the Sesan River in Cambodia.

In Thailand, the species was previously known to enter large rivers, including the Chao Phraya (Lekagul & Mcneely, 1977) and Chanthaburi River, as reported by Chantaburi residents living along the river. It is possible that pollution and heavy river traffic on the Chao Phraya River and dams on the Chantaburi River have resulted in the dolphins' disappearance from these rivers in recent years. Irrawaddy dolphins are also found in brackish estuaries and saltwater coastal waters in many Asian

countries, including Thailand, where they are often refered to as "pla loma hooa baht" because their snouts are rounded like monk' s bowl ("hooa baht") (Baird et.al., 1994). In Songkhla Lake, Irrawaddy dolphins are often reported by villagers. Dolphins were also incidentally caught in 1990 and 1991, and two incidental catches were reported in 1995 (Sirimontraporn & Sritakon, 1996). They also dissected a male Irrawaddy dolphin with a lengths of 188 cm., a weight of 64 kg and found 3 tails of Ciprinids fish in the stomach.

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

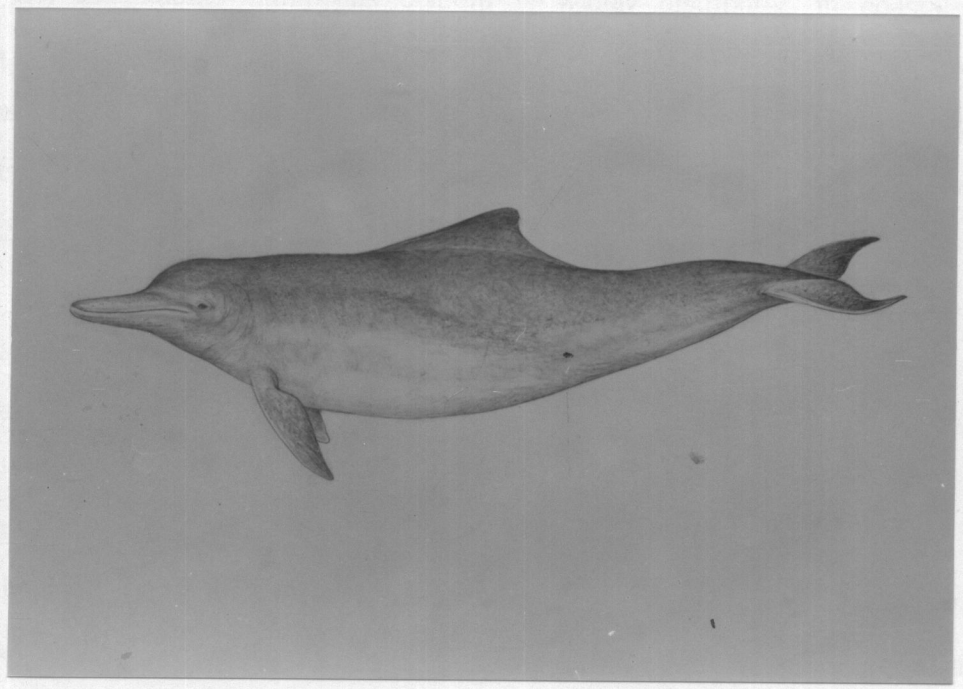

Fig. 5 *Sousa chinensis*, Indo-Pacific humpback dolphin

Sousa chinensis (Osbeck, 1765), the Indo-Pacific humpback dolphin, this highly variable species are characterized by a robust body with a long, well-defined beak. In most population especially those off southern Africa, the dorsal fin sits on a hump, or ridge; in the middle of animal's back. In others, the ridge appear to be

absent, or less well-developed. In most areas, there also appear to have developed ridge on the tail stock. Males are larger and have more exaggerated ridges on the back and tail stock. The color pattern varies with age and area. In most regions, light colored calves darken with age to become dark lead grey above and light grey below. However, off Malaysia and Northern Australia, calves and adults are nearly white. In the western Indian ocean and off China, dark calves lighten with age. In the latter case, adults are pinkish white with spots and blotches. There are 29 to 38 teeth in each tooth row. Maximum known body sizes are 3.2 m., male, and 2.5 m., female. Weight of up to 284 kg. has been recorded. Newborn appear to be around 1 m. in length.

The Indo-Pacific humpback dolphin is widely distributed in coastal and inshore waters of the Indian and western Pacific Oceans. It can also be found in estuaries and sometimes in the lower reaches of rivers, although the latter may be vagrants. Its presence has been confirmed from the southern tip of Africa, northward along the east coast of the continent to the Suez canal, in the Arabian sea and Persian Gulf, along the Indian sub-continent, throughout much of Indonesia, in Australian coastal water from the middle of the west coast northward, eastward and southward to Sydney on the eastcoast, in New Guinea, and from Borneo northward along the Indochinese coast to the northern east coast to the northern East Sea (Leatherwood et al., 1993).

Ross, et al. (1994) reported that humpback dolphins occur in shallow water less than 20 m. deep through out their distribution. The saline and often turbid channels off mangroves and between sandbanks so typical of tropical deltas form a prime habitat for humpback dolphins, and appear to support considerable populations. In southern China individuals may swim up rivers for several kilometers. In Moreton Bay, southern Queensland, 80% of sighting were over depth of less than 10 m. and up to 6 km. offshore, but occured deeper in association with bottlenose dolphin while feeding on discards from trawlers. Klinowska (1991) supported that studies in the Moreton Bay region in northeastern Australia has demonstrated that the Hump-

backed dolphins have a more inshore distribution than the Bottlenose dolphins inhabiting in this area. There is some overlap of range between the two species.

***Tursiops truncatus*, bottlenose dolphin**

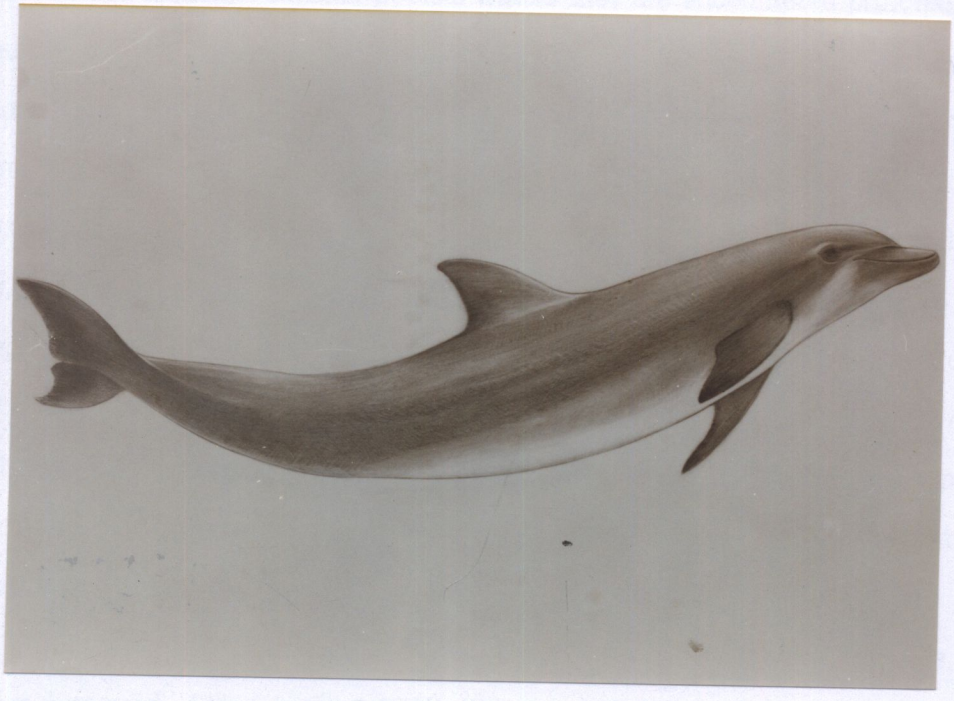

Fig. 6 *Tursiops truncatus*, bottlenose dolphin

Tursiops truncatus (Montagu, 1821), the bottlenose dolphin, is a large, relatively robust dolphin, with a short to moderately stocky snout that is distinctly set off from the melon by a crease. The dorsal fin is tall and falcate, and set near the middle of the back. Color varies from light grey to nearly black on the back and sides, fading to white (sometimes with a pinkish hue) on the belly. The belly and lower side are sometimes spotted. There is a darkstripe from eye to flipper, and a faint dorsal cape on the back (and sometimes an indistinct spinal blaze), generally

visible at close range. Often, there is a brushing of grey on the body especially on the face, and from the apex of the melon to the blowhole. Bottlenose dolphins have 18 to 26 pairs of robust teeth in each jaw. Adults from would have a length from 1.9 to 3.8 m., with male somewhat larger than female. There is extreme variation between different populations. Maximum weight is at about 650 kg., although most animals are much smaller. Length at birth is about 1 - 1.3 m. (Jefferson, et al., 1993).

The bottlenose dolphin is found worldwide in temperate and tropical waters, both offshore and inshore. Outside tropical waters they are encountered principally in the coastal zone, less frequently on the edge of the continental shelf and beyond. Bottlenose dolphins exploit an impressive range of habitats. The inshore form is occasionally reported in freshwater rivers, although these are most likely to be vagrants or temporary visitors. The usual inshore range includes river mouths, bays, lagoons, estuarine complexes and virtually any shallow water marine region (0.5 - 20 m. deep). Passes between open ocean and enclosed bays or lagoons are often centres of abundance, and the dolphins use intracoastal waterways and other deep channels to gain access to productive shallows. The offshore ecotype is well known to the margin of some coastal and oceanic islands and atolls. It is also encountered in the open ocean (Klinowska, 1991).

The arguement on taxonomic status of bottlenose dolphin, genus Tursiops, has been long discussed. Pilleri & Gihr (1974) differentiated *T. aduncus* from *T. truncatus* by the shape of the fin, the slenderness of the body and the pointed snout. They described more differences between *T. truncatus* and *T. aduncus* in body measurements. The maximum body length measured in *T. aduncus* to date is 2.40 m., as against 3.50 m. in *truncatus*. Differences also exist in the body ratios of the two species. A large numbers of quantitative differences were found between the skulls of *T. truncatus* and those of *T. aduncus*. Generally speaking, the skull of the truncatus specimens is longer. The tip of rostrum-vertex, tip of rostrum- pterygoids, tip of rostrum to median spine of palate sections, the mandible and neurocranium, they all are significantly longer in *T. truncatus* than in *T. aduncus*. The *T. truncatus*

specimens also differ from *T. aduncus* specimens in that they posses a significantly wider rostrum and premaxilla, a higher and wider skull, but a shorter mandibular symphysis. The skull of *T. truncatus* is more compact that of *T. aduncus*. The inner ear of *T. aduncus* is smaller and narrower than that of *T. truncatus*. For the configuration of atlas and axis, the vertabral body of *T. aduncus* ends on both sides in a thick, pointed transverse process. The shape of the articular surfaces for the occiput is roughly that of a rounded isosceles triangle. The surface do not touch each other along the midline. In *T. aduncus*, the arch of the atlas is convex and terminates in anabifid spinous process. The medial edge of the scapula of *T. aduncus* is highly convex and its lateral edge is concave. Unlike in *T. aduncus*, the acromion of *T. truncatus* does not narrow at the base. However, these characters should be confirmed by the examination of a large number of specimens.

Ross & Cockroft (1990) studied 103 specimens of *Tursiops* from Australian water. They discussed the taxonomy of the genus which is poorly understood, and opinions vary on the status of nominal species. They refered to many species, *T. truncatus, T. aduncus, T. gilli, T. gephyreus, T. t. truncatus and T. t.aduncus*, but the two most distinct forms of *Tursiops* are *T. truncatus and T. aduncus*. The presence of this genus from north to south on both sides of Australian continent is of considerable interest taxonomically, particularly as there was no morphological differentiation of taxonomic entities at the species level within the samples. Comparison of skull measurment, tooth count, and other skull features with data for two species of *Tursiops* off southern Africa showed that the data ranges for the latter occupied opposite ends of Australian specimens. These southern African forms have been treated previously as two species, *T. truncatus* and *T. aduncus*. In the present perspective, however, there is little doubt that they all should be treated as a single species, *T. truncatus*, and that Australian bottlenose dolphins should be assigned to this species as well.

***Stenella longirostris*, spinner dolphin**

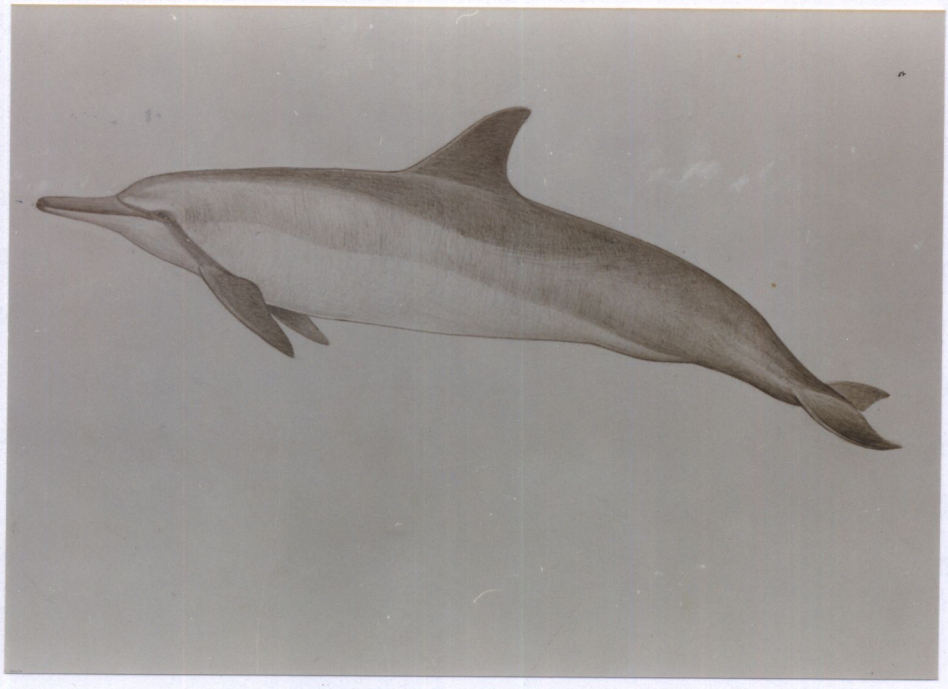

Fig. 7 *Stenella longirostris*, spinner dolphin

Stenella longirostris (Gray, 1828), the spinner dolphin, is a slender dolphin, with an extremely long, thin beak. The head is very slender at the apex of the melon. The dorsal fin ranges from slightly falcate to erect and triangular. Spinner dolphin generally has a dark stripe from eye to flipper on both sides, dark lips and beak tip. The individuals of most spinner dolphin stocks in the world have a three part colour pattern (dark grey cape, light grey side and white belly) and only minor differences in the appearance of male and female. It has 45 to 62 pairs of very fine, pointed teeth in each jaw. Newborn spinner dolphins are about 75 to 80 cm. long; adults reach 2 m. (female) and 2.4 m. (male). They can reach weight of at least 77 kg. (Jefferson, et al., 1993).

The spinner dolphin is found in the Atlantic, Indian and Pacific oceans, where they are mainly restricted to tropical and subtropical waters, although they can be found in some warm temperate areas. The primary distribution is pelagic, but they can be found in continental shelf waters off Central America and the south eastern United State (Klinowska, 1991).

A very small form of the spinner dolphin has been found to inhabit the Gulf of Thailand. Ten specimens from Samut Sakhon differ from specimens of this species collected elsewhere in body size and shape, number of teeth and numbers of thoracic and lumbar vertebrae. The skull of four adult males were 129 - 137 cm. long, well below the ranges for the Indian Ocean, Western Pacific, Central Pacific and Antarctic. Tooth counts and vertebral counts average lower than in series from other part of the range. The color pattern is not significantly different from that of spinner dolphins in the central and western Pacific, Atlantic, and Indian Oceans but differ from that of the small eastern spinner of the eastern Pacific (Perrin et al., 1989).

Chapter 2

Methodology

To gather information on species, distribution and status of dolphins, three methods were used. First, interview surveys were used to indicate the general status and distribution of dolphins in the area. Secondly, specimens were used for the study of dolphin morphology in details. Finally, the sighting surveys had been carried out to confirm the results of the above two methods.

Interview survey

1. Correspondent questionaire by mail

Nine hundred and thirty three replied mail questionaires were distributed to various temples along four major rivers and the coastline. The questions have placed focus on the specimens collected at those temples and on the occurence of dolphin along the coastline in the Inner Gulf and its tributaries.

2. Direct interview survey

Fishermen at all fishlanding sites and villagers along the coastline in the study area were interviewed. Records were made on the occurrence of dolphins, the details about dolphins caught and stranded (species, sex, size), frequency of dolphins accidentally caught by fishing gears and the type of those fishing gears caught and the fishing areas.

The elderly local people along the tributaries of the target rivers, Mae Klong, Tha Chin, Chao Phraya and Bang Pakong, were interviewed concerning the occurrence of dolphins in fresh water. The boundary of the study area was limited to

the last district where no dolphin had ever been seen. The evidences of tributary intrusion by dolphins were based on information gathered from field interviews as well as secondary sources such as published books, newspapers and articles.

Specimen study

1. Bycatch dolphins

Dolphin carcasses used in this research were collected from fishermen at all fishlandings and the stranded ones along the coast. Details of capture such as type of fishing gear and fishing area were gathered by interviewing the fishermen possessing the specimens. Specimens were examined as followed :

1.1. Species identification and condition

Identification was based on external characters, colour pattern and numbers of teeth. Detailed records were made on shape, pigmentation patterns, lesions, and net mark. Sex determination was made at either the mammary slits or the urogenital area. Age was determined from the measurement of body length and weight. Specimens were photographed, measured and dissected for morphological study.

1.2. Morphological study

Thirty four morphometric characters (table 1, fig. 8) were selected for morphological analysis, based on Law (1994). Morphometric characters were measured with measuring tape and calipers to the nearest mm.. Measurements in parallel to the body axis are taken from the tip of the upper jaw to the center of

apertures (genital, anal, eye, etc.). The carcasses were dissected for inspection of some internal organs.

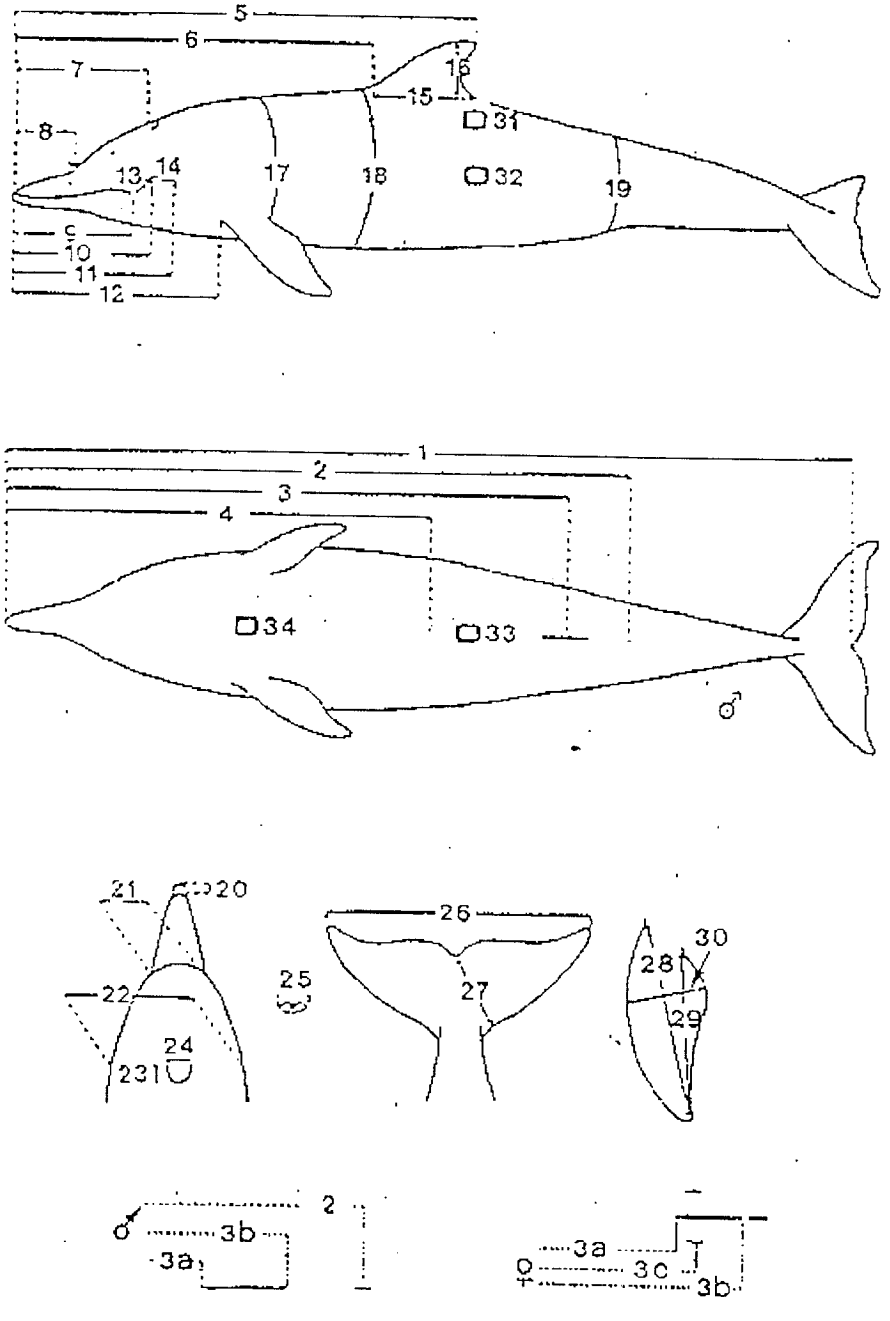

Fig. 8. Morphometric measurement of dolphin and porpoise

Table 1. Morphometric measurements of dolphin and porpoise

All measurements parallel to the body axis were taken from the tip of the upper jaw to the center of apertures (genital, anal, eye, and so on).

1. total length from snout to tail notch
2. Snout to anus
3. Snout to genital slit

3a. Snout to anterior end of genital slit

3b. Snout to posterior end of genital slit

3c. Snout to mammal grand slit

4. Snout to umbilicus
5. Snout to posterior base of dorsal fin
6. Snout to anterior base of dorsal fin
7. Snout to blowhole
8. Snout to melon
9. Snout to the angle of mouth
10. Snout to eye
11. Snout to ear
12. Snout to anterior base of flipper
13. Angle of mouth to anterior base of eye
14. Posterior base of eye to ear
15. Basal length of dorsal fin
16. Height of dorsal fin
17. Body girth at posterior base of flipper
18. Body girth at anterior base of flipper
19. Body girth at anal slit
20. Tip of upper jaw to tip of lower jaw
21. Maximum breadth of beak

22. Breadth of head at eyes
23. Length of blow hole
24. Breadth of blow hole
25. Eye length
26. Breadth of the fluke
27. Fluke notch across fluke to lateral base
28. Anterior edge of flipper to flipper tip
29. Posterior edge of flipper to flipper tip
30. Greatest breadth of the flipper
31. Area of blubber thickness
32. Area of blubber thickness
33. Area of blubber thickness
34. Area of blubber thickness

1.3. Selected internal characteristics study

1.3.1. Stomach contents

Three dolphins' stomachs were dissected for identification of the food contents inside. The numbers of prey eaten were counted and weighed.

1.3.2. Internal organs

Internal organs were weighed and observed for the condition and internal parasites.

After dissection, the flesh was removed from the five carcasses as much as possible and left in water for decomposed within six to seven weeks. After that, skeletons were cleaned by water and left in 10% hydrogen per oxide (H_2O_2) for an hour, 5% H_2O_2 for preparing the skeleton of juvenile dolphin. Then they were washed in water three times and left in water over night. Finally, skeletons were brushed with a tooth brush to remove small pieces of flesh and all bones left to be dried away from sun light. The skeletons were stored for further osteological study.

1.3.3. Osteological study

Osteological study was carried out with all eight skeletons of bycatch and stranded dolphins. Fifty morphometric characters (Table 2, Fig. 9) were selected for morphological analysis, following Yoshida (1994), Perrin (1975) and Kinze (1985). Morphometric characters were measured with calipers or rulers to the nearest mm.. The complete fusion between the vertebral centrum and the epiphysis was determined by the closure of the epiphyseal suture.

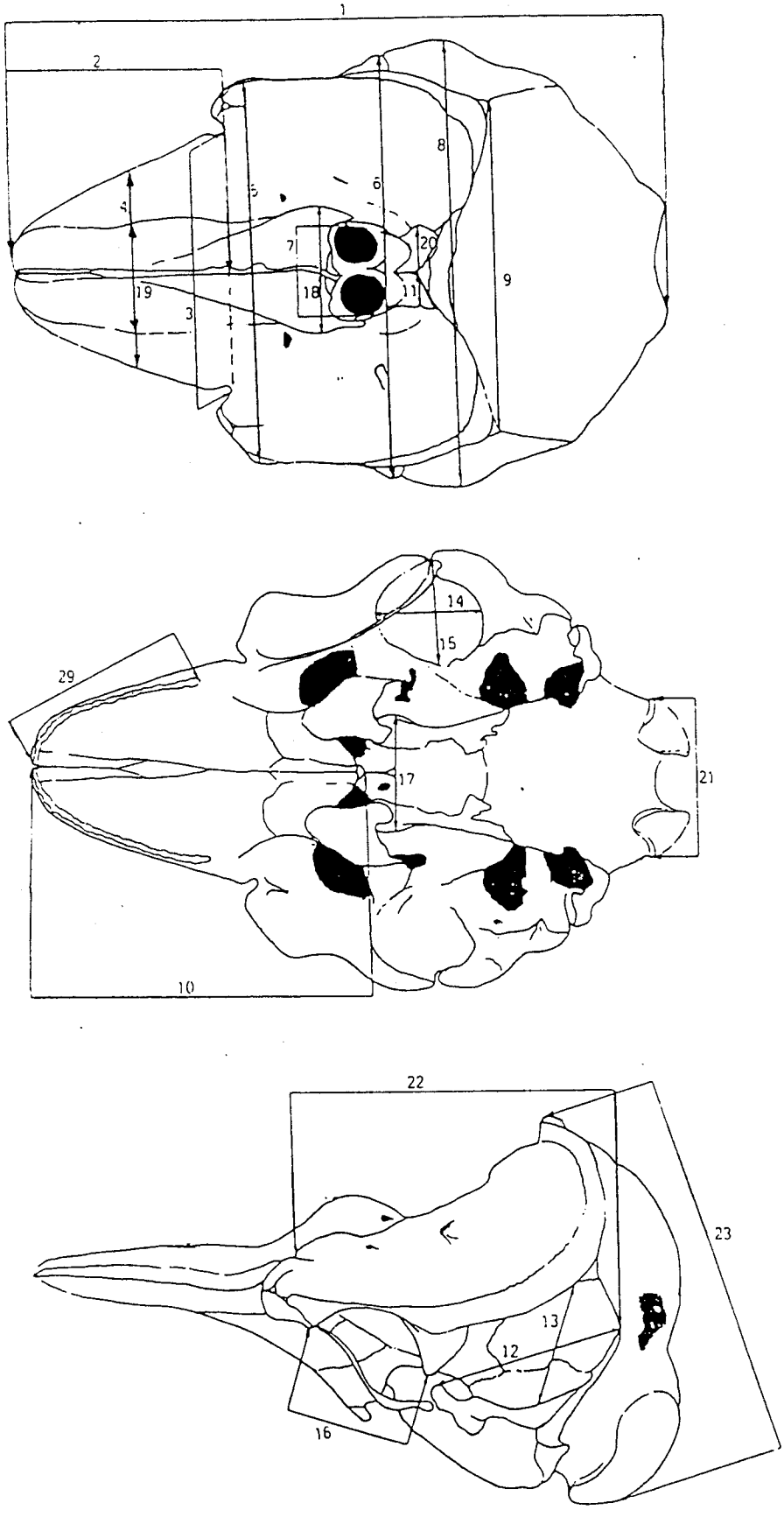

Fig. 9. Morphometric measurement of skeleton

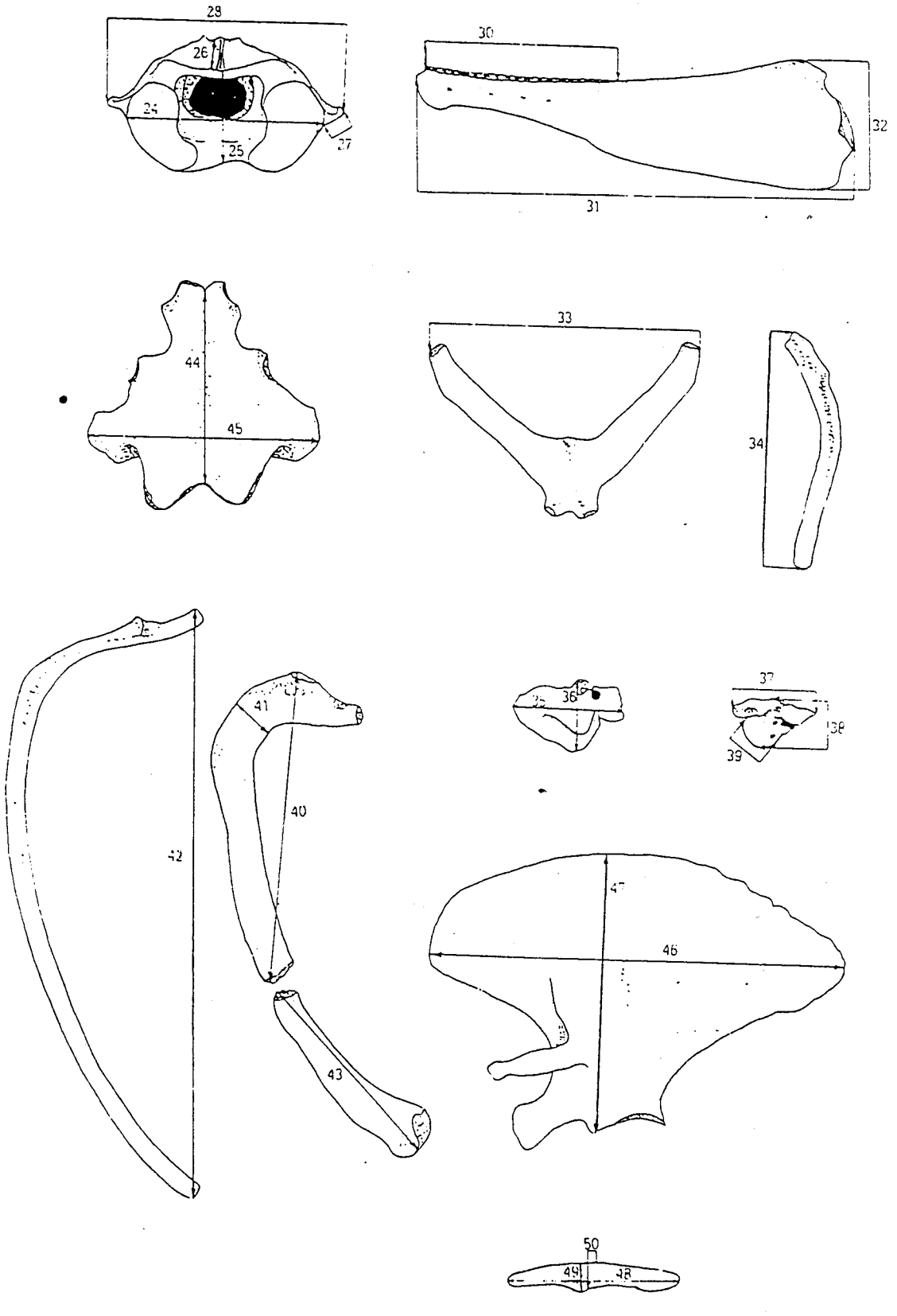

Fig. 9. Morphometric measurement of skeleton (continued)

Table 2. Morphometric measurement of Skeleton

1. Condylobasal length - from tip of rostrum to hindmost margin of occipitalcondyles.
2. Length of rostrum - from tip to line across hindmost limits of antorbital notches.
3. Width of rostrum at base - along line across hindmost limits of antorbital notches.
4. Width of rostrum at midlength.
5. Greatest preorbital width.
6. Greatest postorbital width.
7. Greatest width of external nares.
8. Greatest width across Zygomatic process of Squamosal.
9. Greatest parietal width, within postemporal fossae.
10. Distance from tip of rostrum to internal nares (to mesial end of posterior margin of right pterygoid / to ventral median spine of vomer (in finless porpoise))
11. Greatest width of left nasal.
12. Greatest length of left posttemporal fossa, measured to external margin of raised suture.
13. Greatest width of left posttemporal fossa at right angles to greatest length.
14. Major diameter of left temporal fossa proper
15. Minor diameter of left temporal fossa proper
16. Length of left orbit - from apex of preorbital procees of frontal to apex of postorbital process.
17. Greatest width of internal nares.
18. Maximum width of premaxillary
19. Width of premaxilla at midlength of rostrum
20. Maximum width of nasals
21. Maximum width of occipital condyls
22. Rostrum junction to posterior base of parietal
23. Frontal crest to occipital condyle base
24. Greatest width of articulating surface of atlas
25. Height of atlas - from internal anterodorsal margin of neural canal to bottom of anterior face of body
26. Greatest length of neural spine of atlas

27. Length of lateral process of atlas - from margin of anterior articulating surface to farthest point at end of process

28. Greatest width of atlas

29. Length of upper left tooth row - from hind most margin of hind hindmost alveolus to tip of rostrum.

30. Length of lower left tooth row - from hind most margin of hind hindmost alveolus to tip of mandible.

31. Left mandible length.

32. Maximum height of left mandible.

33. Greatest width between tip of thyrohyals.

34. Greatest length of left stylohyal.

35. Greatest length of left tympanic bulla.

36. Greatest width of left tympanic bulla

37. Greatest length of left periotic.

38. Greatest width of left periotic.

39. Diameter of cochlear portion of left periotic.

40. Greatest length of 1st left vertebral rib.

41. Width of first left vertebral rib at apex of proximal curvature

42. Greatest length of longest left vertebral rib.

43. Greatest length of 1st left sternal rib.

44. Greatest length of sternum along midline.

45. Greatest width of sternum.

46. Greatest length of left scapula.

47. Greatest width of left scapula.

48. Greatest length of left pelvic bone.

49. Greatest width of left pelvic bone.

50. Greatest thickness of left pelvic bone.

2. Old specimens

Taxidermic specimens and skeletal specimens obtained from ten institutions were examined as follows :

Table 3. Examined specimen collections

Institutions	Number of specimens	
	Taxidermic	Skeleton
Faculty of Fishery, Kasetsart University (FKU)	3 (+1)*	3
Department of Zoolgy, Kasetsart University (KUMZ)	6	-
Thailand Inst. of Scientific and Technological Res.(TISTR)	-	1(+1)**
Science Center for Education (SCCE)	-	1
Bangsaen Institute of Marine Science, (BIMST/BIMS)	7 (+1)***	11 (+2)****
Phuket Marine Biological Center (EN)	-	1
Natural History Museum, Chulalongkorn Univ. (CUMZ)	2	4
Oceanic Fishery Division, Samut Prakarn (OCFD)	2	-
Crocodile Farm, Samut Prakarn (CRDF)	3	-
Swankaniwas Fish Farm, Samut Prakarn (SWNF)	3	-
Faculty of Veterinary, Chulalongkorn University (VETCU)	1	-
Dept. of Marine Science, Chulalongkorn University(MSCU)	-	5
Total	27	26

* Body broken specimens of *Neophocaena phonoides.*

** A skull specimen of *Pseudorca crassidens* from Prachuab Kirikan.

*** A preserved calf of *N. phocaenoides* in unopenable bottle.

**** Two skull of *Phocaena phocaena* and *Delphinapterus leucus* from Denmark.

2.1. Taxidermic specimens

Taxidermic specimens were measured the same as morphological study in 1.2 except the character numbers 2, 3, 4, 11, 19, 30, 31, 32 and 34 which could not be measured. Twenty five morphometric characters were measured as complete as possible and were selected for morphological analyses by separating from the external morphology of new bycatch dolphins.

2.2. Skeletal specimens

Old skeleton specimens collected at various locations kept at many institutes were measured according to the osteological study in 1.3.3. Morphometric characters were measured as complete as possible and were selected for morphological analysis with the skeleton from the bycatch dolphins.

Sighting survey

Two specific surveys were conducted in the area where dolphins occurrences were frequently reported by the interviewee. The first study area was around Bang Sa Rae and Ko Kram. The second was around the Bangpakong river mouth. Both were conducted by the pseudotransect method with the binoculars. The appearance of the sighted dolphins was photographed and positioned by a GPS. The numbers of dolphins were determined immediately.

Other surveys were spot-checked at anytime when space was available on the ships belonging to 4 institutions (Table 4). The observation was carried out by using the 7 x 35 binoculars. The appearance of dolphins were photographed and positioned with a GPS.

Table 4. Route of sighting survey.

Institutions	Vehicles	Route
1. Aquatic Resources Research Instistution, Chulalongkorn Univ.	Chula - Research ship	1.1. along the coast of the Inner gulf
2.Dept. of Aquatic Science, Burapha University	rental research ship	2.1. Ang sila - Bangpakong - Ang sila
		2.2. Ang sila - Ko sichang - Ang sila
3. S. V. Marine Co., ltd.	commercial ship	Chao praya - Prachuab
4. Dept. of Marine Science, Chulalongkorn Univ.	rental boat	4.1. Bang Sahrae - Ko Kram
	rental boat	4.2. Around Bang Pakong estuary

Study area

The Gulf of Thailand is semi - enclosed shallow water body. Its northern boundary is almost a straight line extending from about 100 E to 101 E at latitude 13° 30' N. From the northeast corner the eastern boundary runs straight south to approximately 12° 40' N, the southern most boundary of the Inner Gulf of Thailand.

Piyakarnchana, et al,1990 referred to Robinson(1974) that the general shape of the Gulf's bottom topography can be considered as elliptic paraboloid. The maximum depth of the Inner Gulf is approximately 20 metres (Menasveta, 1990).

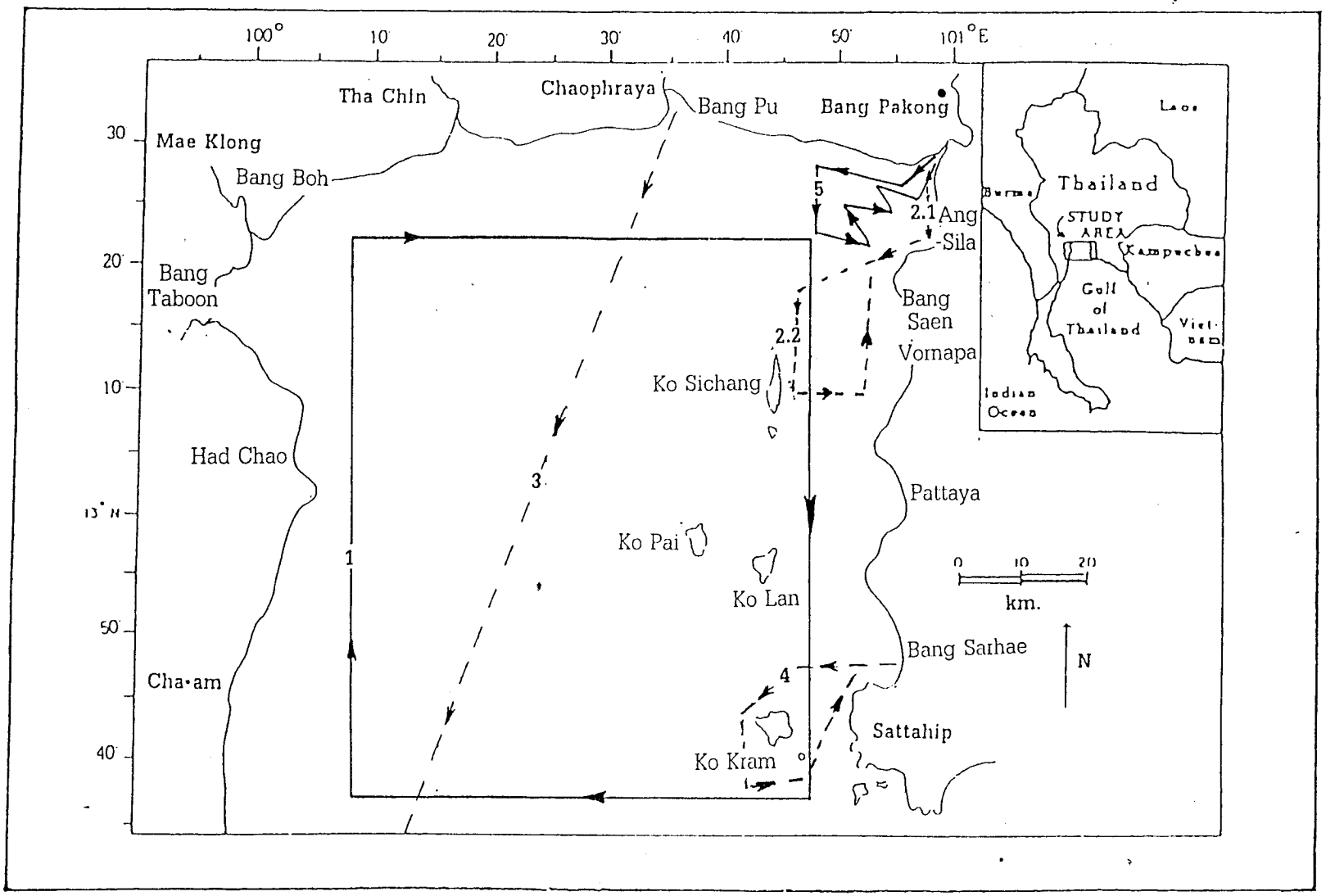

Fig. 10 The study area and routes of sighting survey

Oceanographic characteristics of the Gulf of Thailand

There are four major rivers, Bang Pakong, Chao Phraya, Ta Chin and Mae Klong that discharge fresh water into the northern part of the Gulf of Thailand . The average annual discharge from these rivers is approximately $1.5 * 10^{10}$ cubicmetres (Bunpapong, 1987). There is also some evidence that high salinity water from the south China sea enters the Gulf near the bottom (Pongsapipat and Sapsomwong, 1973; Robinson, 1974). In view of these two factors, the Gulf of Thailand can be considered a two layered system.

On the average, temperature of seawater at the surface level is higher than any of the other levels. The average temperature of every level is 29.66 ^{o}C. The average salinity of seawater is 29.29% with the highest at 32.70% and the lowest at 12.85%. on the offshore area, sunlight can penetrate around 30 cm up to 13 meters at the most. The highest amoung of nutrients accumulated around the river mouth especially at the mouth of Chao Phraya River. The amount of nutrients decreases in direct proportion to the distance of the coastal area. (NRCT,1977)

Chapter 3

Results

1. Species found in the Inner Gulf

From August 1995 to December 1996, one species of porpoise and two species of dolphins specimens were studied. They were *Neophocaena phocaenoides* (finless porpoise), *Orcaella brevirostris* (Irrwaddy dolphin) and *Sousa chinensis* (Indo-Pacific humpback dolphin). Some specimens of these three species had newly been collected from bycatch as well as specimens kept in the older days both as skeleton and taxidermy. Another two species of dolphins *Tursiops truncatus* (bottlenose dolphin)and *Stenella longirostris* (spinner dolphin) can only be studied only from the old specimens kept as skeletal and taxidermic specimens. No sample of these two species had been collected recently. (Table 5)

Table 5. Number of specimens in the Inner Gulf of Thailand up to December 1996.

Species	Numbers of specimens		
	New specimens	Old specimens	
		Skeleton	Taxidermy
N. phocaenoides	6	7	3
O. brevirostris	2	1	2
S. chinensis	1	2	2
T. truncatus	0	6	12
S. longirostris	0	2	8
Total	9	18	27

New specimens of bottlenose dolphin was not found although this species was one of the most common dolphin seen by most interviewees in the study area.

On the other hand, both Irrawaddy dolphin and finless porpoise were very commonly reported only in certain areas (see more in distribution part). Spinner dolphin seemed to have very small population if not without population remaining in this area because only two out of five hundreds and twenty seven interviewees reported seeing this species.

2. Distribution and tributaries intrusion

2.1 Distribution

Distribution pattern of the four species found in the study area *N. phocaenoides* (finless porpoise), *O. brevirostris* (Irrawaddy dolphin), *S. chinensis* (Indo-Pacific humpback dolphin) *and T. truncatus* (bottlenose dolphin) was extracted from interview surveys and confirmed by stranded and bycatch specimens, plus sight surveys and photographs. The interview survey composes of two part, the direct interview and the correspondent questionaire by mail.

Correspondent questionaire by mail

From nine hundred and thirty three distributed questionaires, one hundred and thirty two cases were replied.

Direct interview

Seven persons along the Bang Pakong and six persons along the Chao Phraya river reported the observation of Irrawaddy and bottlenose dolphins. Indo-Pacific dolphins were reported to intrude the four major rivers by the people around the river mouths. The number of interviewees in main six provinces along the coast of study area is presented in table 6-11. The number of interviewees reported seeing dolphins

or porpoises in the Inner Gulf of Thailand were calculated as percentage to inteprete the distribution as in figures 11-14.

Table 6. Percentage of 149 interviewees reported seeing dolphins and porpoises in Petchburi provinces.

Locations	number of interviewee	Percentage of interviewee reported seeing each species			
		N	O	S	T
Bangtaboon	10	60	70	90	20
Laem laey	12	33	83	100	42
Wat Ton Son	15	13	53	100	20
Bang Kaew	8	50	75	88	38
Laem Pak Bia	13	69	77	90	69
Had Chao	20	55	50	45	70
Puk Tian	10	60	30	20	40
Ban Tha, Klong Tian, Tawee Suk	15	67	53	67	60
Cha am (fish landing)	23	70	39	57	83
Cha am beach	23	74	74	74	35

N, *N. phocaenoides* (finless porpoise)

O, *O. brevirostris* (Irrawaddy dolphin)

S, *S. chinensis* (Indo-Pacific humpback dolphin)

T, *T. truncatus* (bottlenose dolphin)

Table 7. Percentage of 211 interviewees reported seeing dolphins and porpoises in Chon Buri province.

Locations	number of interviewee	Percentage of interviewee reported seeing each species			
		N	O	S	T
Ban Sai	15	13	100	80	27
Maung	11	45	72	72	45
Ang Sila	30	67	50	27	57
Sam muk, Vorn Napa, Bang Saen	15	93	73	60	87
Bang Phra Sri Racha	23	39	0	61	100
Ko Sichang	21	43	10	81	100
Ao Udom	11	27	18	73	100
Lam Chabang	17	12	6	71	82
Pattaya, Na Klau	15	7	0	47	87
Bang Sarhae	19	0	0	100	84
Sattahip	20	0	0	90	100
Samae Sarn	29	0	0	79	100

N, *N. phocaenoides* (finless porpoise)

O, *O. brevirostris* (Irrawaddy dolphin)

S, *S. chinensis* (Indo-Pacific humpback dolphin)

T, *T. truncatus* (bottlenose dolphin)

Table 8. Percentage of 47 interviewees reported seeing dolphins and porpoises in Samut Prakarn province.

Location	number of interviewee	Percentage of interviewee reported seeing each species			
		N	O	S	T
Laem Fa Pa	16	0	100	94	89
Fish landing ,Amara	18	11	44	62	75
Klong KoTo, Bang Pu	31	31	100	77	77
Klong Dan	15	15	100	50	69

N, *N. phocaenoides* (finless porpoise)

O, *O. brevirostris* (Irrawaddy dolphin)

S, *S. chinensis* (Indo-Pacific humpback dolphin)

T, *T. truncatus* (bottlenose dolphin)

Table 9. Percentage of 49 interviewees reported seeing dolphins and porpoises in Samut Sakorn province.

Locations	number of interviewee	Percentage of interviewee reported seeing each species			
		N	O	S	T
Sahakorn	9	44	100	44	66
Kampra	14	79	79	64	86
Fish Landing, Yha Phrake	16	63	81	81	81
Chy Tale Laung	10	60	90	70	90

N, *N. phocaenoides* (finless porpoise)

O, *O. brevirostris* (Irrawaddy dolphin)

S, *S. chinensis* (Indo-Pacific humpback dolphin)

T, *T. truncatus* (bottlenose dolphin)

Table 10. Percentage of 47 interviewees reported seeing dolphins and porpoises in Samut Songkram province.

Location	number of interviewee	Percentage of interviewee reported seeing each species			
		N	O	S	T
Klong Kone	13	0	69	100	62
Bang Jkreng	17	18	35	100	71
Rong Kung, Bang bho	17	35	65	100	59

N, *N. phocaenoides* (finless porpoise)

O, *O. brevirostris* (Irrawaddy dolphin)

S, *S. chinensis* (Indo-Pacific humpback dolphin)

T, *T. truncatus* (bottlenose dolphin)

Table 11. Percentage of 24 interviewees reported seeing dolphins and porpoises in Chachoengsao province.

Location	number of interviewee	Percentage of interviewee reported seeing each species			
		N	O	S	T
Bang Pakong	12	25	100	100	25
Samae Kao	12	33	100	75	60

2.1.1. *Neophocaena phocaenoides*, finless porpoise

Although finless porpoise is the coastal species but it is commonly found at the depth of 10-15 m or even deep. They has wider distribution than Irrawaddy dolphin. In this study, a population of finless porpoise appeared to be the resident of Bang Saen to Vornapa beach throughout the year. They were seen frequently from Sri Racha to Laem Chabang and Patthaya. However they were never been spotted further south from Pattaya to Sattahip in the lower part of the Inner Gulf.(Fig. 11) They were also not frequently seen along the coast of the upper part of the Inner Gulf.

Because of the absence of its dorsal fin, it was very difficult to sight finless porpoise during the field survey. However, at 1450 hrs. of October 8, 1996, three finless porpoise were observed at 13°19'.10'N 100°53'.36'E off the coast of Laem Tan. Unfortunately, the photographs did not well enough. They were surfacing at 50-60 m away from the boat and could not be able to follow them.

Many stranding and bycatch specimens found during the study period firmly support the distribution pattern determined by interviewing survey. Along the east coast, Chon Buri, one dead female juvenile, BIMS16 was collected floating near Bang Phra on August 17, 1995, a male adult, MSCU001 recieved from fishlanding at Kao

Sam Muk on March 15, 1996, a female subadult, BIMS019 was accidentally caught from Vornnapa beach in September, 1996, and a juvenile male MSCU005 was trapped by driftnet off 2 km off Ang-Sila on October 1, 1996. Toward the east of Samut Prakarn province, a juvenile male, CUMZ006 was tangled by driftnet off Klong Dan. On the west coast in Petchaburi province, two specimens and four photographs were recorded from this area. First on July 2, 1996 the deteriorating specimen from Had Chao Samran, slightly north of Cha-am was dug up to clean for skeleton examination. This skeletal sample was without head but it can be identified as finless porpoise according to its size and the 3 fused cervical vertebrae. Local people reported that this porpoise was stranded and died on the beach about 2 months before this recovery. Later on August 29, 1996, a lactating female MSCU003 was accidentally caught by driftnet 1 km off Cha-am.

The two photographs of adult finless porpoise tangled by driftnet off Had Chao Samran on January 20, 1997 and another adult also tangled by driftnet off Cha-am beach on September 21, 1996 were taken.

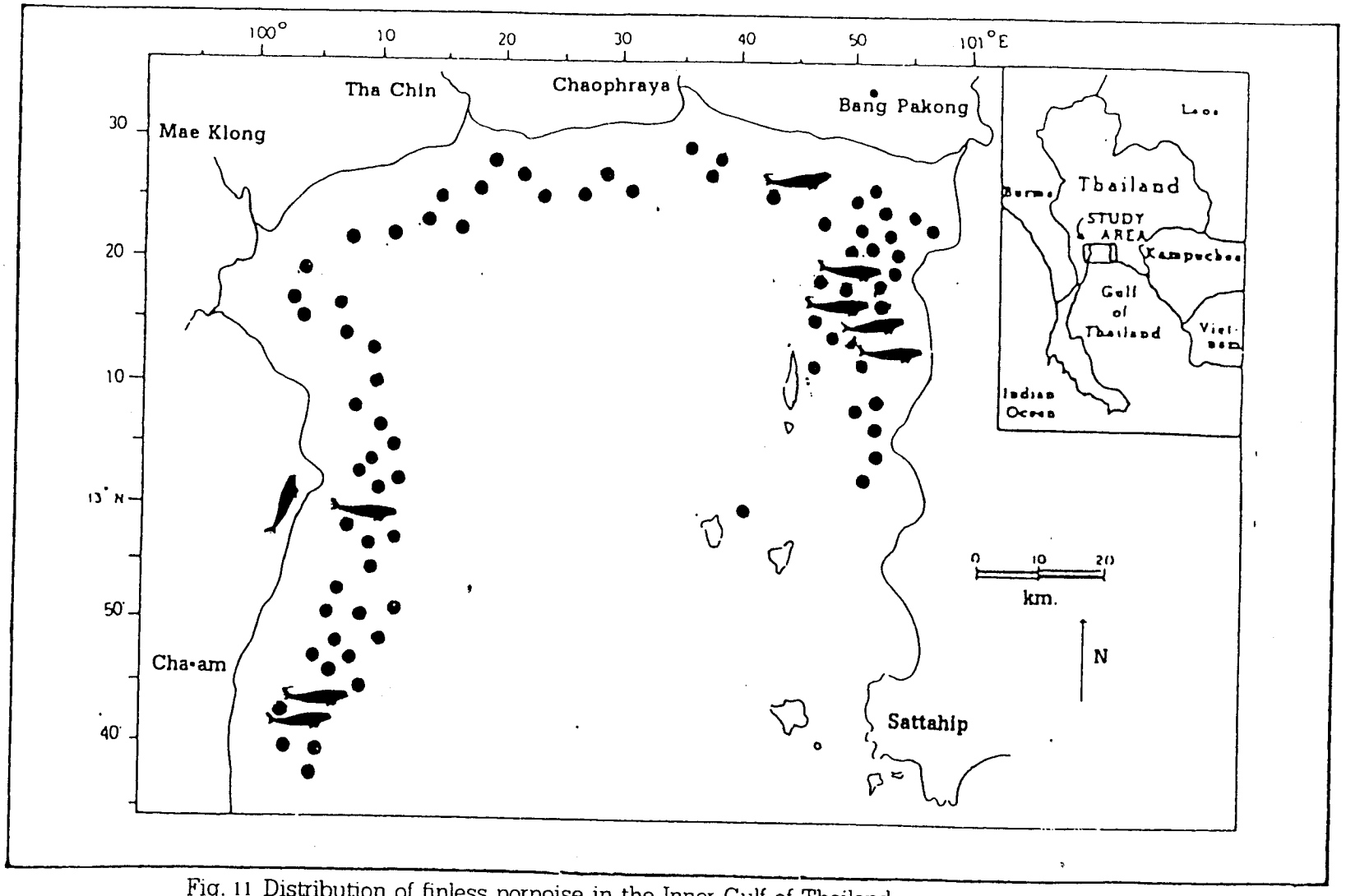

Fig. 11 Distribution of finless porpoise in the Inner Gulf of Thailand

● = 20% of interviewees reported seeing this species = photographs or carcasses of finless porpoises

2.1.2. *Orcaella brevirostris*, Irrawaddy dolphin

The interview records showed that Irrawaddy dolphin had formerly distributed in the riverine, estuarine and coastal habitats near the mouth of Bang Pakong and along the coast of the Inner part of the Gulf including the Chao Phraya, Tha Chin and Mae Klong estuaries. The distribution extended over on the west along the coast of Petchaburi. On the east coast of Chon Buri province, this dolphin was reported to be seen only in Sri Racha It had never been spotted from Patthaya further southward. (Fig. 12) This dolphin was commonly seen in the shallow water at about 1.5 m depth near mudflat. Stranded dolphins were often reported on the mud flat along the Inner part of the Gulf.

One decaying carcass was discovered in the mangrove at Bang Pu, Samut Prakarn, on July 18, 1996. It was identified as MSCU 002 and preserved as skeleton at Department of Marine Science, Chulalongkorn University. Another decayed specimen, EN 062, was found floating off Bang Boh coast between Mae Klong and Tha Chin river mouth in March, 1996. Now EN 062 is kept at Phuket Marine Biological Center. These two specimens supported the nearshore distribution pattern as revealed from the interview survey.

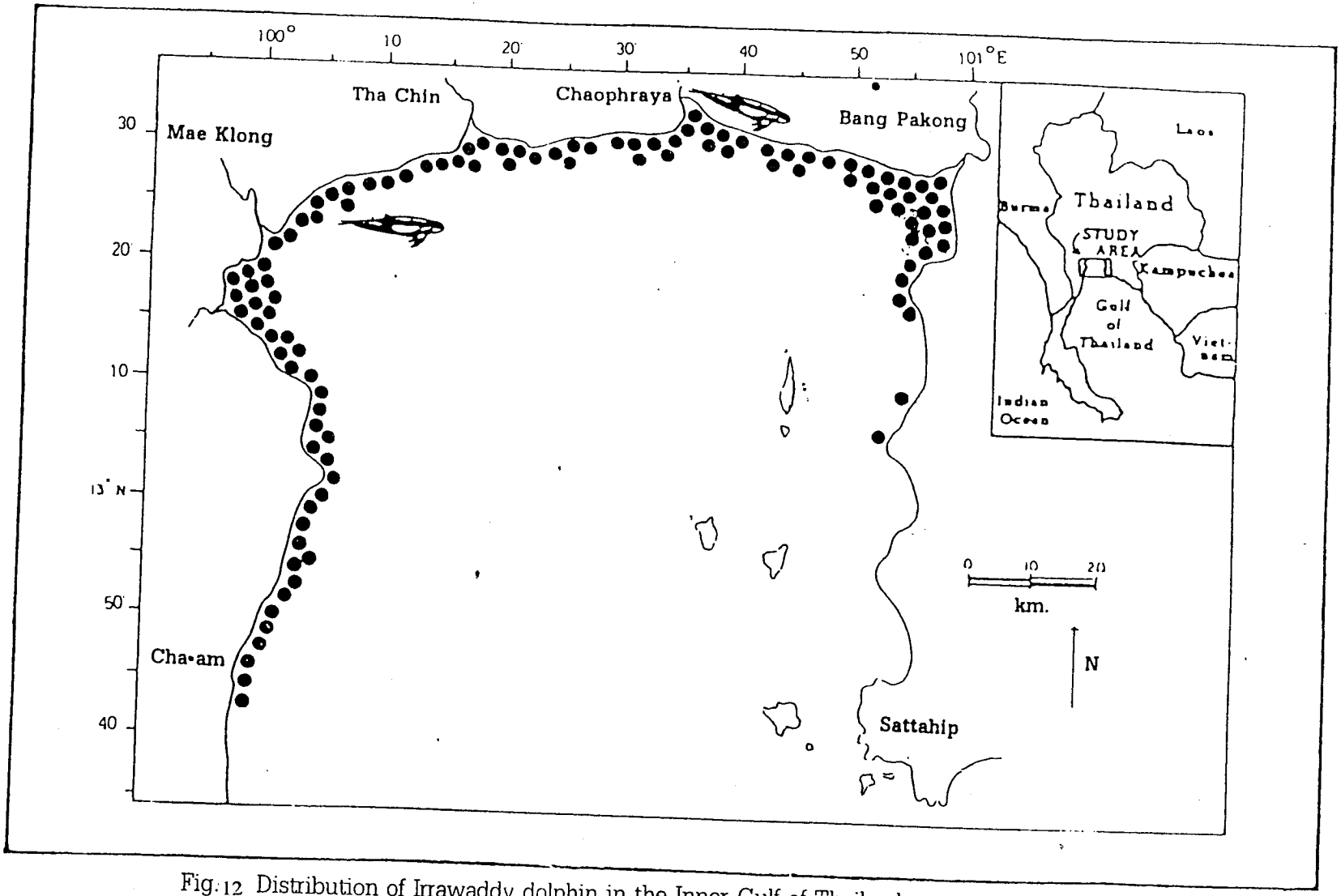

Fig. 12 Distribution of Irrawaddy dolphin in the Inner Gulf of Thailand

● = 20% of interviewees reported seeing this species = carcasses of Irrawaddy dolphins

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

Indo-Pacific humpback dolphin was found to be widely distributed slightly offshore of the Inner Gulf. The distribution was reported to be concentrated more at the rivermouth of all four rivers particularly Bang Pakong and Mae Klong and in the coastal area to about 20 m depth. It was also often seen far from the river mouth in areas such as Ko Sichang, Bang Sarhae and around Sattahip (Fig 15). This population of hump-backed dolphins at the mouth of Bang Pakong appeared to be the resident there throughout the year. Most fishermen could recognized them by their distinctive greyish pink body color.

Only one specimen was available for detail studied in this research. This specimen (MSCU004) was found floating near Ko Pai on September 6, 1996 by the fishermen from Ang-Sila (Fig. 13). This skeleton is now kept at the Department of Marine Science, Chulalongkorn University. Another stranded dead female was found by an officer of Sichang Marine Research Station in the morning of December 22, 1996, on the beach infront of the station.

Fig. 13 The half decayed specimen of Indo-Pacific humpback dolphin

Photographs of sightings these humpback dolphin were taken by few observers. One was taken by a reporter of Thai Rath newspaper at Chao Phraya rivermouth on January 7, 1997. The other photo was taken by the village chief of Moo 10, Ban Laem district, Petchaburi province. He observed 3 dolphins around Petchaburi rivermouth in March 1994. (Fig. 14)

Fig. 14 Indo-Pacific humpback dolphin around Bang Taboon

On February 16, 1997, the intensive sighting survey at the Bang Pakong rivermouth encountered approximated ten Indo-Pacific humpbacked dolphins at the position of 13° 24'.250' N 100°56'.118' E at 1304 hrs at the depth of about 10 m. They generally remained at distance of 20-30 m from the boat and approaching at 4-5 m on two occassions. This area was far from the mangrove area of Bang Pakong. It was possible to bring the boat approaching close to them. They let us follow them for about one and a half hours.

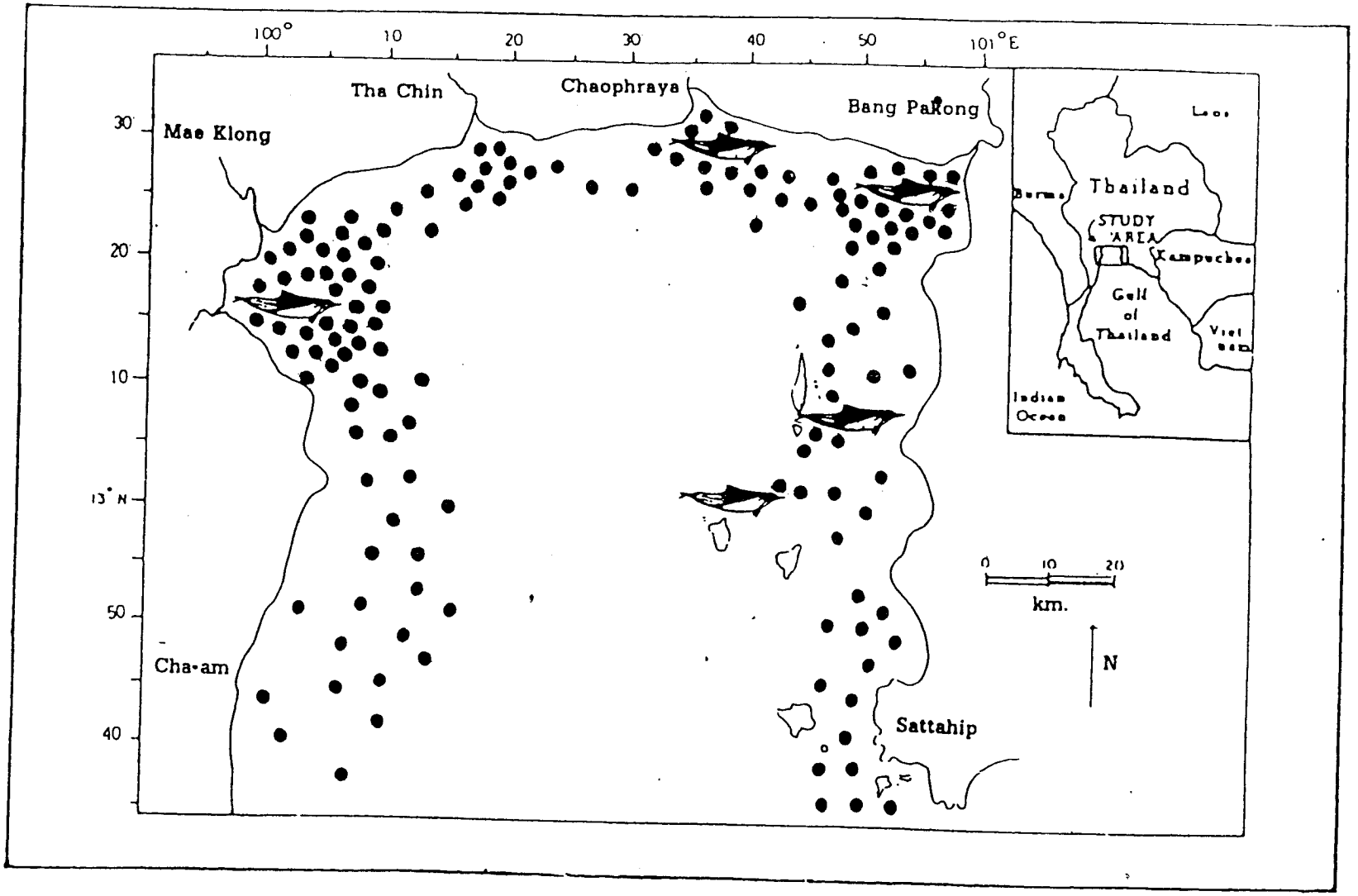

Fig.15 Distribution of Indo-Pacific humpback dolphin in the Inner Gulf of Thailand

● = 20% of interviewees reported seeing this species = photographs or carcasses of Indo-Pacific humpback dolphins

2.1.4. *Tursiops truncatus*, bottlenose dolphin

This dolphin possibly has the wider distribution than other three species. They were commonly encountered by people along the coast of the study area. This species was reported to be common around most of the islands on the east coast of the Inner Gulf from Ko Si chang, Ko Pai, Ko Lan, Ko Kram throughout Sattahip and Samae Sarn (Fig. 16). Although the depth of the water where bottlenose dolphin was found varied greatly, they prefer 20 m or deeper waters and seldom seen visited nearshore. In most areas, eventhough they were not seen as frequent as the other three species but they were well known to most interviewees because of their acrobatic behaviors, such as bowriding and breaching. They were often reported to follow the ferries between Sri Racha to Ko Si Chang and between Pattaya to Ko Lan and Ko Pai.

Information regarding the bycatch of this species was rare and no new specimen was able to obtain for this study. Most fishermen believed that their fast swimming behavior abale them to avoid being caught.

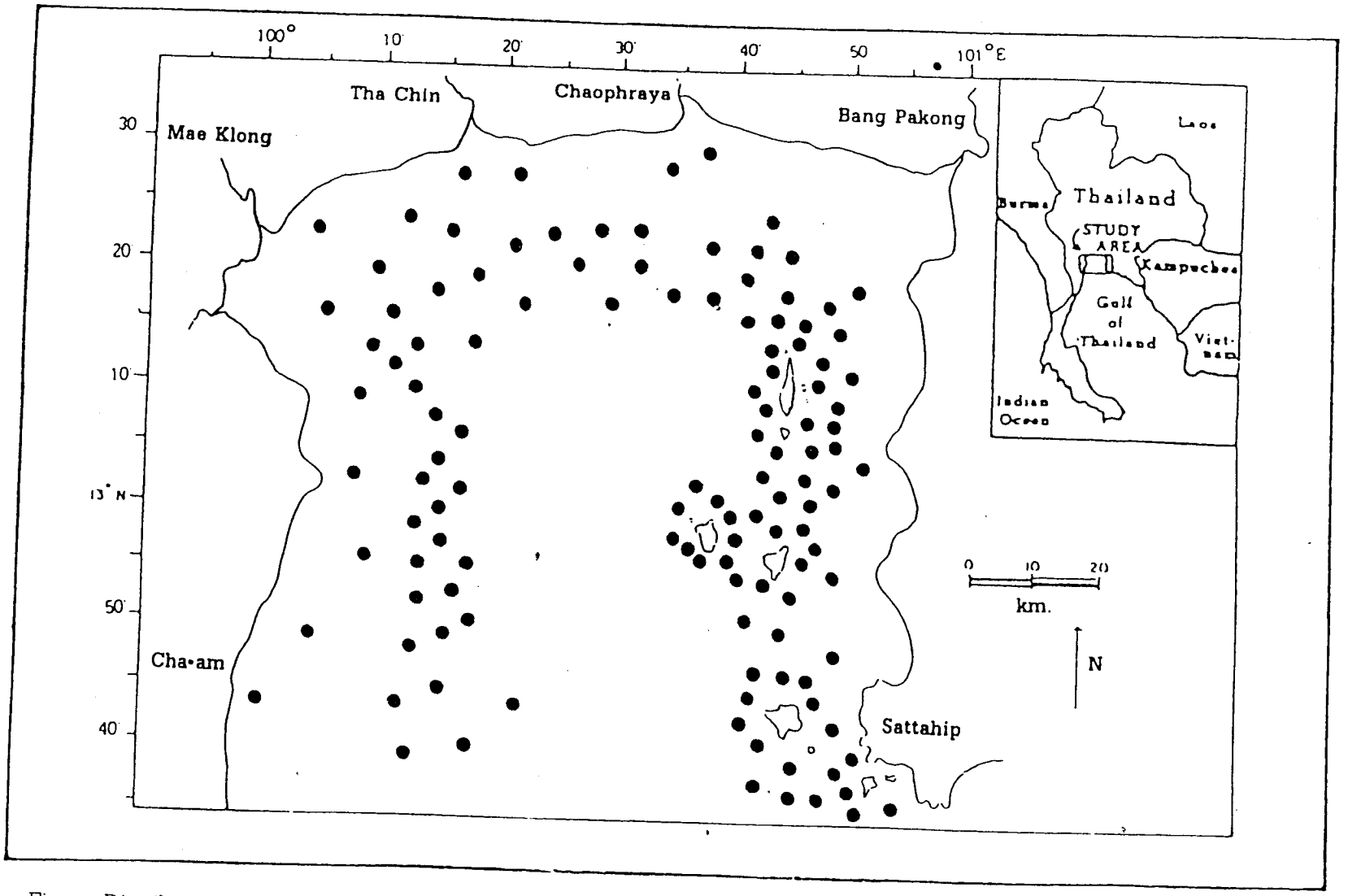

Fig.16 Distribution of bottlenose dolphin in the Inner Gulf of Thailand ● = 20% of interviewees reported seeing this species

2.2. Tributaries intrusion

From the intensive interviews of the elderly people who live along the tributaries of the Inner Gulf, Bang Pakong, Chao Phraya, Ta Chin and Mae Klong three species from five inhabited in the Inner Gulf of Thailand, Irrawaddy dolphin, Indo-Pacific humpback dolphin and bottlenose dolphin had been claimed to intrude freshwater into the tributaries in the past decades. The other two species, finless porpoise and spinner dolphin never been seen to swim through freshwater. Recently, only humpback dolphin are sometimes observed to intrude approximately two km of every river mouth (Fig. 17).

Among all dolphins known to the fishermen, Irrawaddy dolphin had been confirmed to be the most common fresh water intrusion species during the past 30 years or over. It had been known to intrude far from the river mouth of Chao Phraya and Bang Pakong. In Chao Phraya river, many people reported seeing Irrawaddy dolphin at Ko Kret, Nonthaburi, about 85 km from the river mouth in 1958. It was also reported by one old man that he had seen the dolphin as far as 60 km from the river mouth in 1962. He saw the dolphin at night and thought that it was a crocodile. This Irrawaddy dolphin was reported to be killed and consumed by local people. In Bang Pakong, the occurrence of Irrawaddy dolphin had been confirmed by many elderly local people. They were seen about 30 years ago to intrude about 60 km from the river mouth. At present, Irrawaddy dolphin is also occasionally found only few kilometers from the Bang Pakong river mouth.

Recently, Indo-Pacific humpback dolphin had sometimes been observed to intrude approximately two km of every river mouths.

Bottlenose dolphin are not as good at freshwater intrusion. Surprisingly, a young man reported that he observed seeing this species at Klong Jek, Bangkok 30 km from the river mouth in 1983. That bottlenose dolphin was shot by local people mistaking that it was an invader crocodile. This specimen had been cleaned for skull study and still kept at Science Museum, SCMS001.

For the other two rivers, Ta Chin and Mae Klong, more than 200 elderly local people were intensively interviewed but nobody reported to have seen any dolphins intruded further into these two rivers except recent reports at the river mouths.

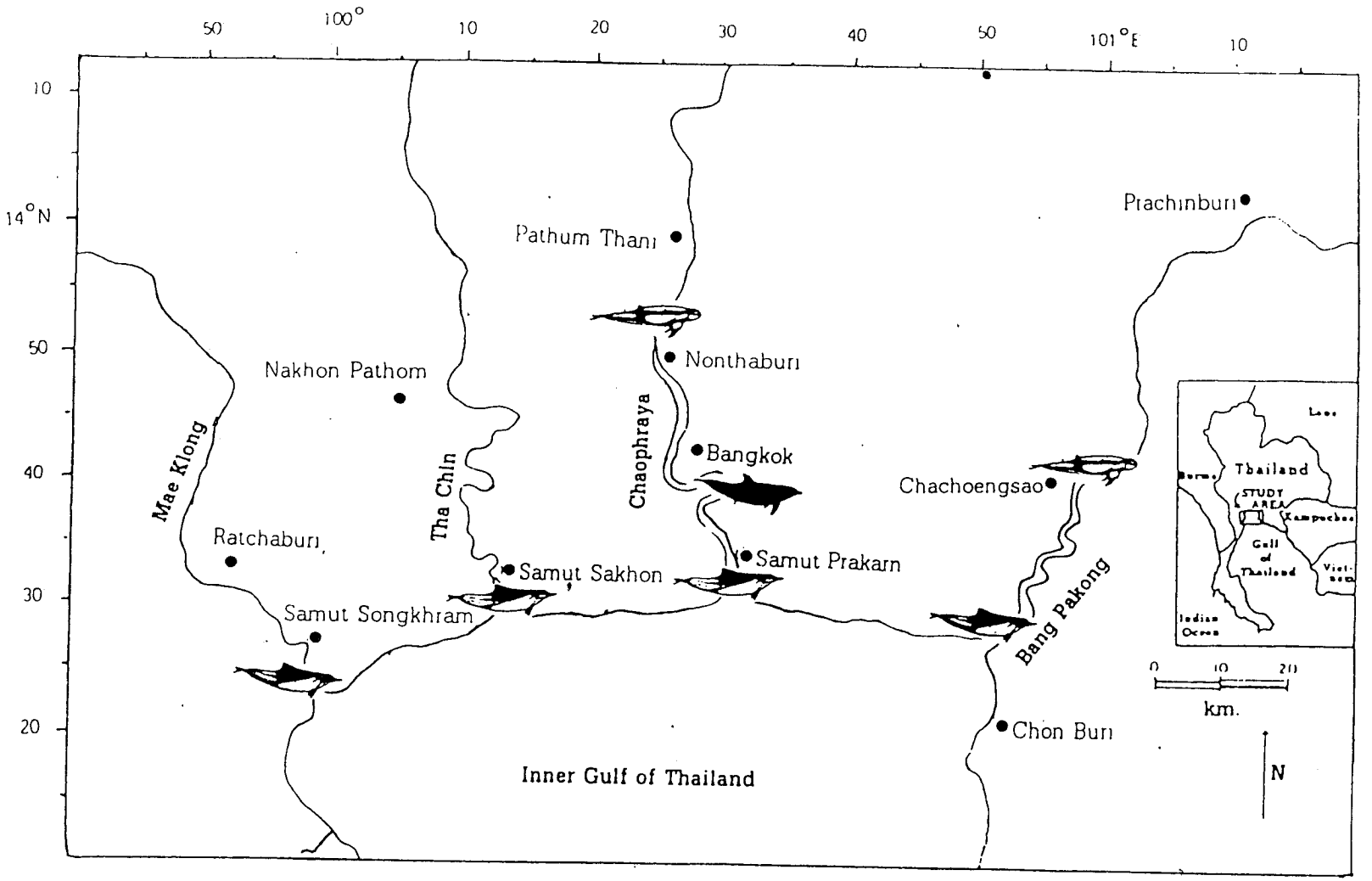

Fig. 17 Tributaries intrusion of dolphins in Bang Pakong, Chao Phraya, Mae Klong and Ta Chin River

= Irrawaddy dolphin = Indo-Pacific humpback dolphin = bottlenose dolphin

3. Specimens studied

A total of fifty four specimens of dolphins and porpoises were studied in detail. Nine new specimens obtained during this study were recorded in table 12. Twenty seven taxidermies and eighteen skeletons were also checked and recorded in table 13 and 14.

Table 12. New specimens of dolphins and porpoises collected between 1995 and 1996.

Code •	Species	Date	Sex	TL**	TW**	Locality
BIMS016	*Neophocaena phocaenoides*	Aus17, 95	F	80	9.00	Bang Phra, CB.
MSCU001	*N. phocaenoides*	Mar15, 96	M	141	31.50	Khao Sam Muk, CB.
MSCU002	*Orcaella brevirostris*	July18,96	*	*	*	Bang Poo, SP
MSCU003	*N. phocaenoides*	Aus29, 96	F	133	24.50	Cha Am, PB.
MSCU004	*Sousa chinensis*	Sep6, 96	F	225	*	Kao Pai, CB.
MSCU005	*N. phocaenoides*	Oct1, 96	M	74.50	9.00	Angsila, CB.
CUMZ006	*N. phocaenoides*	Mar5, 96	M	84	*	Klong Dan, SP
BIMS019	*N. phocaenoides*	Nov13,96	F	122	16	Angsila,CB.
EN062	*O. brevirostris*	Mar,96	*	*	*	Samut Sakorn

* specimens incompleted, unable to determined sex, TL(total length) and TW (total weigth)

** Total length and total weight, unit in cm

Abrreviation : CB ; Chonburi, SP ; Samut Prakarn, PB ; Petchburi

Table 13 Taxidermic specimens of dolphins and porpoises.

Specimens	Species	Date	Locality	Remarks (kept at)
CRODF001	*Orcaella brevirostris*	U	Samut Prakarn	Crocodile Farm, SP
BIMST004	*O. brevirostris*	U	Chonburi	Bangsaen Inst. of Marine Science
BIMST007	*Sousa chinensis*	U	Chonburi	Bangsaen Inst. of Marine Science
BIMST005	*S. chinensis*	U	Chonburi	Bangsaen Inst. of Marine Science
OCFSH002	*Tursiops truncatus*	U	Samut Prakarn	Oceanic Fishery Division, SP
BIMST002	*T. truncatus*	U	Chonburi	Bangsaen Inst. of Marine Science
BIMST006	*T. truncatus*	U	Chonburi	Bangsaen Inst. of Marine Science
SWKN001	*T. truncatus*	1977	Ban Pae, Rayong	Swankaniwas Fish Farm, SP
SWKN002	*T. truncatus*	1977	Ban Pae, Rayong	Swankaniwas Fish Farm, SP
SWKN003	*T. truncatus*	1977	Ban Pae, Rayong	Swankaniwas Fish Farm, SP
VETCU001	*T. truncatus*	1974	Death at Sarom Palace Bangkok	Fac. of Veterinary, Cu has recieved from Florida Dolphin Show
ZMUKU001	*T. truncatus*	U	Samut Sakorn	Zoological Mus., KU
ZMUKU002	*T. truncatus*	U	Samut Sakorn	Zoological Mus., KU
FSHKU004	*T. truncatus*	U	U	Mus. of Fac. of Fishery, KU
FSHKU005	*T. truncatus*	U	U	Mus. of Fac. of Fishery, KU
SCCE001	*T. truncatus*	1983	Klong Jek, Chaopraya river Bangkok	Science Center for Education, Bangkok
OCFSH001	*Stenella longirostris*	1977	Samut Prakarn	Oceanic Fishery Division
NHMUS005	*S. longirostris*	U	U	Natural History Museum, CU
CRODF002	*Stenella spp.*	U	Samut Prakarn	Crocodile Farm, SP
CRODF003	*S. longirostris*	U	Samut Prakarn	Crocodile Farm, SP
BIMST001	*S. longirostris*	U	Chonburi	Bangsaen Inst. of Marine Science
ZMUKU003	*S. longirostris*	U	Samut Sakorn	Dept of Zoology , KU
ZMUKU004	*S. longirostris*	U	Samut Sakorn	Dept. of Zoology , KU
FSHKU006	*S. longirostris*	U	U	Old Mus. of Fac. of Fishery, KU
ZMUKU005	*Neophocaena phocaenoides*	U	Samut Sakorn	Dept. of Zoology, KU
ZMUKU006	*N. phocaenoides*	1991	Bangkok fish landing	Dept. of Zoology, KU
BIMST003	*N. phocaenoides*	U	Chonburi	Bangsaen Inst. of Marine Science

U, Data unavailable ; SP, Samut Prakarn province ; KU, Kasetsart University ; CU, Chulalongkorn University

Table 14 Skeletal specimens of dolphins and porpoises

Specimens	Species	Date	Locality	Remark (kept at)
FSHKU001	*Tursiops truncatus*	1965	Hua hin, Prachuab.	Mus. of Fac. of Fishery, KU
FSHKU002	*T. truncatus*	U	U	Mus. of Fac. of Fishery, KU
TISTR001	*T.truncatus*	1982	Pratew, Prachuab.	Th. Inst. of Sc. & Tech. Res.
BIMS015	*T. truncatus*	U	Bangsaen, Chon.	Bangsaen Inst. of Marine Science
SCCE001	*T.truncatus*	1983	Klong Jek, Chaopraya river, Bangkok	Science Center for Education
CUMZ001	*T. truncatus*	U	U	Natural History Museum, CU
CUMZ002	*Orcaella brevirostris*	1992	Mae Kong river, Lao	Natural History Museum, CU
EN0062	*O. brevirostris*	1996	Samut Sakorn	Phuket Marine Biological center
MSCU002	*O. brevirostris*	1996	Bang Poo, SP	Dept. of Marine Science, CU
BIMS003	*Sousa chinensis*	1993	Bang Lamung, Chon.	Bangsaen Inst. of Marine Science
FSHKU003	*S. chinensis*	U	U	Mus. of Fac. of Fishery, KU
MSCU004	*S. chinensis*	1996	Ko Pai, Chon.	Dept. of Marine Science, CU
BIMS013	*Stenella longirostris*	U	Bangsaen, Chon.	Bangsaen Inst. of Marine Science
BIMS014	*S. longirostris*	U	Bangsaen, Chon.	Bangsaen Inst. of Marine Science
CUMZ003	*Neophocaena phocaenoides*	U	U	Natural History Museum, CU
CUMZ004	*N. phocaenoides*	1989	U	Natural History Museum, CU
BIMS012	*N. phocaenoides*	U	Bangsaen, Chon.	Bangsaen Inst. of Marine Science
BIMS010	*N. phocaenoides*	U	Bangsaen, Chon.	Bangsaen Inst. of Marine Science
BIMS007	*N. phocaenoides*	1994	Bangsaen, Chon.	Bangsaen Inst. of Marine Science
BIMS016	*N. phocaenoides*	1995	Bangsaen, Chon.	Bangsaen Inst. of Marine Science
BIMS008	*N. phocaenoides*	1994	Bangsaen, Chon.	Bangsaen Inst. of Marine Science
BIMS011	*N. phocaenoides*	U	Bangsaen, Chon.	Bangsaen Inst. of Marine Science
BIMS019	*N. phocaenoides*	1996	Chon.	Bangsaen Inst. of Marine Science
MSCU001	*N. phocaenoides*	1996	Kao Sam Muk	Dept. of Marine Science, CU
MSCU003	*N. phocaenoides*	1996	Cha am, Petchburi	Dept. of Marine Science, CU
MSCU005	*N. phocaenoides*	1996	Ang sila, Chon.	Dept. of Marine Science, CU

Abbreviations are the same as table 13 .

4. External and internal morphological data

Specimens of each species of dolphins and porpoises encountered in the Inner Gulf of Thailand had been carefully measured. Their external morphological characteristics had been recorded whenever possible and the new specimens had been dissected to record the data on the internal morphological characteristics.

• 4.1. *Neophocaena phocaenoides*, finless porpoise

4.1.1. External morphological characteristics

Two most distinctive characteristics of finless porpoise are the lack of dorsal fin and beak. Replacing the dorsal fin is the dorsal ridge characterized by thick denticulated epidermis along the back. This ridge would rise slightly higher in juvenile. The body is streamline in shape and dark grey in color but the ventral side is paler with light reddish color. Body color would turn darken during the postmortem time within about 24 hours. The round head has steep forehead. Mouthline runs gradually upward. (Fig. 18 - 20).

Fig. 18. Lateral view of finless porpoise

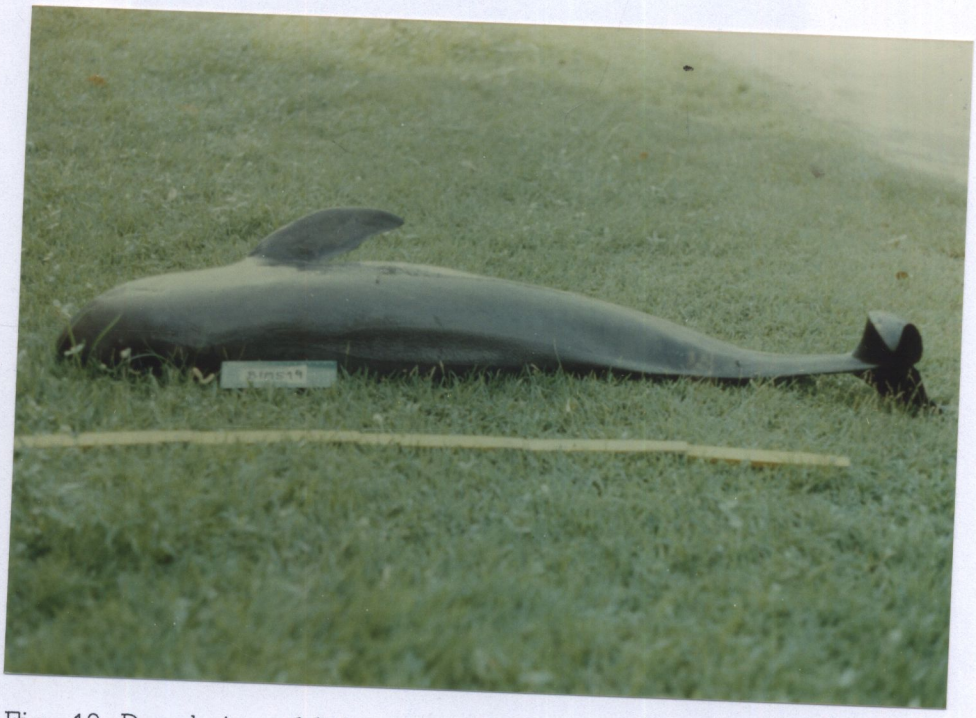

Fig. 19 Dorsal view of finless porpoise

Fig. 20. Head shape of finless porpoise

Six new specimens and three old taxidermies were studied for external morphology. The teeth are spatulate. The ranges of upper/lower tooth counts are 15 - 21/14 - 21 in each tooth row with the mode of 16/18,19 (n=10). In juvenile, the numbers of eruptive teeth are higher in the upper jaw.

Finless porpoise is the smallest cetacean in Thai waters. The biggest male, MSCU001 of this study is 141 cm long with 31.5 kg weight. The biggest female , MSCU003 is 133 cm long and 24.5 kg weight. The taxidermic smallest one, KUMZ006 is 62.5 cm long. The smallest new female carcass, MSCU005 is 74.5 cm long with 9 kg weight. The smallest male, BIMS016 is 80 cm long and 9 kg weight. Breadth of the fluke is 29.24% of body length. This is broader than flukes of other four dolphins. Flippers have pointed tip with the length (measurement no. 28) of 18.38% of body length. This is similar to Irrawaddy's flippers but they are longer than those of Indo-Pacific humpback, bottlenose and spinner dolphin.

Table 15. Percentage of morphometric measurement/total length in finless porpoise

Measurement characters	Mean	Range	n
Snout to blowhole	7.96	7.09-9.42	4
Snout ot eye	7.95	7.38-8.72	4
Snout to ear	20.00	19.15-21.72	4
Anterior edge of flipper to flipper tip	18.38	17.39-19.17	4
Posterior edge of flipper to flipper tip	13.80	12.32-15.16	4
Greatest breadth of the flipper	6.18	5.43-6.70	4
Breadth of the fluke	29.24	27.82-30.14	4
Fluke notch across fluke lateral base	7.04	6.52-7.54	4

4.1.2 Comparision on some selected morphometric between adult and juvenile porpoises

Porportions of head, flipper, body girdle and blubber thickness to body length were different. When compared the mean length of head measurements nos. 7, 10, 11 and 12, girdle measurement nos. 17 and 19, flipper measurement nos. 28, 29 and 30, blubber thickness measurement nos. 31, 32, 33 and 34, they revealed that juveniles showed the higher numbers of these ratios. (Table 16)

Table 16 Percentage of morphological measurements/total length between adult and juvenile finless porpoise

Measurement characters	Adult			Juvenile		
	Mean	Range	n	Mean	Range	n
Snout to blowhole	7.88	7.09 - 9.42	3	8.70	8.05 - 9.92	3
Snout to eye	4.63	3.55 - 5.64	3	6.27	4.97 - 7.20	3
Snout to ear	10.49	9.62 - 11.35	2	15.88	15.88	1
Snout to ant. base of flipper	19.42	19.15 - 19.57	3	22.58	21.72 - 24 13	3
Body girth at post. base of flipper	48.84	49.97 - 49.65	3	60.45	58.75 - 62.15	2
Body girth at anal slit	33.62	32.48 - 34.75	3	41.61	40 - 43.22	2
Ant. edge of flipper to flipper tip	18.22	17.39 - 19.17	3	21	20.40 - 21.60	3
Post. edge of flipper to flipper tip	13.34	12.32 - 14.18	3	16.69	15.44 - 17.50	3
Greatest breadth of the flipper	6.05	5.43 - 6.70	3	7.68	7.38 - 8.00	3
Bubbler thickness (31)	0.40	0.30 - 0.50	2	1.375	1.37 - 1.38	2
Bubbler thickness (32)	0.55	0.45 - 0.64	2	1.24	1.13 - 1.35	2
Bubbler thickness (33)	0.40	0.30 - 0.50	2	1.115	1.11 - 1.12	2
Bubbler thickness (34)	0.69	0.60 - 0.78	2	1.26	1.12 - 1.39	2

4.1.3. Internal anatomical characteristics

4.1.3.1. Organs

Data on the internal organs of dolphin and porpoise are very rare because it is difficult to get the specimen for examination. Five samples of this species were availabled during the time of the study.

Table 17 Percentage of weight of organs(g.)/total weight

organ	BIMS016	MSCU001	MSCU003	MSCU005	BIMS019
liver	1.73	2.37	3.27	2.44	3.49
lung	3.40	-	3.27	-	3.46
heart	0.47	-	0.72	0.44	0.69
kidney	-	-	1.10	0.89	1.38
pancrease	-	-	0.29	0.11	0.19
testis L/R	-	290/330	-	-	-

From all specimens examined, the liver weight is in the range 1.73 - 3.49 % of body weight, kidney 0.89 - 1.38 % , pancrease 0.11 -0.29 %, heart 0.44 - 0.72%. and lung 3.27 - 3.46% of body weight. The pneumortic tract of this species composed of double tracheas. The trachrea on the left is bigger. The one on the right branched into smaller tubes to supply the upper part of the right lung (Fig.21). Main trachea on the left is similar to other mammals in dividing into two bronchus upon entering the thorax to supply the left lung.

Fig. 21. The respiratory tract of finless porpoise

4.1.3.2. Stomach content

The main food content of three finless porpoise composed of cephalopods, crustaceans and fishes (Table 18). The dominant prey is cephalopods. Two small stones and one remaining valve of bivalves mollusk were also found in the stomach.

Table 18 Stomach contents of 3 finless porpoise

Contents	Weight (g)		
	MSCU001	MSCU003	BIMS019
Cephalopods (Loligo sp.)	43.96*	2.09**	0.02
Crustaceans	14.22	-	-
Fishes	18.84	4.25	-
Bivalves	-	0.02	-
Stones	0.07 (1 piece)	0.26 (2 pieces)	-
Unidentified	27.37	1.95	-
Total	104.46	8.57	0.02

*including 70 beaks and 51 eyeballs

** including 71 beaks and 15 eyeballs

4.1.3.3. Internal parasite

Numerous worm cysts were found in the lungs of juvenile finless porpoises, BIMS016 and MSCU005. They were nematodes of the family Pseudalliidae. In an adult porpoise MSCU003, the encapsulated (calcified) parasites were found in the lung but no living worm was found. No parasite could be recorded in other organs.

4.1.3.4. Skeleton

Cranium

The skull of finless porpoise is quite small. The rounded tip rostrum is very short with 33.43% of the condylobasal length,CBL. The margins of rostrum are almost parallel. The mandible is 72.42% of CBL long and 21.17% of CBL broad. The bony bosses of premaxilla are located in front of the nares. This is one of the characters used in recognition between dolphin and porpoise.

Fig. 22 Dorsal view of finless porpoise's skull

Fig. 23 Ventral view of finless's porpoise skull

Fig. 24 Lateral view of finless porpoise's skull

Fig.25 Posterior view of finless porpoise's skull

The size of the tympanic bulla and periotic bones of adult and juvenile are not obviously difference, Table 19, Fig. 26 .

Table 19 Percentage of tympanic bulla (TB) and periotic (PR)/ condylobasal length between adult and juvenile finless porpoise.

Measurement nos.	Adult			Juvenile		
	mean	range	n	mean	range	n
Greatest length of TB	3.70	3.60 - 3.80	3	3.62	3.52 - 3.70	4
Greatest width of TB	2.27	2.10 - 2.34	4	2.33	2.30 - 2.40	4
Greatest length of PR	2.76	2.70 - 2.87	3	2.66	2.59 - 2.80	4
Greatest width of PR	1.71	1.67 - 1.75	4	1.78	1.74 - 1.86	4
Diameter of cochlear portion of PR	1.29	1.24 - 1.35	4	1.28	1.24 - 1.30	4

Fig. 26. Tympanic and periotic bone of adult and juvenile finless porpoise

Postcranial skeleton

Most postcranial skeletons of old skeletal specimens were lost or broken. Therefore, most informations were gathered from three new skeletons examined.

Scapula

When divide the width of scapula by its length (measurement no. 47/46), the higher ratio was shown in scapula of juvenile. (Table 20)

Table 20 Comparision on percentage of scapula (47/46) and sternum (45/44) width/length between adult and juvenile finless porpoise.

Measurement nos.	Adult			Juvenile		
	mean	range	n	mean	range	n
47/46	66	64 - 71	5	74	73 - 77	4
45/44	10.6	9.1 - 11.6	4	12.9	12.5 - 13.4	3

Sternum

Sternum ratio between width/length (45/44) is also reflected the growth as in the ratio of sternum width/length (45/44). The shape and size of sternum is obviously different between male and female (Fig. 27)

Pelvic

The shape and size of pelvic bone is distinctively different between male and female. The male pelvic, MSCU001 was 6.75 cm long, 1.04 cm broad and 0.56 cm thick with rough surface and twisted, while female, MSCU003, was only 6.18 cm long , 0.79 cm broad and 0.31 cm thick with smooth surface and untwisted (Fig. 28).

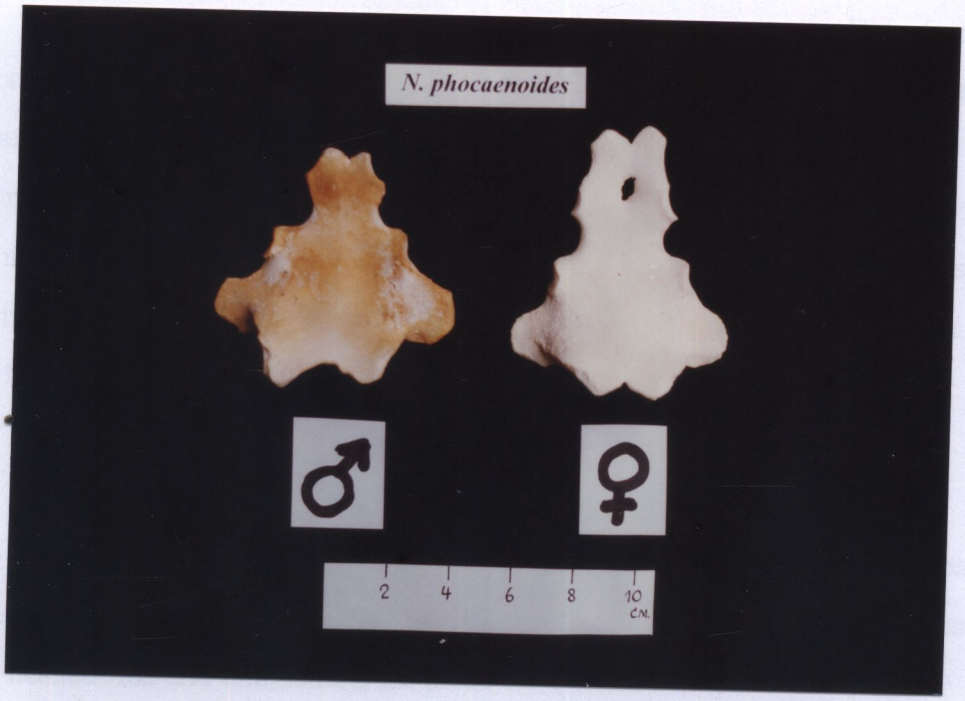

Fig. 27 Sternum of male and female finless porpoise

Fig. 28 Pelvic bone of male and female finless porpoises

Vertebrae

Finless porpoise has the first three fused cervical vertebrae. This fusion of vertebrae occured since the porpoise was young, MSCU005. The last fusion between the centrum of a vertebra and its epiphysis occurs in the thoracic vertebrae. This phenomenon could be observed in lactating MSCU003, whose milk was still flowing from mammary gland even when dead. This can be concluded that the sexual maturity occur before physical maturity. The common vertebral formula of both male, MSCU001, and female, MSCU003, is C7+Th13+L11+Ca30.

Ribs

Ribs are bilatteral symetry. Finless porpoise has thirteen vetebral ribs and eight sternal ribs on each side. Vertebral ribs compose of seven two-headed ribs, five single-headed ribs and one floating rib (n=3).

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

A lactating female, MSCU003 taken in August 29, 1996 was 133 cm long and weight 24.50 kg. Although MSCU003 was sexually mature, she was not physically mature because some of her thoracic vertebrae and their epiphyses were still not fused together yet. The physically mature male, MSCU001 was taken in March 15, 1996. He was 141 cm long and weight 31.5 kg with the right testis of 290 g and the left of 330g. Although the smallest 9 kg new specimen, MSCU005 is 74.5 cm long and was taken in october 1, 1996 and the old smallest specimen ZMKU006 is 62.5 cm long.

4.2. *Orcaella brevirostris*, Irrawaddy dolphin

Only two available old taxidermies and two new skeletons had been examined. Hence, detail of internal organs and life history of this species could not be studied and are still unknown. The total length of the two taxidermic specimens, CRDF001 and BIMST004, are 160 cm and 171 cm. Morphometric measurements are also based on these two specimens.

4.2.1. External morphology

A falcately tiny dorsal fin of Irrawaddy dolphin sets behind midback or about 52.9% of body length from the head tip. Among four species dolphins found in the study area, Irrawaddy dolphin has smallest dorsal fin. The base of dorsal fin is 7.6% and the height is 2.7% of body length. The flipper is quite large with rounded tip. The length of anterior part is 17.7% and 13.8% of the posterior part. The breadth of the flipper is 6.7% of body length. The fluke is broad and concave but propotion of the size is not different from other four dolphins.

Tooth count of upper/lower jaws ranged from 14 - 17/12-14 on each side with the mode of 15/13 (n=4).

Table 21 Percentage of morphometric measurement/total length in Irrwaddy dolphin

Measurement characters	Mean	Range	n
Snout to blowhole	6.05	5.85-6.25	2
Snout to eye	10.00	9.36-10.63	2
Snout to posterior base of dorsal fin	59.98	57.89-61.88	2
Snout to anterior base of dorsal fin	52.90	52.05-53.75	2
Basal length of dorsal fin	7.62	5.85-9.38	2
Height of dorsal fin	2.72	2.34-3.10	2
Snout to anterior base of flipper	21.01	20.76-21.25	2
Anterior edge of flipper to flipper tip	17.74	15.79-19.69	2
Posterior edge of flipper to flipper tip	13.80	12.28-15.31	2
Greatest breadth of the flipper	6.67	5.84-7.50	2
Breadth of the fluke	26.27	25.63-26.90	2
Fluke notch across fluke lateral base	7.26	7.02-7.50	2

4.2.2. Internal anatomy

4.2.2.1. Skeleton

Cranium

The condylobasal lengths were 27.2 cm.(EN062) and 29.8 cm.(MSCU002). The intensive skull measurement are shown in Table 22. Rostrum was moderately short with pointed tip. Length of rostrum is 40.71% of CBL. Width of rostrum at base is closed to length or about 39.62% of CBL but width at midlength is much shorter than length or 23.40%.

Fig. 29 Dorsal view of Irrawaddy dolphin's skull

Fig. 30 Ventral view of Irrawaddy dolphin's skull

Fig. 31 Lateral view of Irrawaddy dolphin's skull

Fig. 32 Posterior view of Irrawaddy dolphin's skull

Postcranial skeleton

In MSCU002 the first two cervical vertebrae are fused. In EN062 the atlas and axis were lost and the four cervicals are free. The important point feature is the acromion on scapula. The shape of acromion is thin and slender.

Table 22 Percentage of skull measurement/CBL between finless porpoise and Irrawaddy dolphin

Measurement characters	N. phocaenoides			O. brevirostris		
	mean	range	n	mean	range	n
LR	33.43	29.23-36.34	6	40.71	39.34-42.08	2
WRB	34.21	31.41-36.91	6	39.62	38.86-40.37	2
WRH	23.40	13.89-27.55	6	23.99	21.14-26.84	2
PRO	65.62	59.90-68.04	6	73.26	71.14-75.31	2
LPF	26.58	22.22-29.90	6	29.96	28.94-30.97	2
WPF	16.04	13.62-19.48	6	15.57	14.85-16.28	2
LUTR	31.35	30.29-33.14	5	35.64	35.64	1
LLTR	32.05	30.17-35.67	5	33.27	31.38-35.15	2
LRA	72.49	70.85-73.47	5	82.85	81.88-83.82	2
HRA	21.17	20.45-22.28	5	26.95	26.68-27.21	2
WEN	14.13	11.88-15.62	6	16.87	16.76-16.98	2
WLN	5.52	4.83-6.86	6	6.79	4.87-8.71	2
WIN	19.33	17.00-22.17	6	18.81	18.16-19.46	2
PRO	55.48	50.24-60.41	6	62.71	61.07-64.34	2
LO	21.62	20.36-23.71	6	19.81	19.40-20.22	2
PRW	58.33	53.86-62.63	6	53.12	50.54-55.70	2

Abbreviation : LR, length of rostrum ; WRB, width of rostrum at base ; WRH, width of rostrum at midlength ; PRO, preorbital width ; LPF, length of post temporal fossa ; WPF, width of post temporal fossa ; LUTR, length of upper left toothrow ; LLTR, length of lower left toothrow ; LRA, length of left mandible ; HRA, height of left manible ; WEN, width of external nares ; WLN, width of left nasal ; WIN, width of internal nares; PRO, preorbital width ; LO, length of left orbit ; PRW, preorbital width

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

Only one already half-decayed specimen was dissected. Most of its internal characteristics could not be studied. This sample and two taxidermic specimens were examined for external morphological informations. The largest, BIMST005 is 224.5 cm long. One new and two old skeletons were also examined for osteological study.

4.3.1. External morphology

Most humpback dolphin share the pale greyish pink background with various grey spots or patches. Some with wider grey patches while some with very few grey spots.

The beak length is 8.97% of body length. This is longer than that of bottlenose dolphin but shorter than that of spinner dolphin. Indo-Pacific humpback has the smallest proportion of flipper among all species found in the study area. The length of anterior part of flipper (measurement no. 28) is 14.47% of body length and 10.88% in posterior part. A small dorsal fin has wide base and the prominent crease between dorsal fin and back is hardly distinct or absent. Dorsal fin appears to run smoothly on the back of the animal. However it can not be concluded that this dolphin has no hump or ridge on the back at all. When surfacing dolphin archs its back to begin diving, the hump or ridge on the back will be present with a small dorsal fin on top.

The range of upper/lower tooth counts are 33-39/34-38 on each side with the mode of 36/35 (n=5).

Table 23 Percentage of morphometric measurement/total length in *S. chinensis*

Measurement nos.	Mean	Range	n
Snout to melon	8.97	8.46-9.33	2
Snout to the angle of mouth	13.70	12.44-15.75	2
Snout to blowhole	16.62	14.92-18.51	2
Snout to eye	16.57	14.70-19.89	2
Snout to pos. base of dorsal fin	63.73	60.13-67.96	2
Snout to ant. base of dorsal fin	43.87	41.65-48.89	2
Basal length of dorsal fin	18.68	17.37-20.44	2
Height of dorsal fin	7.87	4.01-5.80	2
Snout to ant. base of flipper	25.74	24.00-28.73	2
Ant. edge of flipper to flipper tip	14.47	13.80-15.11	2
Post. edge of flipper to flipper tip	10.88	10.39-11.56	2
Greatest breadth of the left flipper	5.20	4.89-5.80	2
Breadth of the fluke	25.65	24.50-26.80	2
Fluke notch across to fluke latteral base	7.10	6.46-7.73	2

4.3.2. Internal anatomy

4.3.2.1. Skeleton

Cranium

The CBL of three skulls examined are 54 cm, 51 cm and 57.75 cm. *S. chinensis* has long and very narrow rostrum. Length of rostrum is 58.88% of CBL (n=3). Width of rostrum at base is 20.64% of CBL but it is only 7.28% at midlength.

Postcranial skeleton

The vertebral formula examined of this species is C7,Th12,L11,Ca21. The first two cervicals are fused. A 225 cm female (MSCU004) is physically immature because of her free epiphysis. Twelve vertebral ribs composed of five two-headed ribs and other seven single-headed ribs. Seven sternal ribs are present. There is no floating rib on both sides.

Fig. 33 Dorsal view of Indo-Pacific humpback dolphin's skull

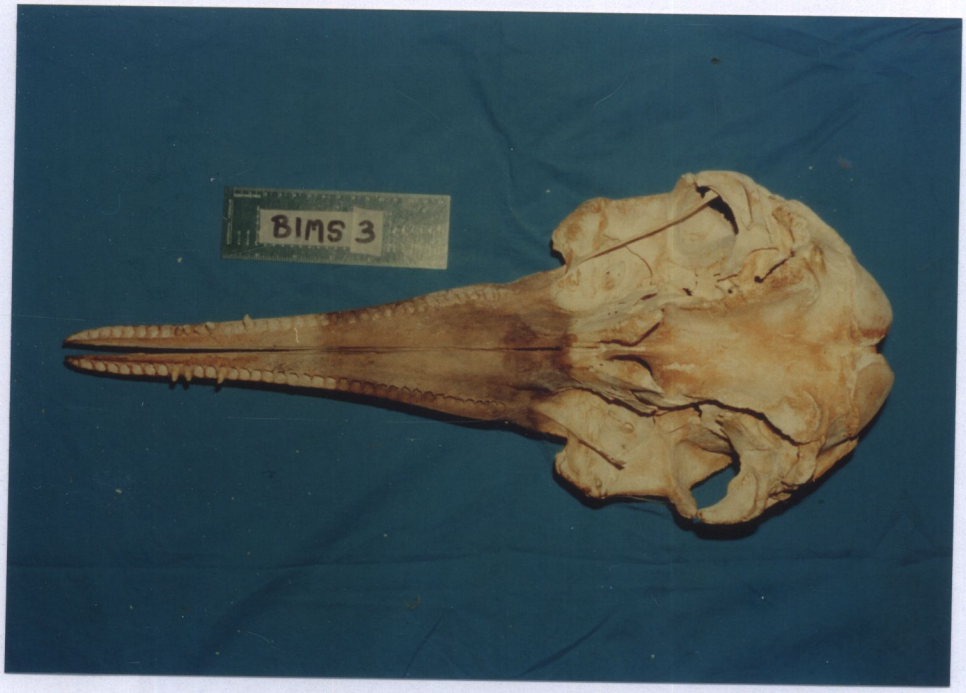

Fig. 34 Ventral view of Indo Pacific humpback dolphin's skull

Fig. 35 Lateral view of Indo-Pacific humpback dolphin's skull

Fig. 36 Posterior view of Indo-Pacific humpback dolphin's skull

4.4. *Tursiops truncatus*, bottlenose dolphin

4.4.1. External morphology

All external characters were studied from old taxidermic specimens. The body color therefore could not be described. This species, however, is one of the most typical dolphin whose body color was said to be bluish grey to dark grey. Furthermore, one bycatch male bottlenose dolphin from Rayong landed at Samut Prakarn fish landing but only part of the animal could be collected. Its available skin shows bluish grey color on side and pale pink belly. A prominently large beak is well defined but rather short about 7% of the body length. A fulcate dorsal fin is tall and sits on midback. The biggest sample examined is 190 cm in total length. A dorsal fin is erectly falcated.

Tooth count on upper/lower jaws ranged from 22-26/21-25 on each side with the mode of 24/23 (n=16).

Table 24 Percentage of morphometric measurement/total length in bottlenose dolphin.

Measurement characters	Mean	Range	n
Snout to melon	7.00	5.06-7.74	6
Snout to the angle of mouth	13.82	12.11-11.84	6
Snout to blowhole	17.55	15.79-19.06	6
Snout to eye	17.22	16.05-18.18	6
Snout to pos. base of dorsal fin	58.82	57.83-61.50	6
Snout to ant. base of dorsal fin	46.07	43.95-48.09	6
Basal length of dorsal fin	16.07	14.13-19.03	6
Height of dorsal fin	10.62	8.29-11.41	6
Snout to ant. base of flipper	25.77	23.67-29.03	6
Ant. edge of flipper to flipper tip	15.81	13.23-17.65	6
Post. edge of flipper to flipper tip	11.38	8.71-12.77	6
Greatest breadth of the left flipper	6.64	5.44-7.33	6
Breadth of the fluke	24.49	22.01-28.42	6
Fluke notch across to fluke latteral base	7.27	6.45-8.21	6

4.4.2. Internal anatomy

4.4.2.1. Skeleton

The 6 skulls have the CBL of 40.80, 47, 45.50, 44.50, 49 and 45 cm. Length of rostrum is only 37% of CBL. The first two cervicals are fused (n=6). An acromion is paddle shape.

Fig. 37 Dorsal view of bottlenose dolphin's skull

Fig. 38 Ventral view of bottlenose dolphin's skull

Fig. 39 Side view of bottlenose dolphin's skull

Fig. 40 Posterior view of bottlenose dolphin's skull

4.5. *Stenella longirostris*, spinner dolphin

New specimen of these species could not be obtained. The body color can not be described from the taxidermy. Only two skeletons were available for this study. This species seemed to have problem in maintaining population in the study area. All of the specimens are very old and undated.

4.5.1. External morphology

In this region, spinner dolphin is the smallest dolphin with the total length ranged from 88-129.5 cm (n=7).

External morphological characteristics gather from seven taxidermies show that their dorsal fin is erectly falcate. Hight of dorsal fin is as tall as bottlenose dolphin or 10.33% of total length (n=5). Prominent beak is moderately streamlined and much longer than others, 10.83% of body length.

Teeth are very tiny, sharp and pointed. The range of teeth on upper/lower jaws are 37-46/36-45 on each side with the mode of 41/41 (n=9).

Table 30 Percentage of morphometric measurement/total length in *S. longirostris*

Measurement characters	Mean	Range	n
Snout to melon	10.83	8.33-12.50	5
Snout to the angle of mouth	18.28	15.83-20.00	5
Snout to blowhole	21.66	18.53-24.00	5
Snout to eye	21.53	19.31-23.26	5
Snout to pos. base of dorsal fin	60.36	59.46-61.00	5
Snout to ant. base of dorsal fin	45.48	44.40-46.50	5
Basal length of dorsal fin	17.04	14.92-19.53	3
Height of dorsal fin	10.33	7.50-13.51	5
Snout to ant. base of flipper	28.00	24.17-31.05	5
Ant. edge of flipper to flipper tip	15.96	14.67-17.02	5
Post. edge of flipper to flipper tip	11.71	11.20-12.10	5
Greatest breadth of the left flipper	6.26	5.41-7.00	5
Breadth of the fluke	24.51	22.58-26.67	5
Fluke notch across to fluke latteral base	6.65	5.80-7.50	5

4.5.2. Internal anatomy

4.5.2.1. Skeleton

Cranium

Only two old skeletons could be obtained for this study. The CBL are 35 and 33.5 cm.. The skull of this species is rather small but rostrum are extremely long. Length of rostrum is 63.22% of CBL. The first two cervical vertebrae are fused.

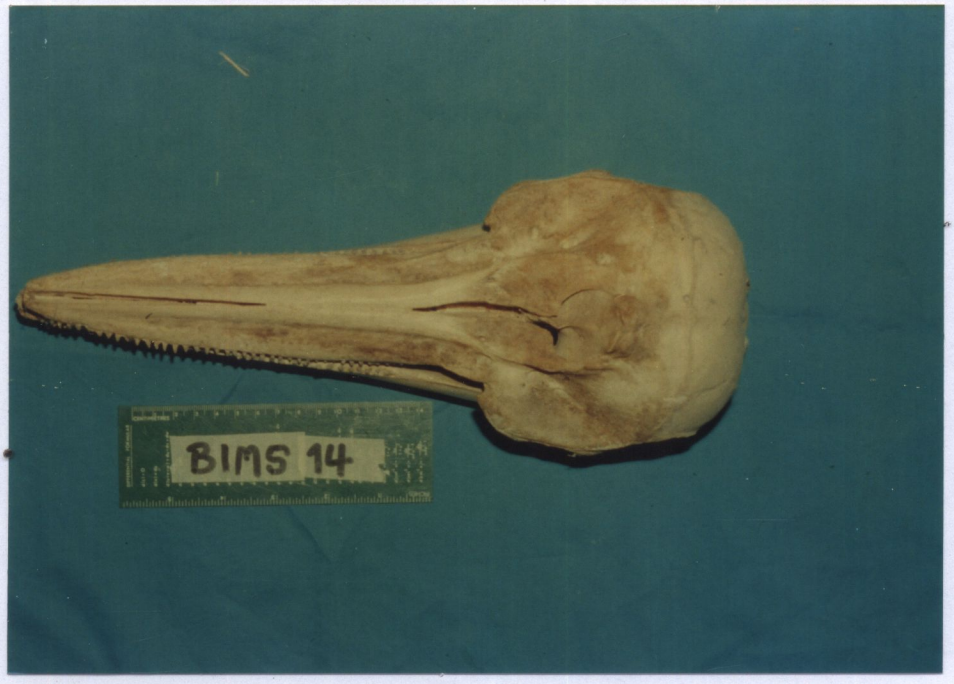

Fig. 41 Dorsal view of spinner dolphin's skull

Fig. 42 Ventral view of spinner dolphin's skull

Fig. 43 Lateral view of spinner dolphin's skull

Fig. 44 Posterior view of spinner dolphin's skull

Table 26 Comparision on percentage of skull measurement/CBL between *S. chinensis*, *T. truncatus* and *S. longirostris*

meas.	*S. chinensis*			*T. truncatus*			*S. longirostris*		
char.	mean	range	n	mean	range	n	mean	range	n
LR	58.88	57.06-60.56	3	57.00	54.26-58.82	6	63.22	62.86-63.58	2
WRB	20.64	20.14-21.04	3	22.27	21.43-22.95	5	19.14	18.40-19.88	2
WRH	7.28	5.15-8.80	3	14.51	12.25-20.45	6	11.94	10.27-13.58	2
PRO	39.25	37.75-40.74	2	45.05	42.86-48.57	5	38.07	36.97-39.16	2
LPF	20.02	19.12-20.65	3	19.55	16.89-20.90	6	13.44	13.14-13.73	2
WPF	15.91	15.20-16.29	3	12.33	12.70-17.14	6	11.34	11.13-11.54	2
LUTR	53.53	52.64-54.63	3	48.39	47.66-49.51	3	53.73	53.43-54.03	2
LLTR	52.80	50.21-54.26	3	47.65	45.74-48.67	3	52.55	52.24-52.86	2
LRA	81.89	48.79-83.73	3	83.03	79.79-85.29	3	82.39	80.00-84.78	2
HRA	16.07	15.36-16.86	3	16.86	16.60-17.07	3	13.24	13.14-13.34	2
WEN	9.86	9.06-10.27	3	12.01	10.70-14.94	6	9.40	9.34-9.46	2
WLN	3.95	3.64-4.25	2	5.56	4.40-6.25	4	4.31	3.55-5.06	2
WIN	10.56	9.26-11.75	3	12.89	11.03-16.36	4	9.90	9.77-10.03	2
PRO	34.67	33.59-35.47	2	40.93	38.97-44.40	5	34.63	33.74-35.52	2
LO	10.50	10.22-11.02	3	14.06	12.87-16.74	5	11.56	11.17-11.94	2
PRW	23.22	19.57-26.87	3	32.66	27.74-36.89	5	33.28	33.25-33.31	2

Abbreviation : LR, length of rostrum ; WRB, width of rostrum at base ; WRH, width of rostrum at midlength ; PRO, preorbital width ; LPF, length of post temporal fossa ; WPF, width of post temporal fossa ; LUTR, length of upper left toothrow ; LLTR, length of lower left toothrow ; LRA, length of left mandible ; HRA, height of left mandible ; WEN, width of external nares ; WLN, width of left nasal ; WIN, width of internal nares; PRO, preorbital width ; LO, length of left orbit ; PRW, preorbital width

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).

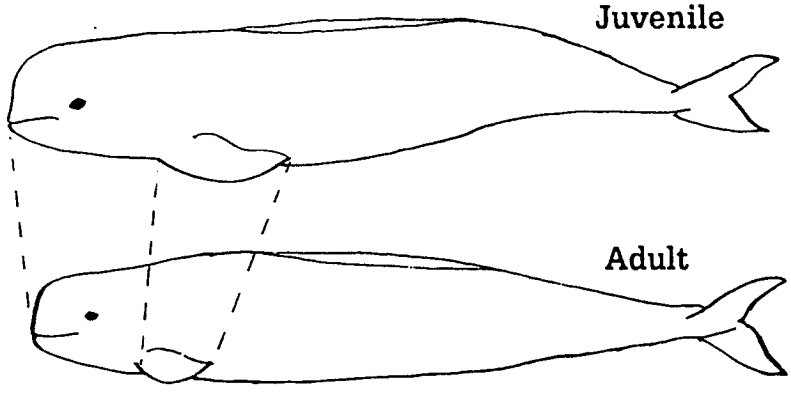

Fig. 45 External proportion of adult and juvenile finless porpoise

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)

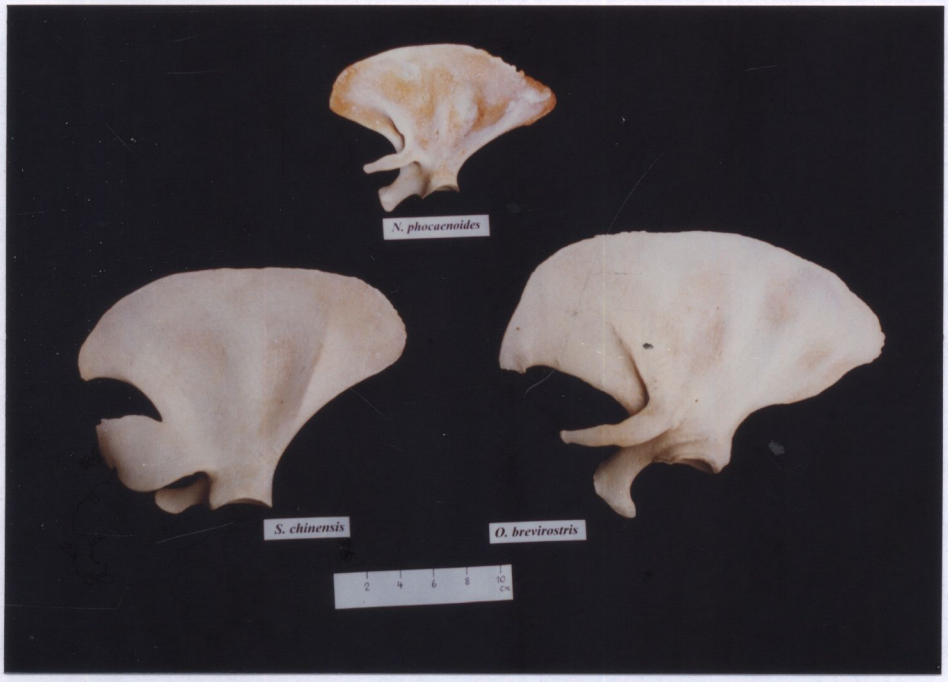

Fig. 46 Scapula of finless porpoise, Irrawaddy and Indo-Pacific humpback dolphin

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

Chapter 5

Conclusions and Recommendations

Conclusions

1. One species of porpoise *Neophocaena phocaenoides* (finless porpoise) and three species of dolphins *Orcaella brevirostris* (Irrawaddy dolphin), *Sousa chinensis* (Indo-Pacific humpback dolphin) and *Tursiops truncatus* (bottlenose dolphin) were found in the Inner Gulf of Thailand. Although there was no new specimens of *T. truncatus* available for studied but this species was very commonly seen by most people in the study area. *S. longirostris* seemed to have very small population if still remaining in the Inner Gulf of Thailand because very few people reported in sighting.

2. *N. phocaenoides* distributed somewhat off the coast, not too much in the northern area and prefered the depth of about 10-15 m.. It was found along the coast except for Pattaya and lower part of the east coast. Many records on the east coast come from Ang-sila, Kao Sammhuk and Vornapa. On the wast coast most carcasses were taken from Had Chao and Cha-am. Finless porpoise is not widely distributed but highest records of entanglement occured in this species.

3. *O. brevirostris* inhabited close to the shore in the shallow water of about 1.5 m depth particularly at the northern end around the river mouths. Not so many people reported seeing this species on the lower part of the west coast and it was absent from Pattaya and the lower part of the east coast. Most local people reported to be friendly with Irrawaddy dolphin.

4. S. *chinensis* was encountered by many people along the coast. It was commonly found almost in all estuaries although it could infrequently be seen offshore to about 20 m depth. Most fishermen believed that this dolphin was the animal of the angle and they did not harm this dolphin although it was sometimes shot when it robbed some caught fish from the net.

5. *T. truncatus* was reported to be often seen offshore, particularly around the islands but it could somtimes be seen approached the coast as well. There are rich populations around the lower part of the east coast. This species was not reported to be entangled in the study area.

6. Only Chao Phraya and Bang Pakong River were found to be deeply intruded by dolphins. In Chao Phraya, intrusion of *O. brevirostris* were recorded about 30 years ago to be up to at Ko Kret, 85 km from estuary and in Bang Pakong they were commonly seen up to 60 km from the river mouth. *T. truncatus* were surprisingly found to be up to only about 30 km from the Chao Phraya river mouth. *S. chinensis* has still been reported to go into every rivers but to only few km.

7. The commonly entangled species is *N. phocaenoides,* finless porpoise. The skull of physically mature male, MSCU001, in this study has smallest CBL than those of Indian ocean, Yangtze river and Japan. August is in the lactation period of the female of this species but the whole period is still unknown. The trachea of finless porpoise is inside divided into double trachea which never been reported earlier. The frequent reports of incidental catches of this species is causing worry for maintaining its population.

8. Proposed to separate O. fluminalis from O. brevirostris could not be accepted because the differences refered to are not important enough. The thin

acromion of Irrawaddy's scapula can be used to recognize this species from other dolphin which have large acromion.

9. The hump on the back of Indo-Pacific humpback dolphin could be clearly observed when it arched its back to begin diving. Furthermore the morphometric of Thai dolphin is similar to those of other *Sousa chinensis*. Hence proposed to split this dolphin from *S. chinensis* by some authors still could not be accepted.

10. The small *T. truncatus* in this study had the same characters as *T. aduncus* refered to by some authors but the differences is still not acceptable because most proportions of *T. aduncus* such as the tooth formula, 24-25/25, is in the range of *T. truncatus*, 18-26 teeth on each tooth row.

11. CBL, no. of teeth and many features of *S. longirostris* in this study were much smaller than those of spinner dolphins from other area. The spinner dolphin in this area should be separated from other *S. longirostris* by the number of teeth of Thai spinner, 37-45/36-45, while much higher number of teeth are recognized in spinner dolphins from other sources. However more new samples should be studied to confirm.

12. The disappearance of dolphin in the Thai rivers can contradicted to the changes in environrental condition. The decreasing of dolphin observed in the sea can also indicate the change of their food availability and environment from past to present. The distribution of four dolphins and a porpoise are somewhat differences although some species do have overlaping distribution. Among all, Irrawaddy dolphin plays a role as top predator in the most shallow waters, finless porpoise, Indo-Pacific humpback dolphin and bottlenose dolphin follow in deeper water respectively.

Recommendations

1. Eventhough few museums can preserve the old specimens of dolphin well but many collections were still found to be in bad condition. No central museum for mammal research as yet to set up in Thailand. Most museum preserve dolphin specimens just for exhibition but there is hardly any museum aimed for research. Collections for reseach and for public exhibition should be separated because sunlight, insect and fungi from exhibition activities might destroy and decrease quality time of preservation. Artificial exhibit specimens can be well used for exhibition instead of the real specimen of which can not be easily collected.

2. Taxidermic specimens has less value to study than skeleton. Therefore it should not be encourage to carry on. At present to keep specimen in taxidermic form had long been abandoned worldwide. This study emphasize the important value of skeletal specimens which could determine sex, age, species and some natural history character in consideration of both cranium and postcranial skeleton which taxidermy cannot.

3. Not enough samples to confidentially confirm the study is the common problem in marine mammal research. The network within the country from various locations in reporting the availability of specimens should effectively been set up. This study lost few specimens several times becuse of the delay in recieving the informations and it was too late to save that specimen either it was thrown away or too much rotten or damage to be abale to examine properly.

4. In the Inner Gulf of Thailand, the interview survey confirmed to be a good study method while the sighting survey is less effective but still needed. The interview survey had been considered not a good technique by some researchers but this study proved to be quite efficient perticularly, in the closed area where the

diversity is not too high, such as the Inner Gulf of Thailand. In the areaof higher diversity such as in the Andaman sea the high number of offshore species of dolphins might cause confusion to the interviewees. Hence, the interview technique would not be effective in that circumstance.

Most coastal species found in the Inner Gulf are not acrobatic and shy to boat or disturbance, the sighting survey by boat would be hard to conduct in the Inner Gulf of Thailand. Particularly, finless porpoise has no dorsal fin and Irrawaddy dolphin has a small dorsal fin which would be difficult to observe in the sea.

5. Every species of dolphins and porpoise in the Inner Gulf of Thailand is now more difficultly to observe than in the past. The study to understand the situation for dolphin conservation should be immediately conducted. Although the study on dolphin and whale is rather difficult but it is possible to conduct. The disappearance of Irrawaddy dolphin in Thai river and the decreasing of dwarf spinner dolphin are the first alarming sign that the research on dolphin and porpoise in Thai waters must be urgently stimulated.

6. Many marine mammalogists try to designate the new species to those found in the Inner Gulf of Thailand. Due to the small sample size they had no conclusions should yet to be drawn for new species regarding geographical differences. This study still can not reveal the whole life history of finless porpoise and other four dolphin species, the taxonomic status of Thai humpback and spinner dolphin, but this work is presenting a series of questions for further study of Thai marine mammals, for examples :

6.1. Should Thai dwarf spinner dolphin be recognized as another species ?

6.2. Should Thai *Sousa sp.* remains as *Sousa chinensis* or should be recognized as new ?

6.3. Is bottlenose dolphin still a resident of the Inner Gulf of Thailand ?

6.4. What is now the status of population of each species of dolphins and porpoise ?

6.5. Is there any dolphin or porpoise species to be consider as threatened species ?

6.6. From this study August is in the lactation period of Thai finless porpoise. How long is the lactation period ? When is the mating and parturition season ? How large are the sexually mature size of male and female finless porpoises and neonate size ? Can the proportion of scapula be used for age determination as suggested in this study?

7. Thailand is still lack of expert in marine mammal. Any encouragement such as research fund, experience accumulation, advance degree support, etc. should urgently be given to young Thai scientists.

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