FIRST RECORD OF DWARF SPERM WHALE *(KOGIA SIMUS)* FROM TAIWAN

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ABSTRACT—A new record of *Kogia simus* is reported for Taiwan. Summary of descriptions and measurements of the skeleton is as follows: body length, 256cm; condylobasal length, 287mm; mandibular symphysis not keeled, 41mm in length; dorsal cranial fossa cupped posteriorly and subsymmetrical; least width of dorsal sagittal septum, 8mm; vertebral formula, 7C + 13T + 10L + 24Ca = 54; dentition formula, 3/10 − 11 = 24; phalangeal formula, I2 + II6 + III5 + IV4 + V2 = 19; pelvic bones absent; and 15 pairs of chevron bones, of which the first pair is separated. Also includes a brief review of information available on this species in the Northwest Pacific.

INTRODUCTION

The Dwarf Sperm Whale *(Kogia simus)* was first described by Owen in 1866. It was extremely difficult, however, to distinguish this species from its close relative *K. breviceps* until Handley (1966) characterized the differences between these two species. Ross (1978) later confirmed Handley's cranial distinction, but pointed out overlaps between the two species in relative height of the foramen magnum and in the position of the dorsal fin relative to body length.

Both species of *Kogia* presumably have the same distribution range throughout the tropical and temperate waters of the Pacific, Atlantic, and Indian oceans (Nishiwaki, 1972). In the western North Pacific, *K. breviceps* has been reported from Japan and Liukyu (Yamada, 1954), China (Wang, 1984) and Taiwan (Horikawa, 1932; Hirasaka, 1937; Yang, 1976), whereas distribution records of *K. simus* include only Japan (Yamada, 1954) and Guam (Kami and Lujan, 1976). Wang (1984) stated that the two *Kogia* species might be confused in China. Both cranial and mandibular characteristics of the specimen in this report clearly agree with those outlined and illustrated by Handley (1966) for *K. simus*; thus, this specimen represents the first positive record of *K. simus* from Taiwan.

This specimen of *Kogia simus* was collected at the beach of Tunghsiao (通霄), Miaoli County (苗栗縣) (approximately 24° 28' 43" N, 120° 39'45" E) (Fig. 1) in June, 1986. According to a conversation with a local fisherman: at midnight on the 15th of June, several youngsters found two stranded whales and a calf. The three whales were freed immediately, but the next morning, one was found dead on the beach.

By the time the specimen was collected, it had suffered severe external damage from lying on the beach for three days. This may have been caused by fish or crabs, or by children who stabbed it for fun. From the position of the genital slit the specimen was judged to be female. External measurements taken at the site are indicated in Table 1. The carcass was brought back to the lab and macerated in tapwater for a week to obtain the skeleton, which is numbered NMNS 955 and is preserved in the National Museum of Natural Science, Taichung, Taiwan, ROC.

OSTEOLOGY

No evident difference is found between the present skull and the detailed description of Nagorsen (1985). The most notable features of the skull (Plate I) are the short broad rostrum dominated by maxillary bones, marked asymmetry, posteriorly cupped dorsal cranial fossa, and narrow dorsal sagittal septum (least width 8mm). Measurements of skull and mandible (Table 2) are taken according to Ross' (1978) method.

The tympano-periotic bones (Plate IV,2) of this specimen are not fused to the wall of the cranial cavity. Generally. these bones vary considerably

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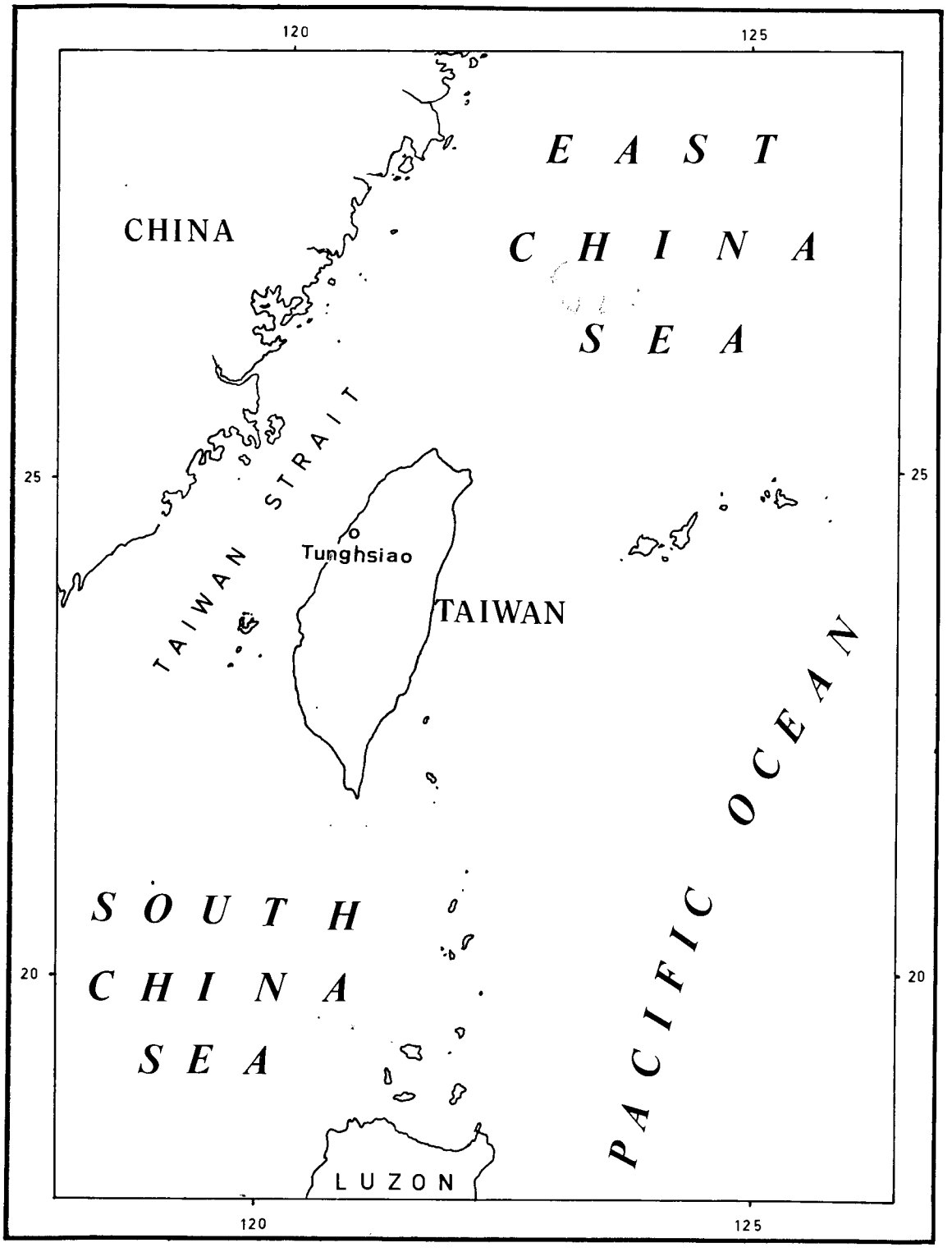


Fig. 1. Stranding locality of *Kogia simus* found dead June 16, 1986. Tunghsiao, Miaoli County, Taiwan (24° 28' 43" N, 120° 39' 45"E).

in their attachment to the cranium (Nishiwaki, 1972).

The mandibles are thin, smooth, and slightly semi-translucent. The short symphysis between them is not ventrally keeled (Plate I,6), which is one of the features distinguishing *K. simus* from *K. breviceps* (Handley, 1966). The alveolar region of the mandible is double-layered and the dental sulcus is positioned laterally on mandible between the inner and outer layers (Plate I,7 and 8). Teeth sockets are bottomed with cancellous bone. A total of 23 alveoli, 12 left and 11 right, are found and the posteriormost one on both sides is partly formed. There are twenty-four teeth and three of which are vestigial (Plate IV,4). Nishiwaki (1972) states that there are usually three vestigial teeth in the upper jaw. Handley (1966) concurs with this, but also notes that maxillary teeth may not be present. Mandibular teeth are long, slender, lack enamel, and vary in their curvature. Of these, one is deformed and two are dramatically small. The length and max. diameter of the largest tooth are 19mm and 2.8mm respectively and its pulp cavity closure is 87%. The dentition formula, 3/10-11 = 24, differs from other formulae which are reported as 1/8 − 9 = 18, 0 − 1/9 − 9 = 20 (Yamada, 1954) and 1-1/9 − 9 = 20 (Owen, 1866).

Vertebral formula of this specimen, 7C + 13T + 34L − Ca = 54, indicates little difference from other individuals reported: 7C + 14T + 29L − Ca = 50 (Owen, 1866); 7C + 13T + 36L − Ca = 56 (Nishiwaki, 1972); 7C + 14T + 36L − Ca = 57 (Hale, 1962) and 7C + 12T + 11L + 24Ca = 54 (Yamada, 1954). Variation of vertebral formula is also found in other cetaceans, e.g. *Balaena mysticetus* (Nishiwaki and Kasuya, 1970), *Lagenodelphis hosei* (Tobayama et al., 1973), *Balaenoptera edeni* and *B. borealis* (Omura et al., 1981). Omura et al.(1981) propose a method to distinguish the last lumbar vertebra from the first caudal: the articulating facet of the last lumbar to the chevron bone is absent at the ventro-posterior end. Accordingly, an alternative vertebral formula for this specimen is 7C + 13T + 10L + 24Ca = 54 (Plate II, 1-3 and 5-7). Measurements of vertebrae are indicated in Table 3.

The seven cervical vertebrae, as stated by Nishiwaki (1972), are fused together into a unit resembling three fused bones. Careful examination reveals that the second intervertebral foramen is much bigger which represents a fusion of the five succeeding foramina.

There are thirteen thoracic vertebrae. The spinous process of the first thoracic vertebra is not

	cm	%
1. Total length	256	100.0
2. Tip of snout to centre of eye	30	11.7
3. Tip of snout to ext. auditory meatus	36.5	14.2
4. Centre of eye to ext. auditory meatus	6.5	2.5
5. Tip of snout to blowhole	29	11.3
6. Tip of snout to ant. insertion of flipper	61	23.8
7. Tip of snout to tip of dorsal fin	153	59.7
8. Tip of snout to midpoint of genital slit	183	71.5
9. Tip of snout to anus	188	73.4
10. Projection of snout beyond lower jaw	11	4.2
11. Girth on transverse plane at axilla	14	54.6
12. Girth on transverse plane at anus	5	37.1
13. Flipper length: ant. insertion to tip	36	14.1
14. Flipper length: axilla to tip	25	9.7
15. Maximum width of flipper	14	5.4
16. Height of dorsal fin	16	6.3
17. Length of dorsal fin	34	13.3
18. Width of flukes: tip to tip	60	23.4
19. Anterior border of flukes to notch	21	8.2

Table 1 External measurements of *K. simus* and percentage of the total length.

well formed because its two halves are not fused together (Plate II,1 and 8). Only the seven anterior thoracic vertebrae have caudal costal demifacets articulating to the capitulum of the ribs. Cranial costal demifacets are not evident. Prezygapophyses on the seven anterior thoracic vertebrae are difficult to determine and are considered a part of the diapophyses, or transverse processes. The prezygapohysis and transverse process are slightly separated at T8 where the transverse process is slightly above the centrum. At T9 they are distinctly separated and the transverse process descends to the top of the centrum.

Transverse processes on T1 to T12 are rod-like or thickened plates with well marked articulating facets at their distal ends. T13 has relatively small facets at distal ends of thin and broad transverse processes.

The ten lumbar vertebrae (Plate II,2) are distinguished from thoracic vertebrae by their lack of articulating facets to the ribs at the transverse processes, and from caudal vertebrae by their lack of ventral facets articulating to the chevron bones. Lumbar vertebrae are marked with a keel-like hypapophysis under the centrum which is not evident among thoracic and caudal vertebrae.

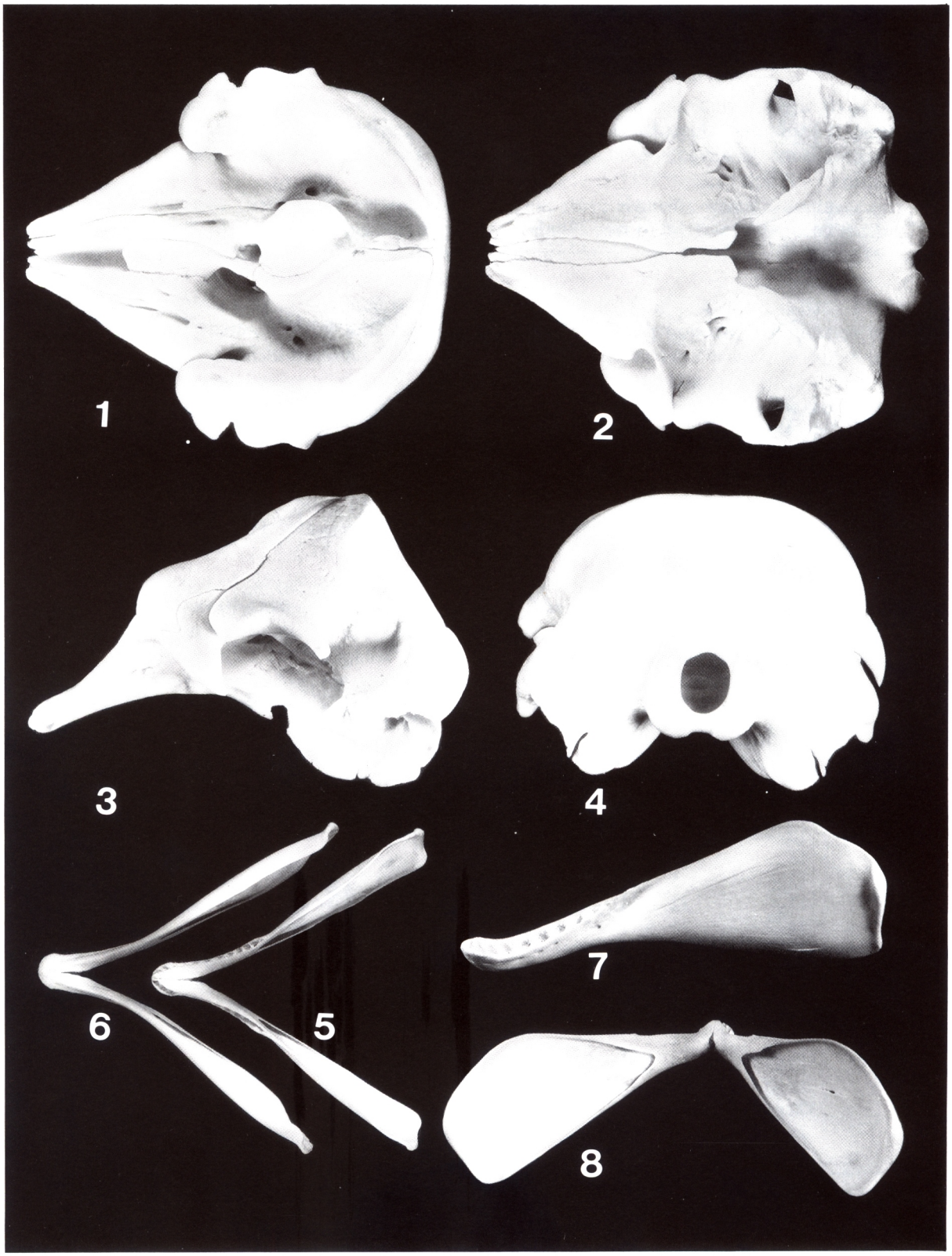
	mm	%
1. Total (condylobasal) length.	287	100.0
2. Rostrum length.	127	44.3
3. Rostrum, basal width.	133	46.3
4. Rostrum, width at its middle.	100	34.8
5. Width across pre-orbital angles of supra-orbital process.	246	85.7
6. Width across post-orbital process.	256	89.2
7. Zygomatic width.	245	85.4
8. Height to vertex.	195	67.9
9. Width of vertex.	16	5.6
10. Width of supra-occipital at narrowest part between posterior margins of temporal fossae.	183	63.8
11. Tip of rostrum-left naris.	128	44.6
12. Height of ventral border of foramen magnum.	25	8.7
13. Length of right maxillary toothgroove.	62	21.6
14. Length of left maxillary toothgroove.	51	17.8
15. Width of outer margins of occipital condyles.	76	26.4
16. Tip of rostrum-hind margin pterygoids.	162	56.4
17. Length of mandible.	248	86.4
18. Number of alveoli-left.	12	-
19. Number of alveodi-right.	11	-
20. Height of mandible at coronoid.	79	27.5
21. Length of madibular symphysis.	41	14.3
22. Length of lower toothrow-left.	108	37.6
23. Length of lower toothrow-right.	109	38.0
24. Height of foramen magnum dorsal border to vertex.	131	45.6
25. Length of anterior margin mesorostral ossification to anterior border of left naris.	122	42.5

Table 2 Measurements of skull and mandible of *K. simus* and their percentage of the total length.

→

PLATE I Skull and mandible of *Kogia simus*. 1) Dorsal view of skull; 2) Ventral view of skull; 3) Lateral view of skull; 4) Posterior view of skull; 5) Dorsal view of mandible; 6) Ventral view of mandible; 7) Lateral view of mandible; 8) Posterior view of mandible.

PLATE I



Vertebra	No.	A	B	C	D	E	F	G
C	1-7	44	34	40	109	115	32	40
T	1	27	28	39	87	92	-	35
	2	31	30	39	115	94	35	31
	3	33	27	39	121	90	37	31
	4	36	28	39	133	83	37	28
	5	37	27	37	133	81	37	27
	6	38	27	39	133	79	37	27
	7	40	29	38	141	78	35	26
	8	43	29	38	143	96	33	25
	9	45	30	40	146	101	32	24
	10	47	32	39	152	117	31	23
	11	48	32	40	156	137	32	23
	12	48	33	42	160	154	29	23
	13	50	34	46	165	170	31	32
L	1	46	37	44	170	184	29	22
	2	52	37	46	174	180	28	21
	3	52	40	49	178	181	30	20
	4	54	41	48	176	182	20	19
	5	54	42	49	176	179	24	19
	6	55	44	48	167	178	29	16
	7	55	46	50	169	174	24	15
	8	55	45	51	162	171	22	13
	9	50	46	50	151	171	19	9
	10	53	46	50	142	169	16	11
Ca	1	52	45	50	126	163	14	9
	2	51	47	52	112	148	14	9
	3	49	45	49	102	138	13	8
	4	47	44	49	96	122	12	8
	5	46	45	50	93	104	11	8
	6	44	43	47	88	98	11	8
	7	42	43	50	83	86	10	8
	8	40	43	49	78	70	10	8
	9	39	40	50	73	54	7	7
	10	38	42	42	67	51	6	6
	11	37	40	42	60	45	5	6
	12	35	38	40	54	41	3	6
	13	32	36	37	51	40	3	5
	14	27	32	34	44	37	-	-
	15	22	29	30	37	38	-	-
	16	18	23	27	31	38	-	-
	17	16	22	26	27	34	-	-
	18	15	19	23	24	32	-	-
	19	14	16	20	21	30	-	-
	20	13	15	19	18	26	-	-
	21	11	13	17	15	23	-	-
	22	10	12	14	12	19	-	-
	23	10	8	12	11	18	-	-
	24	9	6	10	8	15	-	-

Table 3 Measurements of vertebrae (mm) of *K. simus*. A: Length of body at ventro-laterally below the transverse process. B: Height of body at front end. C: Width of body at anterior end. D: Total height from ventral anterior. E: Bilateral width of transverse process. F: Greatest height of neural canal. G: Greatest width of neural canal.

Prezygapophyses of lumbar vertebrae are, in general, thin and flat. They gain in thickness from the first caudal, becoming rod-like at third caudal. Two elements of prezygapophyses meet at fourth caudal uniting to form the anterior head of spinal process at fifth caudal. Spinal process disappears at fifteenth and succeeding caudals, allowing the neural arches to separate, making the neural canals incomplete.

Hypapophysis of the first caudal vertebra is dramatically short compared to the last lumbar, and its posterior end has double facets that articulate with chevron bones. This specimen has fourteen complete chevrons and a pair of ununited bones. In most species of whales, cranial and caudal chevrons are not united (Nishiwaki and Kasuya, 1970). As this specimen has only one pair of ununited laminae, they are thought to be the first chevron due to their size (Plate II,4). Hale (1962), however, in a *K. simus* misidentified as *K. breviceps* (Nagorsen, 1985), noted that the members of the last chevron were not united. *K. simus* has a range of 14 to 18 chevron bones (Nagorsen, 1985). Measurements of chevrons are indicated in Table 4.

Of the thirteen pairs of ribs (Plate III,1, Table 5), the last pair is extremely small and rudimentary, and is always considered as floating. They are not identical in appearance as the left is slightly longer and thicker than the right. The profile of the first pair of ribs is flat, broad, and angular. Its tuberculum is pointed and the capitulum is represented by a long and narrow articulating facet. The second through eighth ribs are clearly bicipital. Although the ninth rib is bicipital in appearance it is considered to have only a single articulation as the eighth thoracic lacks posterior parapophysical facet. The other ribs are obviously monocipital.

Nagorsen (1985) stated that the sternum usually has three elements which are attached by cartilaginous part to the four anteriormost ribs. The sternum of this specimen also has three elements, each of which resembles two fused bones (Plate III,2, Table 6). The manubrium is flat, "Y"-shaped, and bends slightly upward. Its thickness increases from 3mm at the base of anterior notch to 18mm and 17mm, the right and left antero-external angles, to 14mm at the posterior end. The second sternebra is somewhat rectangular and its posterior part is bent slightly downward, where the depth increases and edges are sharper. The third sternebra, the shortest of the sternal elements, is definitely two united bones. Like the posterior part of second sternebra, the third is also bent downward with sharp edges.

The basihyoid of the hyoid apparatus (Plate III,3, Table 7) is a flat, more or less hexagonal bone, with a "U"-shaped median notch. The thyrohyoids are oval and basically flat. Stylohyals are cylin-

	Height	Antero-posterior width at distal end	Transverse length
1.	L 30	L 34	- -
	R 29	R 33	- -
2.	47	30	28
3.	61	34	28
4.	56	36	29
5.	50	35	30
6.	45	29	29
7.	41	27	28
8.	39	26	28
9.	36	26	26
10.	33	26	25
11.	26	25	23
12.	22	23	22
13.	17	21	20
14.	12	15	17
15.	8	10	13

Table 4 Measurements of chevron bones (mm) of *K. simus*.

drical or rod-like.

No pelvic bones are found in this specimen, concurring with Nagorsen's findings that the pelvic bones of *K. simus* are either absent or unossified (1985).

The scapula (Plate IV,3) is a flat, slightly concave, axe-shaped bone with two flattened acromion and coracoid processes directed anteriorly. The spine is absent. The acromion, more or less subquadrangular in appearance, is much larger than the coracoid process. The glenoid cavity is oval. Measurements of scapulae are indicated in Table 8.

The humerus (Plate IV,1, Table 9) has a large globular head that attaches to the scapula. An elongate tubercle dominates the outer edge of the shaft. The distal end of the humerus is slightly flattened where it joins the ulna and the radius.

The radius is larger than the ulna (Plate IV,1). A small bony process, the olecranon, is present at the proximal end of ulna. The distal ends of these two bones are flattened. Measurements of radius and ulna are indicated in Table 9.

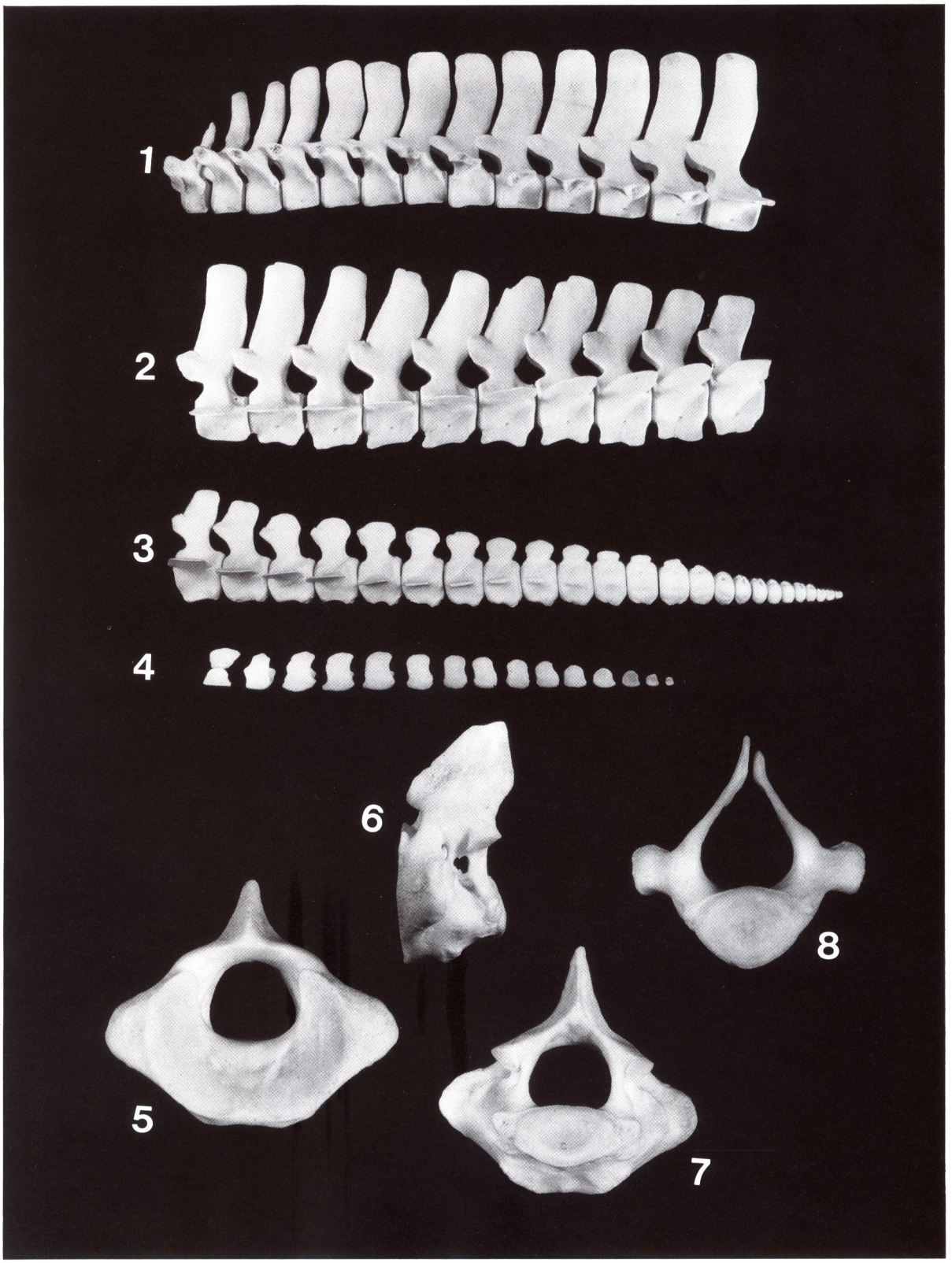
Unfortunately the pectoral limbs were not X-rayed before maceration making reassembly of the carpals, metacarpals, and phalanges difficult. Nevertheless, this specimen has five types of metacarpal bones and ninteen types of phalanges. The only phalangeal formula for *K. simus* is provided by Owen (1866): I2+II5+III4+IV4+V2=17. Using Benhams description of the pectoral limbs of *K. breviceps* (1902), the formula of the present specimen is concluded to be I2+II6+III5+IV4+V2=19. The number of phalanges is variable in *K. breviceps* (Tomlin, 1957), and, *K. simus* as well.

	A		B		C	
No. of ribs	L.	R.	L.	R.	L.	R.
1.	249	257	33	35	2	3
2.	365	375	22	22	16	16
3.	413	417	19	20	21	19
4.	429	435	20	20	21	20
5.	444	447	18	19	18	18
6.	439	444	17	17	16	17
7.	426	443	18	19	19	18
8.	412	427	16	18	20	20
9.	376	377	16	17	5	3
10.	338	347	20	21		
11.	314	320	20	19		
12.	296	304	19	19		
13.	35	23	14	13		

Table 5 Measurements of ribs (mm) of *K. simus*. A: Length along visceral border. B: Width at middle. C: Distance between two heads.

PLATE II Vertebrae and chevron bones of *Kogia simus*. 1) Thoracic vertebrae; 2) Lumbar vertebrae; 3) Caudal vertebrae; 4) Chevron bones; 5) Anterior view of cervical vertebrae; 6) Lateral view of cervical vertebrae; 7) Posterior view of cervical vertebrae; 8) Posterior view of 1st thoracic vertebra.

PLATE II



DISCUSSION

Osteological comparison of this specimen with other skeletons reveals that the skeleton of *K. simus* varies in many aspects such as vertebral formula, teeth, sternum, phalanges, and pelvic bones. Benham (1902), from a fresh skelton of *K. breviceps,* found a remarkable amount of cartilaginous portions between adjacent bones. The degree of ossification of cartilaginous portions may affect the size, shape, and even the number of bones. The variation of these bones may also be due to careless preparation. Yamada (1954) documented the individual variation of *Kogia* in such aspects as occipital condyles, mandibles, sternum, dental formula and vertebrae. At present, as only Handley's cranial criteria for distinguishing the *Kogia* species are widely accepted, classification of *Kogia* based on skeletal features other than cranial still needs further exploration.

Little is known about the herding or schooling behavior of *K. simus.* Ross (1978) indicated that *K. simus* may be found in groups of females with calves. He also noted that immature animals form schools which may contain sexually mature males and females. He estimated that the school size consists of no more than 10 whales. The present Taiwan specimen, as reported by a local fisherman, was stranded with a bigger individual and a calf of about 60kg. The fisherman referred to the three animals as a family and stated that the specimen was the female parent. Although there is no data to support his assumption, the body length of 256cm and the condylobasal length of 287mm demonstrate that the specimen is an adult. It is estimated that most females reach sexual maturity when 2.1m to 2.2m in body length, or 265-275mm in condylobasal length (Ross, 1978).

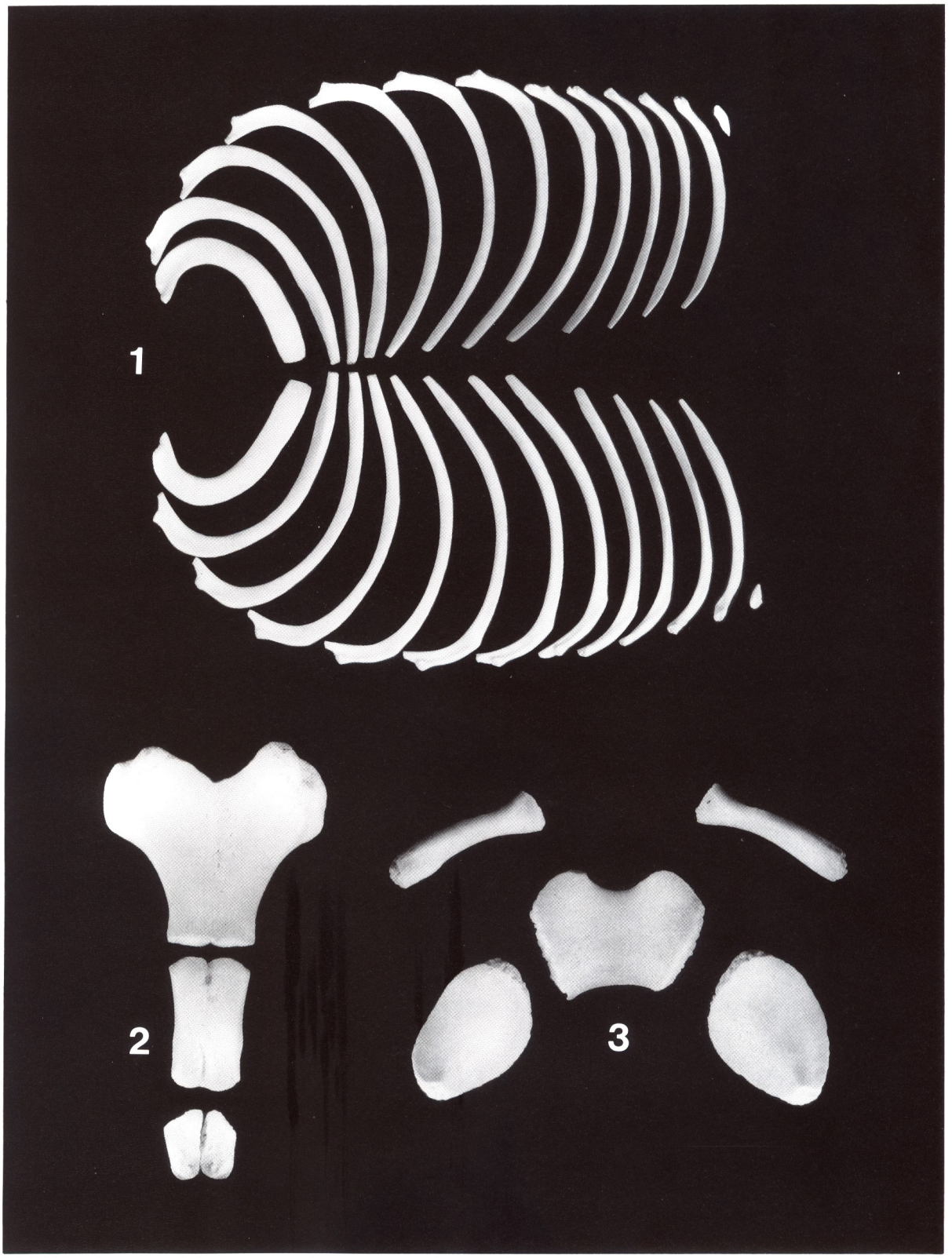
The precise distribution of *Kogia simus* is uncertain because most reports prior to Handley's work

Manubrium		
	Greatest length	104
	Greatest width	118
	Greatest thickness	
	anterior end	3
	right antero-external angle	18
	left antero-external angle	17
	posterior end	14
Second sternebra		
	Greatest length	68
	Greatest width	43
	Greatest thickness at anterior end	14
	Greatest depth at posterior end	18
Third sternebra		
	Greatest length	36
	Greatest width	36
	Greatest depth	19

Table 6 Measurements of sterum (mm) of *K. simus.*

PLATE III Ribs(1), sternum(2), and hyoid bones(3) of *Kogia simus.*

PLATE III



(1966) did not clearly distinguish between *K. breviceps* and *K. simus*. This is further compounded by the fact that there are no reliable criteria for distinguishing the species from sightings at sea. All the *Kogia* found near Taiwan have been documented as *K. breviceps* (Horikawa, 1932; Hirasaka, 1937; Yang, 1976). Lack of detailed description makes it virtually impossible to reclassify these specimens. Reexamination of Yang's (1976) data, however, does prove the occurrence of *K. breviceps* in Taiwan waters.

At present, available data about the seasonal movements of *K. simus* is limited. Yamada (1954) recorded that catches of *Kogia* off Japan are confined to the summer season, presumably due to seasonal migration. The cause for migration is largely unknown, but there is evidence suggesting that it is in response to the seasonal abundance of food (Jones, 1981). Nagorsen (1985) states that the diet of *K. simus* is composed of cephalopods, fish, and crustaceans. From their food preferences, there is some evidence that *K. simus* feeds off the edge of the continental shelf at depths of 250m. Other food species, however, indicate that *K. simus* is a deep water feeder at depths of 500m to 1,300m. The circumstances concerning the presence of this specimen in the Taiwan Strait is unknown. There is no published data supporting the distribution of this species to the South of Taiwan along the coast of the western North Pacific.

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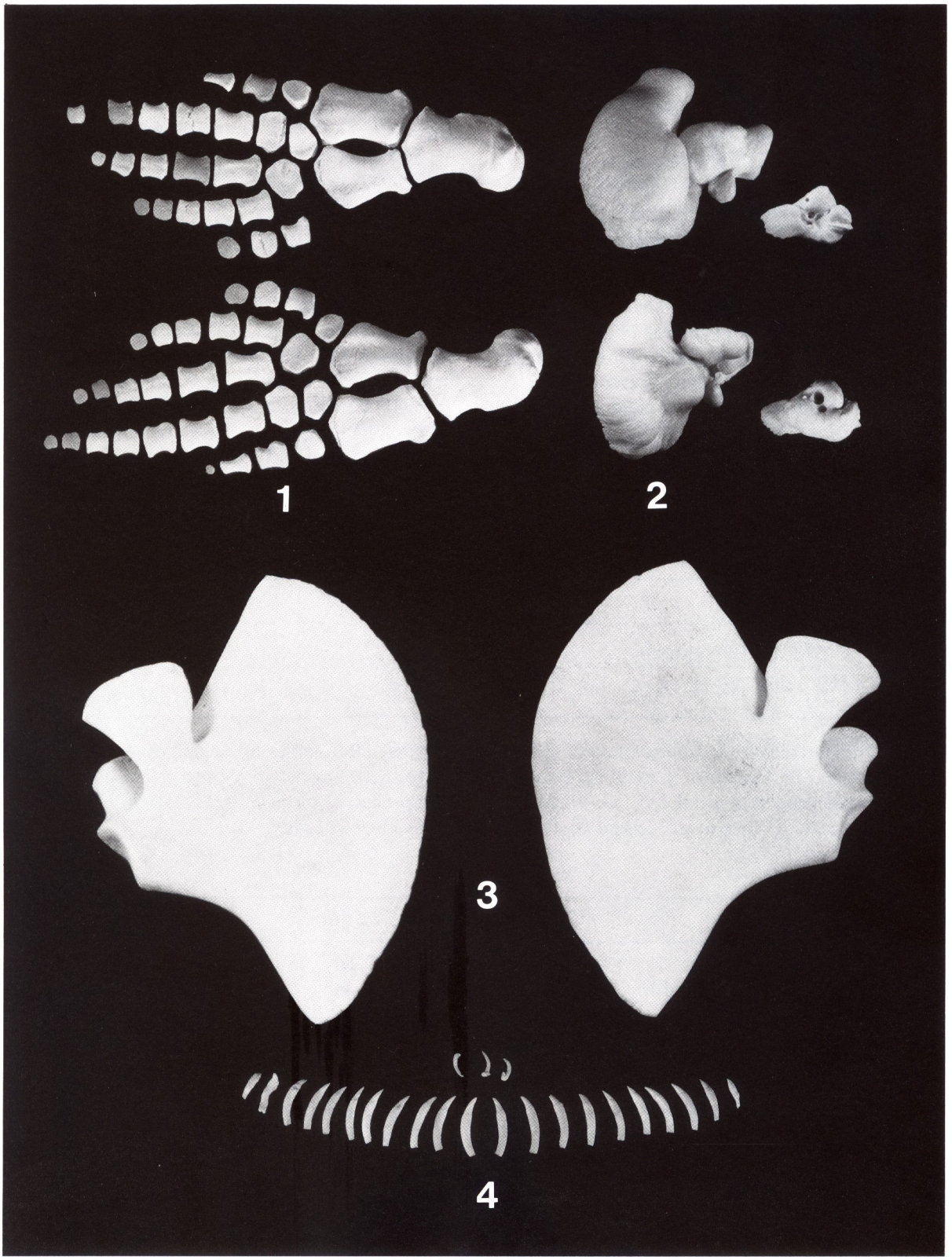
Basihyoid		
Greatest length		59
Greatest width		78
Distance between anterior cornu		30
Thyrohyoids		
Greatest length	R	71
	L	68
Greatest width	R	51
	L	45
Stylohyoids		
Gratest length	R	74
	L	73
Greatest width	R	20
	L	20

Table 7 Measurements of hyoid bones (mm) of *K. simus*.

PLATE IV 1) Pectoral limbs with proposed phalangeal arrangement. Top: left limb (incomplete). Bottom: right limb; 2) Tympano-periotic bones. (Top left: dorsal view of left tympanic bulla, height: 51mm, width: 55mm; top right: ventral view of left periotic bone, height: 18mm, width: 29mm; bottom left: ventral view of right tympanic bulla, height: 51mm, width: 56mm; bottom right: dorsal view of right periotic bone, height: 18mm, width: 29mm; 3) Scapulae; 4) Teeth.

PLATE IV



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	A	B	C	D	E	F	G	H	I	J
Left	211	139	116	139	54	49	26	32	36	24
Right	211	136	120	141	58	48	27	33	36	24

Table 8 Measurements of scapulae (mm) of *K. simus*. A: Length. B: Width. C: Length of glenoid-inferior angle. D: Length of glenoid-superior angle. E: Height of coracoid process. F: Width of coracoid process at distal end. G: Width of acromion process at distal end. H: Height of acromion process. I: Length of glenoid cavity. J: Width of glenoid cavity.

	Left	Right
Humerus, length	80	80
proximal width	44	46
distal width	49	48
Radius, length	67	67
proximal width	38	39
distal width	41	42
Ulna, length	57	56
proximal width	30	32
distal width	42	44

Table 9 Measurements of humerus, radius and ulna (mm) of *K. simus*.

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臺灣新記錄種擬小抹香鯨之研究

周文豪

摘 要

擬小抹香鯨*Kogia simus*是臺灣海生哺乳類的新記錄種，於一九八六年六月擱淺於苗栗縣通霄海濱。本文描述該標本之骨骼並記錄各項測量資料，其數據摘要如下：體長256公分；頭骨基底長287㎜；下頜髁短，無龍骨狀突起，長41㎜；顱骨頂部呈凹狀且不對稱；顱中隔最小寬度8㎜，脊椎骨式 7C+13T+10L+24Ca=54；齒式 3/10−11=24；指式 I 2+II 6+III 5+IV 4+V 2=19；腰帶骨缺如；15對V型骨，其中第一對分離，本鯨骨與其他報告比較顯示擬小抹香鯨的骨骼變異甚鉅。