MORPHOLOGICAL STUDY ON THE HYBRID BETWEEN *TURSIOPS* AND *PSEUDORCA*

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ABSTRACT

A hybrid calf born in Kamogawa Sea World, Chiba, on May 3, 1981 was supposedly between mother *Tursiops truncatus gilli* and a male *Pseudorca crassidens*. It lived 277 days. In the past record of Kamogawa Sea World, there were three abortively born fetuses of hybrid in different degree of growth. External observation and comparison of osteological examinations on the calf, the fetuses and parents species cleared that the calf was an offspring of the above two species. Situation of the pool and relation between the mother dolphin and males of variety of species, and the process of growing and death of the particular individual were studied.

INTRODUCTION

The first report on the interspecies hybrid of cetaceans is the three anomalous dolphins stranded at the Blacksod Bay, Ireland. The specimens were presumed as hybrids between *Tursiops truncatus* and *Grampus griseus* (Fraser, 1940). It is well known that a hybrid individual was born in Sea Life Park, Hawaii in Oct. 1971 between male *Tursiops truncatus* and *Steno bredanensis* (Shallenberger and King, 1977; Nishiwaki, 1978). The present hybrid was born in Kamogawa Sea World in 1981. From morphological aspects and also from the situation in the pool, in which the mother and males were living together, we presumed that it was a hybrid between *Tursiops truncatus gilli* and *Pseudorca crassidens*. The senior author spoke on the hybrid calf while it was living, at Symposium on Cetacean Reproduction, La Jolla, California at the end of 1981. Cromozome study was desired on the hybrid in the symposium in case if the individual should have died, and was to be carried out in cooperation with Dr. Deborah S. Duffield of the Portland State University. The death of the individual was a big disappointment, but the study became available, undesirablly soon. The senior author carried a fresh blood sample from the dead calf to USA on his way to Silver Bank, a breeding area of humpback whales. A result of examination has not yet appeared, morphological aspects of the hybrid calf in comparison with data of other hybrid fetuses and those of parents species are in this report.

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Fig. 1. The hybrid calf with her parents.

PROCESS OF GROWING AND DEATH OF THE CALF

Parturition was observed at 16:45 on May 3, 1981. The first sucking of the new-born calf was recognized after five hours. The mother and the calf were swimming closely for the first couple of weeks, and the calf was growing in very good health, which had been known as female till then. Individual swimming apart from mother was increasingly frequent after 19 days or so. She showed her attracted to food after 74 days and she bit a hand of caretaker after 85 days, so he gave her a smelt (*Mallotus villosus*). She touched the fish by her snout tip, bit it and swallowed it. This first food taking was about a month earlier than that of the calves of general *Tursiops*. She had four errupted teeth in the central part of each upper tooth row at that time. Since then, the calf continued to take boneless smelts and mackerel (*Scomber japonicus*) as well as sucking milk, while she was often seen with her tongue-tip showing out of mouth. Number of fish indidivual taken by the calf in each month in average per day was 0.19 kg in Aug., 0.5 kg in Sept., 1.3 kg in Dec. and 1.4 kg in Jan, 1982.

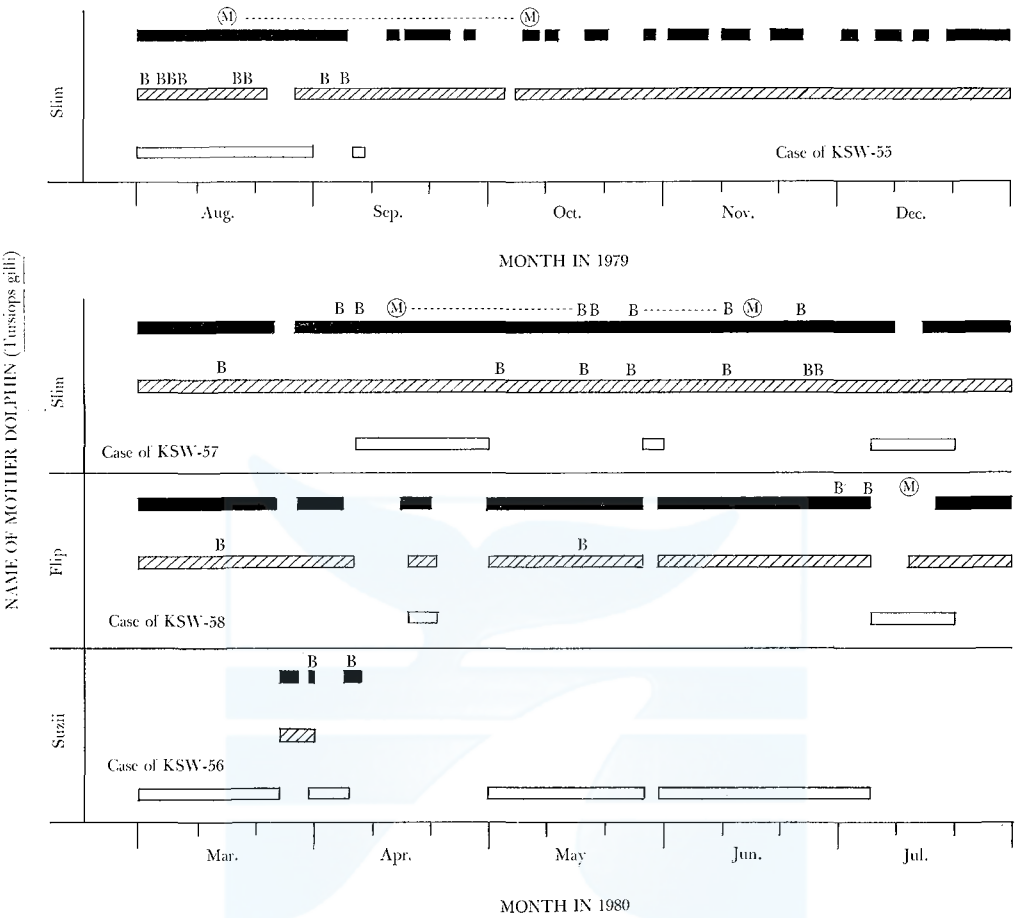

Fig. 2. Situation of the mother dolphins live together with each male in the pool.
Periods of each males in the mothers' pool.
■ *Pseudorca crassidens* ▨ *Lagenorhynchus obliquidens* □ *Tursiops gilli* (immature)
B Witnesses of chasing Ⓜ Witnesses of copulation

On the late afternoon of the 273rd days after birth, calf's appetite decreased, and without serious disorder seen in appearence, she died three days later, Feb. 2, 1982. The sudden death of the calf was a shock to whole Kamogawa Sea World and related scientists. Examination after death made it clear that the cause was acute-pneumonia. Body length was 190 cm and weight was 81.6 kg at its death.

INCIDENTS OF HYBRID BETWEEN *TURSIOPS* AND *PSEUDORCA*

When the two abortive fetuses occurred, it was considered each time that a hybrid from so divergent parents would never grow normally to reach parturition and was not a matter of serious report. However, after one successful birth of KSW-57,

TABLE 1. LIST OF HYBRIDS BETWEEN *TURSIOPS GILLI* AND *PSEUDORCA CRASSIDENS* AND THEIR MOTHER DOLPHINS

Hybrids					Mother dolphins			
Specimen No.	Sex	Body length in cm	Date of birth		Species	Name	Body length in cm	Period in captivity
KSW–55	F	74.0	Jan. 29 1980	Deadborn	*Tursiops gilli*	Slim	289	10 years
KSW–56	M	116.0	Apr. 30 1981	Deadborn	*Tursiops gilli*	Suzii	284	5 years
KSW–57	F	190.6*	May 03 1981	Live born	*Tursiops gilli*	Slim	289	10 years
KSW–58	M	121.5	Jul. 07 1981	Deadborn	*Tursiops gilli*	Flip	278	10 years

* measured at her death on Feb. 02 1982.

TABLE 2. LIST OF MALE DOLPHINS KEPT IN THE POOL WITH MOTHER DOLPHINS

Species	Name	Body length in cm	Period of captivity
Pseudorca crassidens	Leo	409	10 years
Lagenorhynchus obliquidens	Billy	185	6 years
Tursiops gilli	Ace	250	4 years

another abortive delivery occurred, and the fetus was nearly parturient.

In the pool of Kamogawa Sea World, in which all those incidents of hybrid occurred, there happened to be no mature male *Tursiops*, but one *Pseudorca*, one *Lagenorhynchus* and one immature male *Tursiops*, less than four years old. Observation on mating behavior in the pool is shown in Fig. 2, in which mark " B " is chasing behaviors and " M " is copulations. From Fig. 2, we can tell that mating between the female *Tursiops* (by the name of Slim) and a male, *Pseudorca* (Leo) in August or that in October 1979 delivered abortive fetus KSW-55 74 cm in length, which may have been in mother's womb for about 4 months. Similarly, mating between female *Tursiops* (Flip) and Leo in July 1980 delivered the abortive KSW-58. Again, mating between the third female *Tursiops* Suzii and Leo in April 1980 delivered abortive KSW-56. The present specimen KSW-57 was an offspring of mother Slim, her mating with Leo had been seen from April to June 1980. Other male *Lagenorhynchus* in the pool was also chasing females, but his lesser sized body may not have been strong enough, no mating mark of him is recorded. The only male *Tursiops* in the pool was a young son of Slim and a male *Tursiops*, his father died before those incidents. The young *Tursiops* was four years old (fifth year from birth) reaching an age of sexual maturity, he only showed some chasings.

MORPHOLOGICAL FEATURE OF THE FOUR HYBRID SPECIMENS

To compare the body proportion of the three hybrid fetuses and that of general *T. t. gilli* in similar stage of growth, external measurement in the certain parts of the body is shown in Table 3, in which values are indicated in parcentage against the total length. As a reference, measurements from parents species in respec-

TABLE 3. COMPARISON OF FOETAL AND CALF BODY PROPORTION BETWEEN *TURSIOPS-PSEUDORCA* HYBRIDS AND NORMAL *T. GILLI*.

Specimen No.	KSW-55	*T. gilli*	KSW-56	*T. gilli*	KSW-57*	*T. gille**	KSW-58	*T. gilli*
Sex	F	M	M	F	F	M	M	F
Body weight in kg.	4.4	—	16.8	15.6	81.6	68.8	17.2	22.8
Point of measurement								
1. Total body length in cm.	74.0	73.0	116.0	113.0	190.6	188.0	121.5	127.0
2. Tip of upper jaw to apex melon	1.8	3.4	1.9	4.0	1.4	4.3	1.8	3.7
3. Tip of upper jaw to angle of gape	11.5	13.0	14.6	13.4	11.0	13.6	12.7	13.7
4. Tip of upper jaw to blowhole	12.9	16.4	16.3	14.2	13.1	20.2	13.9	15.1
5. Tip of upper jaw to center of eye	14.2	17.1	16.7	16.1	15.0	16.5	15.0	17.3
6. Tip of upper jaw to anterior insertion of flipper	23.7	—	21.0	26.0	20.0	22.9	23.8	24.8
7. Center of eye to external auditory meatus	3.6	4.7	4.5	3.5	3.5	3.5	4.5	3.9
8. Tip of upper jaw to tip of dorsal fin	62.2	58.9	62.9	63.9	63.4	61.7	61.3	68.0
9. Tip of upper jaw to center of anus	72.7	73.9	72.4	70.3	70.1	71.8	71.3	71.4
10. Tip of upper jaw to midpoint of umbilicus	51.4	52.0	52.7	49.5	46.5	48.7	50.1	49.7
11. Maximum height of body	18.6	28.7	21.6	21.0	24.1	27.4	19.1	23.2
12. Length of flipper, anterior insertion to tip	17.3	16.4	18.7	18.9	17.1	18.4	17.4	15.2
13. Length of flipper, axilla to tip	11.9	10.9	13.3	13.4	12.5	13.3	12.5	12.9
14. Width of flipper, maximum	6.1	6.8	6.9	6.7	6.3	6.4	5.9	6.4
15. Length of dorsal fin (base)	13.5	14.3	12.5	15.0	16.4	17.0	15.2	16.6
16. Height of dorsal fin	9.7	10.9	7.8	7.7	8.5	8.5	9.6	9.4
17. Width of flukes, tip to tip	21.6	21.9	15.5	20.7	23.6	21.0	17.0	19.0
18. Anterior insertion of tail flukes to notch	10.2	8.9	8.2	8.7	7.3	8.5	7.9	8.0
19. Anterior insertion of tail flukes to tip	18.9	16.4	15.7	18.0	15.8	15.4	16.5	17.6

* calf

TABLE 4. ADULT BODY PROPORTION ON EXTERNAL MEASUREMENT OF A MALE *PSEUDORCA CRASSIDENS* AND FIVE FEMALES *TURSIOPS GILLI*.

Species	*Pseudorca crassidens*	*Tursiops gilli*	*Tursiops gilli*	*Tursiops gilli*	*Tursiops gilli*	*Tursiops gilli*
Sex	M	F	F	F	F	F
Pint of measurement						
1. Total length in cm	465	272	292.5	283.5	290	316
2. Tip of upper jaw to apex melon	—	3.7%	3.4%	3.0%	3.8%	3.7%
3. Tip of upper jaw to angle of gape	6.6%	10.7	12.1	10.4	10.7	10.1
4. Tip of upper jaw to blowhole	10.1	11.4	11.4	11.1	13.8	10.6
5. Tip of upper jaw to center of eye	9.2	12.9	11.6	12.2	12.4	11.9
6. Tip of upper jaw to anterior insertion of flipper	13.9	18.9	19.5	20.3	19.6	20.9
7. Center of eye to extermal auditory meatus	1.9	2.7	4.0	3.0	2.7	3.0
8. Tip of upper jaw to tip of dorsal fin	49.2	57.7	61.9	60.8	57.2	59.5
9. Central notch of tail flukes to center of anus	65.5	67.3	72.0	70.4	70.9	65.2
10. Central notch of tail flukes to midpoint of umblicus	39.1	48.7	45.6	44.3	45.2	44.9
11. Girth on anterior insertion of flipper	—	46.3	35.9	39.1	34.5	38.3
12. Girth on anterior insertion of dorsal fin (maximum)	—	54.8	47.9	48.0	43.1	40.8
16. Maximum height of body	24.0	32.3	32.8	—	21.0	23.7
17. Length of flipper, anterior insertion to tip (curved)	13.7	16.9	16.1	15.2	14.1	17.0
18. Length of flipper, anterior insertion to tip (straight)	10.1	12.1	10.6	10.9	10.1	15.7
19. Width of flipper, maximum	5.3	6.2	5.9	5.1	5.2	5.7
20. Length of dorsal fin (base)	10.7	15.8	17.4	18.3	14.8	19.0
21. Height of dorsal fin	7.0	10.1	10.2	8.8	8.3	9.2
22. Total spread of tail flukes	21.0	27.5	21.0	20.1	18.3	25.9
23. Anterior insertion of tail flukes to notch	5.5	8.7	6.8	7.4	6.5	8.5
24. Anterior insertion of tail flukes to tip	12.9	18.0	16.7	16.2	14.8	18.2

tive parts of body are shown together, specimens are one adult male *P. crassidens* and five adult females of *T. t. gilli*, in Table 4.

As seen in Point 2 of Table 3, namely from the tip of upper jaw to the apex of melon, the beak of the hybrid specimens is apparently shorter than that of normal *T. t. gilli*.

Body colour of the hybrid calf and other three still born specimens are altogether darker than that of normal *T. t. gilli* fetuses and living calves of similar stage in growth. Specimen KSW-55, 56 and 58 are still darker than the calf KSW-57.

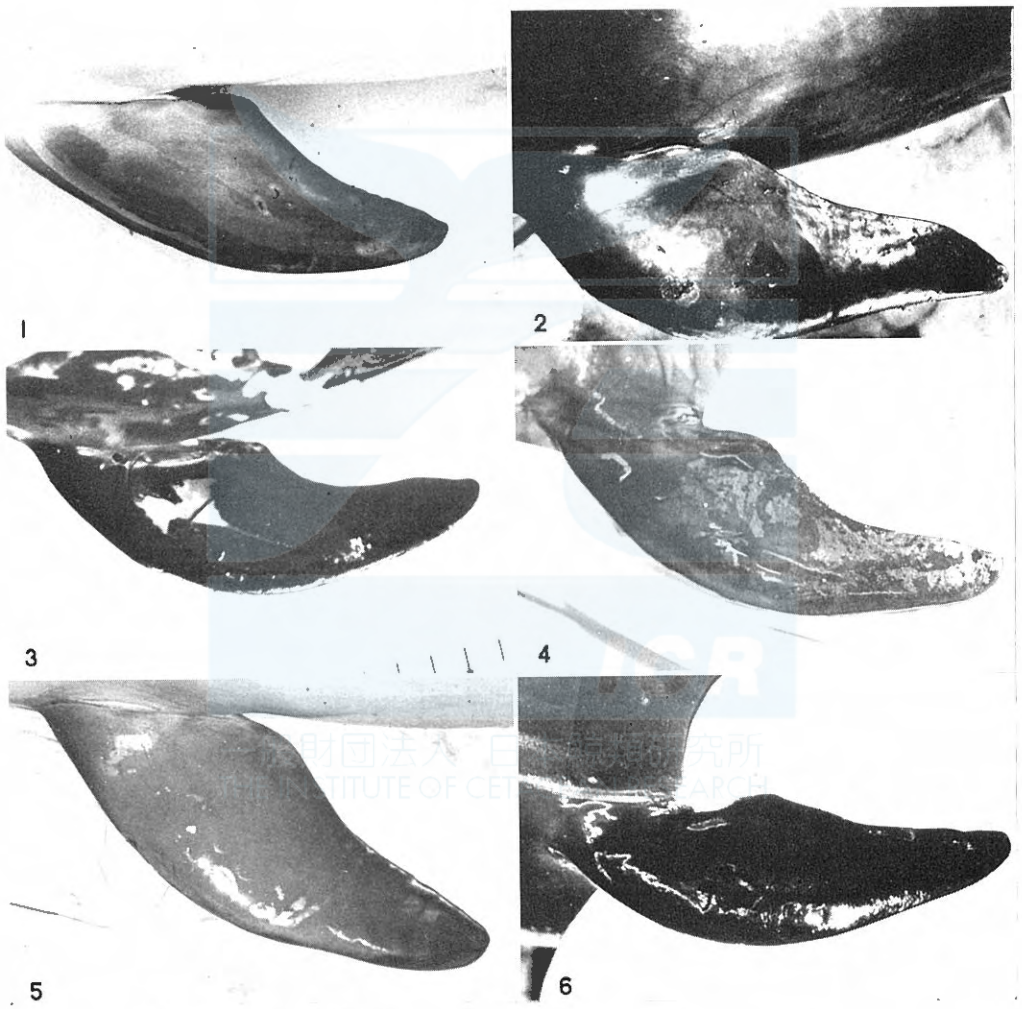

Fig. 3. Shape of flippers.
1: Adult *Tursiops gilli*.
2: Adult *Pseudorca crassidens*.
3: 74.0 cm foetus (KSW-55).
4: 116.0 cm foetus (KSW-56).
5: Living calf (KSW-57).
6: 121.5 cm foetus (KSW-58).

TABLE 5. VERTEBRAL, DENTAL AND PHALANGEAL FORMULAE OF THE HYBRIDS BETWEEN *TURSIOPS* AND *PSEUDORCA* COMPARED WITH THOSE OF STANDARD FORMULAE OF *TURSIOPS GILLI* AND *PSEUDORCA CRASSIDENS*.

Specimen			KSW-55	KSW-56	KSW-57	KSW-58	*Tursiops gilli*	*Pseudorca crassidens*
Body length			74.0	116.0	190.6	121.5		
Vertebral formula		C	7	7	7	7	7	7
		D	11	11	12	12	14	10
		L	10	11	13	11	15	10
		Ca	24	25	25	25	29	23
		Sum	52	54	57	55	65	50
Dental formula	Upper Left		17	15	17	15	20–25*	8–11*
	Upper Right		16	16	17	16		
	Lower Left		17	15	17	15	20–25*	8–11*
	Lower Right		16	16	17	16		
		Sum	66	62	68	62	80–100	32–44
			L R	L R	L R	L R	*	*
Phalangeal formula		I	1 1	2 2	2 2	2 2	2	2
		II	7 7	8 8	9 9	8 8	9	8
		III	5 5	6 6	7 7	6 6	7	6
		IV	2 2	3 3	4 4	4 4	4	4
		V	1 1	1 1	3 3	2 2	2	2

* Number is equal in left and right side.

Osteological X-ray survey was done on the hybrid fetuses. Naturally, there are no big variation in the standard phalangeal formulae between adult *Tursiops* and *Pseudorca*, however, there are considerable varieties in the number of pharanges in KSW 55 and 56, but in 58. Varieties may because of preparturient stages. Specimen KSW-58, 128 cm in length, has the same phalangeal formula as in the standard *Pseudorca*. So, if KSW-55 and 56 had lived longer, they would grow one more finger bone in II and III. Although the phalangeal formulae do not suggest a clear trace to *Pseudorca*, the external shape of flippers are showing more visible characteristics of *Pseudorca*. Shape of flipper in *Pseudorca* has distinct peculiarity among all cetacean species. As seen in Fig. 3, all the fetuses have similar shape of flippers which is descended from father. On the other hand the calf specimen KSW-57 has same numbers as in *T. t. gilli* in pharange I, II, III, and IV except V which shows one more finger bone than in general *Tursiops*. But shape of the flippers is more similar to the flippers in the father species of *Pseudorca*.

In X-ray examination, number of teeth is 15–17 in each fetus specimen. The senior author spoke in the Symposium in La Jolla that the dental number in the calf KSW-57 was 15 in counting on the clear photographs, and that the calf would grow one or two more teeth according to its growth. Actual counting at its death cleared that the dental number was 17. The dental formulae of those hybrid specimens are just inbetween *Tursiops* and *Pseudorca*.

In the vertebral formulae, thoracic, lumber and caudal, of the all hybrid specimens are altogether just inbetween the two species. Table 5 shows all those number and formulae of bones and teeth with the standard of adult *T. t. gilli* and *Pseudorca*. Tables may explain more clearly than words that there is little doubt that all the four specimens are hybrid between the two species.

SKULL MEASUREMENT OF THE HYBRID CALF

The skull and other bones of the hybrid calf was made to be skeletal specimens and preserved in Kamogawa Sea World. The measurement values on the skull are in Table 6. Photographs of them are in Fig. 4 and 5. The tympanic bones are in Fig. 6. Table 6. also indicates that the calf is inbetween *T. t. gilli* and *Pseudorca* in values.

EXPECTATION IN FUTURE

Among land animals, the first interspecies hybrids, between the lion and the tiger for an example, must have been born accidentally, however, it became somehow intentional experiments in some zoos. "The liger" or "the tyon" by intentional hybridization has been seen in many places. But those hybrid animals have never had following generations. The fact is considered as a proof that each parent species is independent.

All the four specimens in this report were born accidentally. In this rare

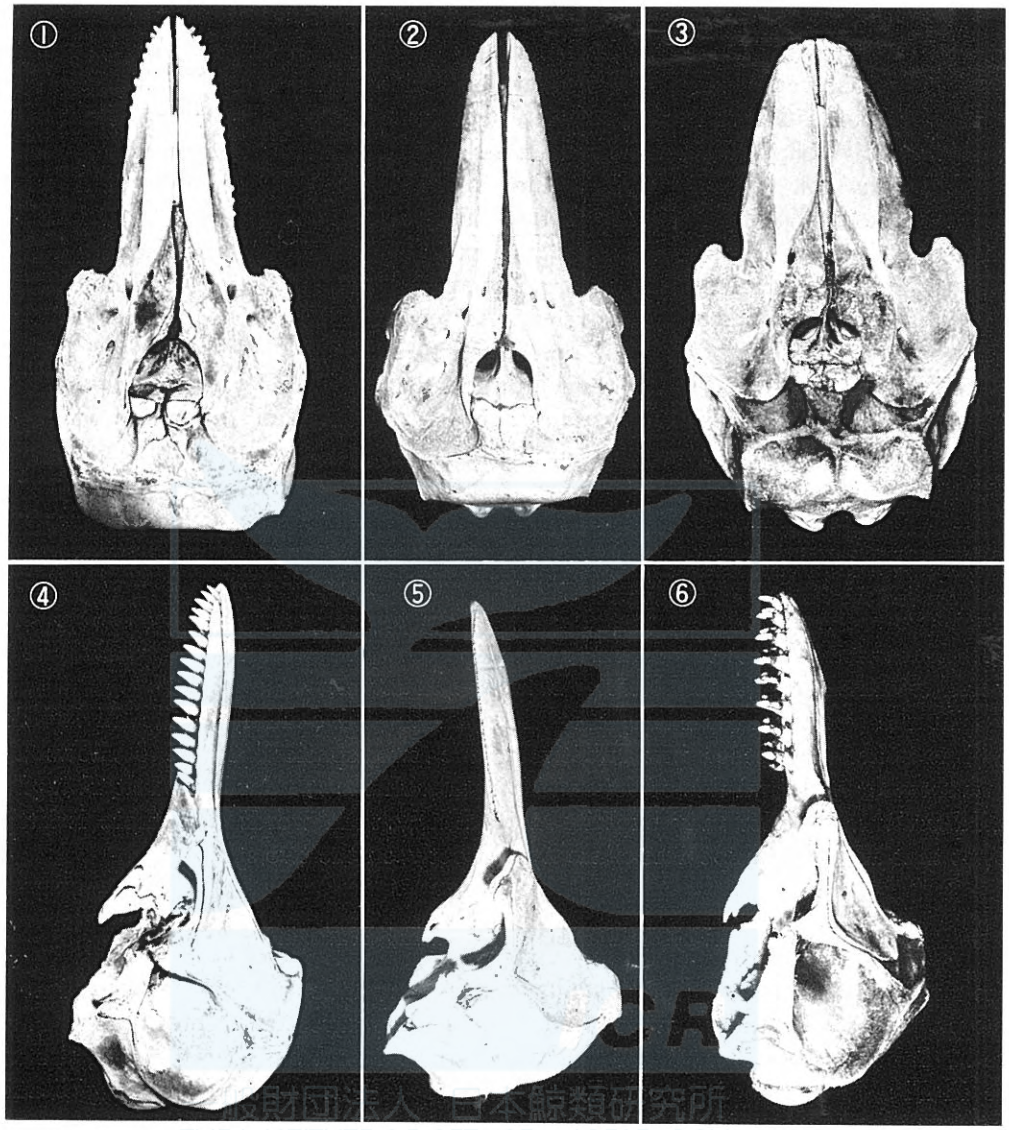

Fig. 4. Skull of the Hybrid between *Tursiops* and *Pseudorca*, *Tursiops gilli* and *Pseudorca crassidens*.
Top to bottom: Dorsal and lateral view.
Left, Hybrid (KSW-57) between *Tursiops* and *Pseudorca*.
Middle, *Tursiops gilli* (B. L. 270 cm).
Right, *Pseudorca crassidens* (B. L. 415 cm).

case, examination on their chromosome number, blood type, electrophoretic pattern of protein (analysis of blood component) etc. were desired, but only a chromosome study is going on in cooperation by Dr. Duffield. In future, based on those genetic studies, we might reach to a point that if there are possibilities of a third

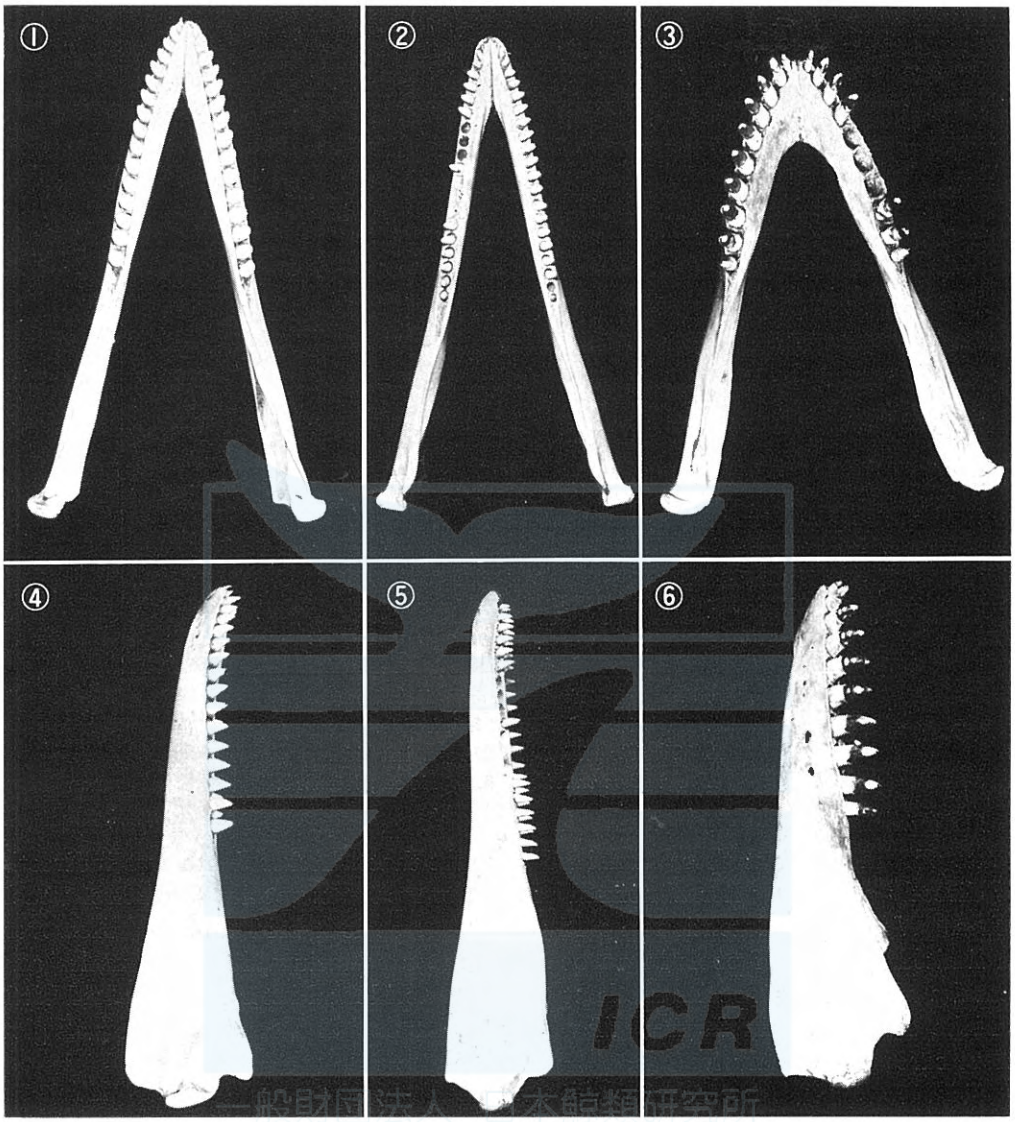

Fig. 5. Mandible of the Hybrid between *Tursiops* and *Pseudorca*, *Tursiops gilli* and *Pseudorca crassidens*.
Top to bottom: Dorsal and lateral view.
Left, Hybrid (KSW-57) between *Tursiops* and *Pseudorca*.
Middle, *Tursiops gilli* (B. L. 270 cm).
Right, *Pseudorca crassidens* (B. L. 415 cm).

generation hybrid of smaller cetacean species.

In the case of Kamogawa Sea World, all available cares were given to the calf born with so divergent blood. As expectation for her growing was great, her death was a disappointment and sadness. Cause of death was diagnosed as

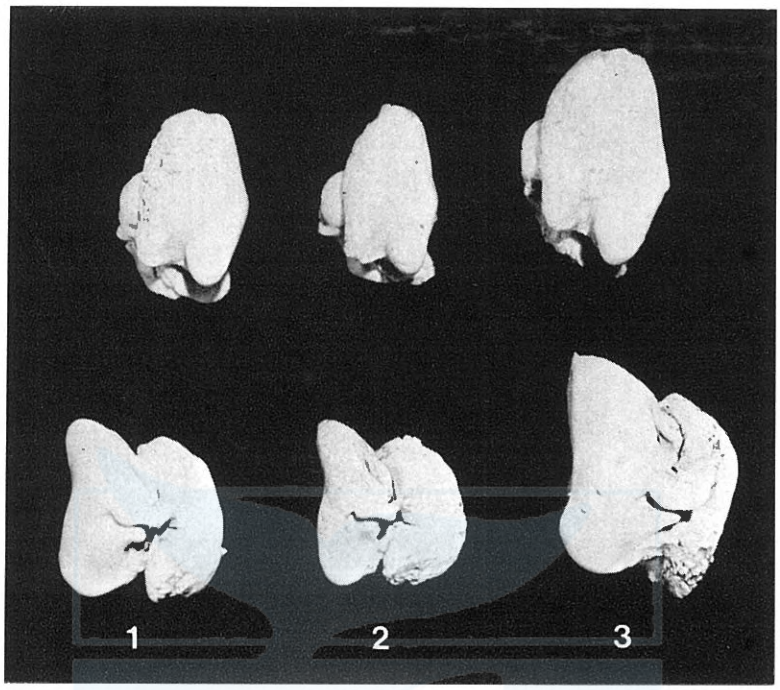

Fig. 6. Shape of Tympano-periotic bones.
1. Hybrid calf, KSW-57, left side.
2. *Tursiops gilli*, B. L. 270 cm, left side.
3. *Pseudorca crassidens*, B. L. 415 cm, left side.

acute-pneumonia, but there remained a doubt that whether death was indirectly or directly caused by her abnormal blood from parents species so different each other. We have no intention in cultivating interspecie-hybrid animals. However, in limited number of pools in an oceanarium or aquarium, in which males and females of variety of species are kept together, accidental interspecies hybrid birth will be seen again in furure. If we would have such cases again, we will give more cares to save calves.

ACKNOWLEDGMENT

This study started from unexpected birth of the hybrid calf. In Kamogawa Sea World, generous care was given to the calf after its birth by veterinarians and caretakers. Owing to the help by those number of people attended to the dolphin pool, in observation, recording and photographs taken and so on, this study was possible. We are deeply indebted to all those people and particularly to Mr. Yoshiaki Maeda of Kamogawa Sea World, who helped us in collecting data and taking skull photographs.

TABLE 6. SKULL MEASUREMENTS OF THE CALF HYBRID BETWEEN *TURSIOPS* AND *PSEUDORCA* COMPARED WITH ADULTS *TURSIOPS GILLI* AND *PSEUDORCA CRASSIDENS*

Specimen	KSW–57		T. gilli		P. crassidens	
Sex	F		F		M	
Body length in cm.	190.6		270.0		415.0	
Point of measurement						
Condylobasal length	422 mm	(100%)	505 mm	(100%)	624 mm	(100%)
Length of rostrum	208	(49.3)	278	(55.0)	294	(47.1)
Width of rostrum at base	117	(27.7)	142	(28.1)	225	(36.1)
Width of rostrum at midlength	79	(18.7)	95	(18.8)	182	(29.2)
Length of premaxillae, L.	297	(70.4)	373	(73.9)	429	(68.8)
R.	318	(75.4)	394	(78.0)	448	(71.8)
Maximum width of premaxillae	85	(20.1)	95	(18.8)	151	(24.2)
Maximum breadth of superior nares	58	(13.7)	57	(11.3)	86	(13.8)
Tip rostrum to anterior margin of superior nares	258	(61.1)	328	(65.0)	363	(58.2)
Tip rostrum to center of eye	259	(61.4)	345	(68.3)	340	(54.5)
Preorbital width	190	(45.0)	246	(48.7)	332	(53.2)
Postorbital width	214	(50.7)	273	(54.1)	363	(58.2)
Parietal width	191	(75.3)	202	(40.0)	262	(42.0)
Length of temporal fossae, L.	105	(24.9)	112	(22.2)	196	(31.4)
Depth of temporal forssae, L.	79	(18.7)	86	(17.0)	143	(22.9)
Length of maxillary toothrow, L.	180	(42.7)	236	(46.7)	232	(37.2)
R.	182	(43.1)	233	(46.1)	236	(37.8)
Length of mandibular rami, L.	351	(83.2)	432	(85.5)	489	(78.4)
R.	353	(83.6)	432	(85.5)	489	(78.4)
Breadth across mandibular condyles	203	(48.1)	268	(53.1)	356	(57.1)
Length of symphsis	59	(14.0)	67	(13.3)	87	(13.9)
Coronoid height of ramus, L.	82	(19.4)	89	(17.6)	133	(21.3)
R.	84	(19.9)	88	(17.4)	135	(21.6)
Length of mandibular toothrow, L.	184	(43.6)	238	(47.1)	243	(38.9)
R.	189	(44.8)	238	(47.1)	243	(38.9)

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