On the Serological Constitution of the Sperm- and Baired beaked-Whales (I) Blood Groups of the Sperm- and Baired beaked-Whales

By Kazuo Fujino

Introduction

In the serological studies on whales, the author at first tried to classify the antigens contained in their erythrocytes. Consequently it was found that four and three kinds of blood group exist in the sei-, fin-, blue- and humpback-whales¹⁾ belonging to the baleen whale and the dolphin²⁾ belonging to the toothed whale respectively. In the same manner as in the above stated cases the blood groups of the sperm whale (*Physeter catodon*) and the baired beaked whale (*Berardius bairdii*) were classified into six kinds as the combination of the two systems, namely Pc₁Pc₂ and Sp systems in the sperm and Br₁Br₂ and Pb systems in the baired beaked respectively.

The author should express his deep gratitude to Mr. Hasegawa, chief, of the Ayukawa whaling land station of Taiyo Gyogyo Co. for his thoughtful help and Prof. Yasuo Suyehiro, Prof. Tanemoto Furuhata and Dr. Hideo Omura for their kind advices in carrying out this study.

Material and method

Erothrocytes of whale: The coastal whaling grounds are generally far off and it takes comparatively long time to tow the catches to the whaling land station. So the carcases are incised in the abdominal region to take away the blood for the purpose of keeping the meat fresh. By this reason it is difficult to collect the sera of whales. Whale erythrocytes were taken from the clots remaining in the heart and were cleaned with the physiological salt solution for the use of the immunization and the other reactions.

Immune animal: Domestic fowels were used as immune animal besides rabbits in the previous work, and prior to the immunization their serum-types were examined.

As regards human erythrocytes, immunization, antiserum, agglutination, hemolysis and adsorption test, materials and methods were just same as in the previous work.

Isohemagglutination and serum-type

As the sera of whales had not been collected, the isohemagglutination and serum-type of whales were not examined.

Antigens proved with immune antibodies

1. Immune antiserum against each antigen

- (a) Anti-sperm-whale Pc₁— and Pc₂— sera: When a rabbit or fowl is immunized with the sperm whale erythrocytes which belong to Pc₁Sp—, the anti-Pc₁Sp— agglutinin and hemolysin are produced in the serum of the animal together with the species specific agglutinin and hemolysin against the sperm whale erythrocytes. When the species specific antibodies are adsorbed away from this serum with the Pc₂Sp— or Pc₂Sp— erythrocytes, the anti-Pc₁ immune agglutinin and hemolysin are obtained. The anti-Pc₂ immune agglutinin and hemolysin are obtained by the same operation. With these immune antibodies, it was proved that the existences of the agglutinogens and hemolysinogens, namely Pc₁ and Pc₂ in both, were perfectly consistent with each other. Consequently, the sperm whale blood was classified into three kinds, namely Pc₁Pc₂, Pc₁ and Pc₂ groups.
- (b) Anti-sperm-whale Sp-ferum: When a rabbit is immunized with such the Pc₁Sp- erythrocytes as contains Sp antigen, the anti-Pc₁Sp- agglutinin and hemolysin are produced in the rabbit serum together with the species specific agglutinin and hemolysin against the sperm whale erythrocytes. If the species specific and the anti-Pc antibodies are adsorbed away from its serum with the Pc₁Sp- erythrocytes, the anti-Sp antibodiers are obtained. Instead of the Pc₁Sp+ and Pc₂Sp-, using the Pc₂Sp+ and Pc₂Sp- erythrocytes as antigens for immunization and adsorption respectively, the anti-Sp immune antibody may be also obtained. By this immune antibody the sperm whale blood was classified independently to the Pc₁Pc₂ system into two groups, namely Sp+ and Sp-: The former contains the Sp antigen and the latter doesn't contain it.
- c) Anti-baired beaked whale Br₁- and Br₂- sera: By the same method as described in the section (a), the existences of the Br1 and Br2 antigens which are contained correlatively each other in the beaked whale red cells were confirmed by the immune agglutinin and hemolysin. Consequently the blood groups of the beaked whale were classified into three kinds, namely Br₁Br₂, Br₁ and Br₂ groups.

(d) Anti-baired beaked-whale Pb-serum: Methods in this section are just same as in the section (b). When an rabbit is immunized with the erythrocytes containing the Pb antigen, several kinds of antibodies are produced in the rabbit serum. If the anti-Br₁, Br₂ and the species specific antibodies are adsorbed away from those by erythrocytes in which Pb antigen is not contained, anti-Pb antibody is obtained. By this immune antibody the baired beaked whale bloods are classified independently to the Br₁Br₂ system, into the two groups, namely Pb+ and Pb-: The former contains Pb antigen and the latter doesn't.

2. Agglutinin titer and hemolysin titer

(a) Anti-sperm whale erythrocytes immune sera: Some examples of the agglutinin and hemolysin titer of the immune sera which is obtained by the said method are shown in the Tables I and II. It may be seen from these tables that the titer of the anti-Pc₁ antibody is lower in the case of using rabbit than fowl as immune animal. While it seems that the sensitivity in rabbit against Pc₂ is higher than that in fowl.

The titers of anti-Pc₂ antibodies which were produced in the rabbit serum by the four-time and seven-time (normal) immunization are shown in (b) of the Table I. It will be seen from the table that the titer of the anti-Pc₂ agglutinin already becomes up to 2,560 times after four-time immunization and reaches to such a high degree as 81,920 times by normal immunization. According to this fact, it seems to the author that the rabbit has a high sensitivity against Pc₂ antigen. As regards the difference between sensitivities of a rabbit against Pc₁ and those against Pc₂, it is to be shown in (c) and (f) of Table I that the anti-Pc₂ antibody reached to a the higher titer than the anti-Pc₁ antibody when the rabbit is immunized with the mixture of erythrocytes of Pc₁Sp— and Pc₂Sp—. It will be seen from this fact that the rabbit seems to be more sensitive to Pc₂ than to Pc₁.

In this experiment, for the purpose of comparison of the sensitivities against both antigens the erythrocytes which are used for the immune antigen should be made equivalently to the three individuals, in each type of Pc_1 and Pc_2 , and their both types of the erythrocytes had to be mixed equally in quantity. And then their total quantity was put into the 10% suspension of the salt solution and was used for the immunization by the regular method. The titers of the anti-Sp antibodies are shown in the Table II.

(b) Anti-baired beaked whale erythrocytes immune sera: Each one example of the agglutinin titer of the anti-bodies, which are produced

Table I. Agglutinin titer and hemolysin titer of the anti-Pc, and Pc2 immune sera

(a) Anti-Pc₁ agglutinin titer

	A+ or adsorption No.,	No. 12 Pc ₁ Pc ₂ Sp- # # #			No. 12 Pc ₁ Pc ₂ Sp- # # # # # #	O/ T TO S. No. 3 Po,Sp. = = = = = = = + + +	1
nune animal Erythrocy		7 ON	0/ A- Do Sw	r c ₂ Sp.	7 ON	10. The Gr	LC25P
mmune	antigen No., Sex		Pr. 2 Rabbit		Ī	P. C. Fowl	

(b) Anti-Pc2 agglutinin titer

					p	9				-			
ē	Imi	Immune animal	al	Erythrocytes	erytnr aggh	Erythrocytes for agglutination		-)iluti	n of	Dilution of antiserum	u	
antigen	No., Sex	Serum type	A+ or A-	adsorption	No.,	Blood-group	$\frac{1}{320} \frac{1}{640}$	$\frac{1}{1280}$	$\frac{1}{2560}$	$\frac{1}{5120} \frac{10}{10}$	$\frac{1}{10240} \frac{1}{2048}$	$\frac{1}{20480} \frac{1}{40960}$	$\frac{1}{81920}$
	No. 23	E)		No.	No. 12	Pc ₁ Pc ₂ Sp-	‡	+	+	1	1	1)
D. G.	Rabbit	۵,′	A-	, C. C.	No. 3	Pc_1Sp -	1	1	ı	ı	1	1	1
<u>-</u>	Female	RC		rciop-	No. 9	Pc ₂ Sp-	‡ ‡	#	+	1	1	1	ı
		Н		No.	No. 12	Pc_1Pc_2Sp -	# #	#	丰	‡	丰	#	+
	"		,,	2 2	No. 3	Pe_1Sp -	1	1	ı	1	l	1	1
				relap-	No. 9	Pc ₂ Sp-	丰丰	#	#	‡	‡ ±	‡	+
	No. 15			N.	No. 12	Pc ₁ Pc ₂ Sp-	‡ ‡	+	ı	ı	1	1	1
	Fowl	0	\	10.00 10.00	No. 3	Pc_1Sp -	l l	1	ı	ı	1	ı	1
	Female		\	rejop-	No. 7	Pc,Sp-	# #	+	1	1	1	ì	ı

* This was collected in the next day of 4th immunization, namely 8 days after 1st immunization. ** This was obtained by the normal immunization.

^{*} *

Table I (cont.)

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Immune	Im.	Immune animal	1a]	Erythrocytes	Erythr aggh	Erythrocytes for agglutination			Dilh	ution	of a	Dilution of antiserum	mn.		
antigen	No., Sex	Serum- type	A+ or A-	adsorption	No.,	Blood-group	$\frac{1}{160} = \frac{1}{3}$	$\frac{1}{320} \frac{1}{640}$	$\frac{1}{0 1280}$	$\frac{1}{30}$ $\frac{1}{2560}$		$\frac{1}{5120} \frac{1}{10240}$		$\frac{1}{20480}$ $\frac{1}{409}$	$\frac{1}{40960}$
Pc_1Sp -		ΉĒ		N.	No. 12	Pc_1Pc_2Sp -	#	+ =	1.	l	1	1			ı
Nos. 1	No. 27	INS		No. 7	No. 3	$Pe_1Sp.$	#	+ =	1	1		l t	1		
n 7,	Rabbit	70	A +		No. 7	Pc ₂ Sp-	1	1	1	1	1				
Pe.Sp.	Female	UTE		M. o	No. 12	Pc ₁ Pc ₂ Sp-	#	# #	#	#	丰	 	#		+
Nos. 7		OF		No. s	No. 3	Pc ₁ Sp-	1	1	1	1]	1	1.		
9, 13		CE		-deis	No. 9	Pc2Sp-	#	‡ ‡	‡	幸	丰	#	 	8	+
(p)	(d) Anti-Pc ₁ h	hemolysin titer	titer											:	
Immune	Im	mmune animal	nal	Erythrocytes	Erythi her	Erythrocytes for hemolysis			Dil	ntion	of a	Dilution of antiserum	un.		
antigen	No., Sex	Serum- type	A+ or A-	adsorption	No.,	Blood-group	1	$\frac{1}{10}$	1 20 4	$\frac{1}{40} \frac{1}{80}$	$\frac{1}{160}$	$\frac{1}{320}$	$\frac{1}{640}$	$\frac{1}{1280}$	$\frac{1}{2560}$
o M	No. 26	EAR		N	No. 12	Pc ₁ Pc ₂ Sp-	‡	*	+	1	t	l	t]	1
P.S. P.	Rabbit	(CH	A-	Pe.Sp.	No. 3	Pc ₁ Sp-	#	‡	+	1	l	I	l	1	ı
200	Female			2	No. 9	Pc ₂ Sp-	1	1	1	1	t i	1	ı	ı	ı
, c	No. 14			N.	No. 12	Pc ₁ Pc ₂ Sp-	#	*	=		+	#	+	ı	ı
Pe.Sp.	Rabbit	,0		Pe.Sp	No. 3	Pe_1Sp -	#	+ #	事	*	‡	‡	+	1	ı
2010	Female)))	No. 9	Pc ₂ Sp-	1	,	1	1	1	1	1	ı	1

Table I (cont.)

(e) Anti-Pc₂ hemolysin titer

Dilution of antiserum	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$			1	+ + + + + +		+ + = = =		1	1
tion	1 8	+	1	+	#	۱	#	 -	1	1
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	10 2	 	1	+	#	1	#	 =	1	<u> </u>
	1 20	‡	ı	#	‡	1	· 幸	丰	1	#
Erythrocytes for hemolysis	Blood-group	Pc ₁ Pc ₂ Sp-	Pc ₁ Sp-	Pc ₂ Sp-	Pc ₁ Pc ₂ Sp-	Pe ₁ Sp-	Pc ₂ Sp-	Pc ₁ Pc ₂ Sp-	Pc ₁ Sp-	Pc ₂ Sp-
Eryth	No.,	No. 12	No. 3	No. 9	No. 12	No. 3	No. 9	No. 12	No. 3	No. 7
Erythrocytes	adsorption	No 3	D 00	rejop.	e oN	D 04	rejop-	No 3	0.00	relap.
	A+ or A-		A-			"			\	\
[mmune anima]	Serum- type	j E Ti	۵,) <u>7</u> 7	E (,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		E	0,	4
	No., Sex	No. 23	Rabbit	Female		,,		No. 15	Fowl	Female
Immune	antigen	No. 7	D. G.	regop-		"			"	

(f) Hemolysin titer of the anti-Pc1 and Pc2 antibodies obtained by the simultaneous immunization

	0						
	$\frac{1}{2560}$	ł	1	1	1	1	1
	1 1280	1	1	l	+	ı	+
rum.	1 8	1	1	1	+	t	#
tise	1 88	1	1	1	#	1	+
f an	1 2	1	i	ı	#	1	#
ion	- 8	+	+	ı	#	1	‡
Dilution of antiserum	1 8	#	#	ı	#	1	#
11 	1 S	#	#	1	#	ı	#
	1 2	#	#	1	‡	1	‡
	10	#	#	ı	#	ı	#
Erythrocytes for hemolysis	Blood-group	Pc ₁ Pc ₂ Sp-	Pc ₁ Sp-	Pe ₂ Sp-	Pc ₁ Pc ₂ Sp-	Pc ₁ Sp-	Pc.Sp-
Erythr hen	No.,	No. 12	No. 3	No. 7	No. 12	No. 3	No. 9
Erythrocytes	adsorption	No. 7	D. G.	regap-	No. 3	130. D	rejop-
nal	A+ or A-		,	+ 4	1		
[mmune anima]	Serum- type			è	>		
Im	No., Sex		No. 27	Rabbit		remale	
Immune	antigen	Pc ₁ Sp-	Nos. 1,2,3	and	Pc_2Sp -	Nos. 7,	9, 13

Table II Agglutinin titer and hemolysin titer of the anti-Sp immune serum

titer
agglutinin
Anti-Sp
<u>a</u>

Immune	Im	Immune animal	nal	Erythrocytes	Eryth aggl	Erythrocytes for agglutination			Ä	latic	lo u	ant	Dilution of antiserum	E		
antigen	No., Sex	Serum- type	A+ or A-	10r adsorption	No.,	dno	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	10	1 20	1 04	1 80	1	1 320 6	10 12	183 80 183	1 990
		THE			No. 10	No. 10 Pe ₁ Pe ₂ Sp ₊	‡	#	#	#	丰	#	# # # # # #	+		1
,	5		AG F	, N	No. 12	Pc ₁ Pc ₂ Sp_	1	1	ì	1	1	1	1	1		1
No.	No. 25	STII	1 	No.	No. 5	Pc_1Sp_+	#	丰	# # # #	丰	丰	‡	 	+		1
Pe Sp.	Female	UTI s	4	PeiSn	No. 3	Pc ₁ Sp_	1	1	1	i	1	1	ı	1		1
+	}	EOI	5人	1	No. 8	Pc2Sp+	丰	丰	丰	丰	丰	#	#	+		
		CE			No. 7	Pc ₃ Sp-	1	ı	ı	1	1	1	1	1		1
ર્	Ch. Anti Ca homolynia titos	+ cinal cons	\$0													

(b) Anti-Sp hemolysin titer

rum	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	1	1	1	1	1 t	1
Dilution of antiserum	$\begin{array}{cc} 1 & 1 \\ 50 & 320 \end{array}$	1	1		1	1 +	l i
n of	$\frac{1}{30}$, =	1	' #		<u>+</u>	1
lutio	1 40 8	+ = = =	1	+ + + + + +	1	+ + + = = =	1
Ö	$\frac{1}{20}$	丰	1	#	,	#	į i
	- Q	丰	1	丰	1	‡	1
	1 2	丰	1	#	1	#	1
Erythrocytes for hemolysis	No., Blood-group	No. 11 Pc1Pc2Sp+	Pc ₁ Pc ₂ Sp_	Pc_1Sp_+	Pc ₁ Sp-	Pc_2Sp_+	No. 13 Pc ₂ Sp.
Eryth he	No.,	No. 11	No. 12	No. 5	No. 3	No. 4	No. 13
Erythrocytes	adsorption		No. 88		Pc ₁ Sp_		•
nal	A ⁺ or A ⁻	开 开写		A-			
[mmune anima]	Serum- A+ or type A-	SEA	RCH	* *			
	No., Sex		No. 25	Rabbit	Female		
Immune	antigen		Z.		Pc_1Sp_+		

		rum	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	ì	l	1	
	1	Dilution of antiserum	$\frac{1}{1280}$	i	1	1	
sera		of a	1	+	+	1	
nne		ion	$\frac{1}{320}$	#	‡	ı	
mm		Jilut	$\frac{1}{160}$	#	#	1	
\mathbf{Br}_2			1 8	+ + + +	+ + = + + +	1	
rug			40	#	#	1	
Br_1 8			$\frac{1}{20}$	丰	#	1	
er of the anti-	,	Erythrocytes for agglutination	No., Blood-group	$\mathrm{Br_{_{1}Br_{z}Pb}}$ -	$\mathrm{Br_{I}Pb}_{-}$	Br ₂ Pb_	
nolysin tit	i	Erythr agglu	No.,	No. 29	No. 26	No. 34	
n titer and her	1	Erythrocytes	adsorption	No. 34		Br ₂ Pb_	
Table III Agglutinin titer and hemolysin titer of the anti-Br ₁ and Br ₂ immune sera	(a) Anti-Br ₁ agglutinin titer	Immune animal	No., Sex Serum- A+ or type A-	目才辰 VSTII	α, A +	人 <u></u> OF CE	
Ĥ	Anti-Br ₁ a	Imi	No., Sex	No. 24	Rabbit	Male	
	(a)	Immune	antigen	No. 23		$\mathrm{Br_1Pb}$	

		$\frac{1}{0240}$	1	1	1
		$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	+	1	+
	ram	$\frac{1}{2560}$	‡	! : ! 1	‡
	Dilution of antiserum	$\frac{1}{1280}$	丰	ı	‡
	of a	$\frac{1}{640}$	# # # # # #	١	‡
	tion	$\frac{1}{320}$	#	t	#
)ilu	$\frac{1}{160}$	#	1	#
	I	$\frac{1}{80}$	#	1	#
		$\frac{1}{40}$	#	1	# # #
		$\frac{1}{20}$	丰	1	#
	Erythrocytes for agglutination	No., Blood-group	$\mathrm{Br_1Br_2Pb}$	Br ₁ Pb_	Br ₂ Pb_
	Erythr agglu	No.,	No. 29	No. 26	No. 34
	Erythrocytes	adsorption	No. 26		Br ₁ Pb.
titer	nal	Surum- A+ or type A-	F.	A+	
agglutinin titer	nmune animal	${ m Surum}$ - ${ m type}$	Н	α,	
(b) Anti-Br ₂ a	Im	No., Sex	No. 22	Rabbit	Female
e	Immune	antigen	No. 34		$\mathrm{Br}_{2}\mathrm{Pb}_{-}$

Table III (cont.)

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Immune	Im	Immune animal	nal	Erythrocytes	Erythi her	Erythrocytes for hemolysis			P	ilutic	o uc	anti	Dilution of antiserum		
antigen	No., Sex	Serum- type	A+ or A-	ror adsorption	No.,	Blood-group	10	1 20	1 40	1 80 1	$\frac{1}{160} \frac{1}{320}$	20 640	$\begin{array}{c} 1 \\ 0 \\ 1280 \end{array}$	$\frac{1}{2560}$	$\frac{1}{5120}$
No. 23	No. 24	EINS	10.87	No. 34	No. 29	$\mathrm{Br_{1}Br_{2}Pb}_{-}$	丰	丰	#	+	,	1	1	I	l
. (Rabbit	TUΤΙΙ α'	A+	,	No. 26	Br ₁ Pb_	‡	#	#	+	. 1	l 1	1	1	1
${ m Br_1Pb}$	Male	EOF	夫人	Br ₂ Pb_	No. 34	Br ₂ Pb.	1	ı	1	1	'	1	1	ì	1
		CETACE	白本色							The second secon	Discourse of the second	*			
(p)	(d) Anti-Br ₂ h	hemolysin titer	titer												
Immune	Im	mmune animal	nal	Erythrocytes	Erythi her	Erythrocytes for hemolysis			D	ilutic	on of	anti	Dilution of antiserum		
antigen	No., Sex	Serum- type	A+ or A-	adsorption	No.,	Blood-group	10	1 2	1 40	$\frac{1}{80}$	$\frac{1}{160} \frac{1}{32}$	$\begin{array}{cc} 1 & 1 \\ 3\overline{20} & 64\overline{0} \end{array}$	$\begin{array}{cc} 1 \\ 0 & 1280 \end{array}$	$\frac{1}{2560}$	$\frac{1}{5120}$
No. 34	No. 22	RCH	7. j	No. 27	No. 29	Br ₁ Br ₂ Pb_	事	≢	#	丰	‡	+	1 +	ı	1
	Rabbit	α,	A+		No. 27	Br ₁ Pb_	l .	1	1	1	i	1	1	1	ı
Br ₂ Pb_	Female			Br ₁ Pb_	No. 34	Br ₂ Pb_	‡	#		#		1	1	1	1

Table IV Agglutinin titer and hemolysin titer of the anti-Pb immune serum

titer
agglutinin
Anti-Pb
(a)

Тттт	Im	Immune animal	nal	Erythrocytes	Erythr	Erythrocytes for agglutination			Ä	llutio	n of	anti	Dilution of antiserum	H		
antigen	No., Sex	Serum- type	A+ or A-	for	No.,	Blood-group	1 5	101	1 20	1 40	1 80 1	$\frac{1}{160}$	1 320 6	1 640 12	1280 24	$\frac{1}{2560}$
		E II	Μ́Л		No. 11	$\mathrm{Br_1Br_2Pb_+}$	#	丰	#	#	· =	+	ı	,	, , ,	1
0 Z	% ON	VST	日十	No. 34	No. 29	Br ₁ Br ₂ Pb-	ı	1	1	1	1			' 1		
0	Rabbit	Z Z	A -		No. 6	Br ₁ Pb+	‡	#	#	#	+	+) 1	,		1
$\mathrm{Br}.\mathrm{Pb}_{\pm}$	Female	TE C	+	Br ₂ Pb_	No. 27	Br ₁ Pb_	1	1	1	ı	1		1	1]	
		OF C			No. 8	Br ₂ Pb ₊	丰	#	#	#	+	+	1	(<i>'</i> 1		
		ETA			No. 34	Br ₂ Pb_	1	1	1	ı	1	1	1	'		1
(e)	(b) Anti-Pb h	hemolysin titer	titer		4					1				:		
Immune	Im	Immune animal	nal	Erythrocytes	Erythi hei	Erythrocytes for hemolysis			Ď	ilutic	n of	ant	Dilution of antiserum	В		
antigen	No., Sex	Serum- type	A+ or A-	adsorption	No.,	Blood-group	-1 2	12	1 20	1 40	$\frac{1}{80}$	1 160	$\frac{1}{320}$	1 640 15	1280 2	$\frac{1}{2560}$
		ARC			No. 11	$Br_1Br_2Pb_{+}$	#	#	#	+	1	1 -	1		1	1
δ. V.	NO. 98	Л Н		No. 34	No. 29	Br ₁ Br ₂ Pb_	1	i	1	ı	1	1	1	1	,	 1
0.004	Rabbit	, σ	Ą	8	No. 6	Br_1Pb_+	#	#	#	+	1	1	1]	1
${ m Br}_{s}{ m Pb}_{\pm}$	Female			Br ₂ Pb_	No. 27	Br ₁ Pb_	1	1	1	ı	1	ı	ı	1	1	1
					No. 8	Br ₂ Pb+	丰	#	#	+	ı	ı		1	1	
					No. 34	Br ₂ Pb_	1	1	1	ı	ı	ı	ı	1	1	ı

in the rabbit sera by immunization with each type of the beaked whale erythrocytes, are shown in the Tables III and IV.

It will be admitted from these tables that the rabbit is a little more sensitive to Br₁ than to Br₂, but the difference of the sensitivities is not so remarkable as in case of the two antigens of the sperm whale.

In case of the immunization by the antigens Br₁ and that by Br₂ fowls as immune animal fell into convulsions and gave up their breath. So the antisera of the fowls were not obtained. It seems to the author that the baired beaked whale erythrocytes are poisonous to the fowl.

As shown in the Table IV, titers of the anti-Pb antibodies are not so high.

3. Frequency of each type

The frequencies of the blood groups which belong to the Pc_1Pc_2 and Sp systems in the sperm whale and the Br_1Br_2 and Pb systems in the beaked whale is shown in the Tables V and VI. As the sampling of these materials were not carried out systematically, it would be expected in the future work to discuss the problems on the whale resources and habits.

The relationship between the foetal blood group ⁽³⁾and its mother whale's one is shown in the Table VI. The blood group of the foetus was confirmed with not only the agglutination and hemolysis but also with the adsorption test of the antibodies by their erythrocytes.

The body length at the period of delivery of the beaked whale foetus has not been classified enough up to the present day. From these examples, however, it may be approved that the blood groups are already formed at the body length of 2.53 meters (8 ft. 3 inch.) in male baired beaked whale and 2.61 metres (8 ft. 7 inch.) in female.

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Table V Frequency of the blood groups of the sperm whale caught in the adjacent waters of Japan, 1953

Pc_1 -type	Pc ₁ -type
Sp+ Sp- To. Sp+	Sp. To.
0 4 4	3 0 4 4
(0.0) (40.0) (40.0)	(40.0)
3 2	3 2 5
(18.8) (12.5) (31.3)	(12.5)
3 6 9	
(11.5) (23.1) (34.6)	(23.1)

Table VI Frequency of the blood groups of the baired beaked whale

med yet.	I :		Į.		t		I
ad not been perfor	Total	2	(100.0%)	4	(100.0%)	11	(100.0%)
ion of Pb system ha	$\mathrm{Br}_{2} ext{-type}$	63	(28.6)	П	(25.0)	හ	(27.3)
951. The classificat	$\mathrm{Br}_{1} ext{-type}$	ිට	(42.8)	63	(50.0)	ಚ	(45.4)
yagi Prefecture in 1	${ m Br_1Br_2}$ -type	2	(28.6)	_	(25.0)	က	(27.3)
(a) Catch off Ayukawa, Miyagi Prefecture in 1951. The classification of Pb system had not been performed yet.	Blood	RCI SISM	- Intaic	Fomolo	remain	Total	- 10cal
<u></u>							

Table VI (cont.)

(b) Catch off Ayukawa, Miyagi Prefecture in 1953

B	Blood	B	$\mathrm{Br_1Br_2}\text{-type}$	Φ		$\mathrm{Br_{1}\text{-}type}$			$\mathrm{Br}_{2}\text{-type}$			Total	
Sex	d so the	Pb_{+}	Pb.	To.	Pb+	Pb	To.	Pb+	-qa	To.	Pb+	Pb_	To.
Mala	q	П		23	61	27	29	7	0	-	4	28	32
7117	0	(3.1)	(3.1)	(6.2)	(6.2)	(84.5)	(90.7)	(3.1)	(0.0)	(3.1)	(12.5)	(87.5)	(100.0%)
 	Fomala	0	0	0	0	7	7	0	H	H	0	8	os.
D 1	0100	(0.0)	(0.0)	(0.0)	(0.0)	(87.5)	(87.5)	(0.0)	(12.5)	(12.5)	(0.0)	(100.0)	(100.0%)
Total	ta1		Œ Œ	63	63	34	36	П	Н	2	4	36	40
2	3	(2.5)	(2.5)	(5.0)	(2.0)	(85.0)	(90.0)	(2.5)	(2.5)	(5.0)	(10.0)	(90.06)	(100.0%)
			·····································										
`	!	•	頁句 RES	0									
ت	(c) Blood groups of the foetus	groups of	the foel	ens									
			Mother Whale	Vhale						Foetus	70		
No.	Date,	Date, caught	Body	Body length in ft.		Blood group		3ody leng	Body length in m.		Sex	Blood	Blood groups
2	July 14,	14, '53		37		$\mathrm{Br_1Pb}$	ļ	2.	2.53		male	Br_1	$\mathrm{Br_1Pb}$
38	Aug.	6, 153		36		Br ₁ Pb_		2.61	61	-	female	Br	Br ₁ Pb_

Anti-Sp Heterohemagglutinin proved in the sei-whale normal serum

Heterohemagglutinin against the Sp antigen was found in the serum of No. 91 northern type sei-whale ⁽⁴⁾(42 ft. long, male) having been caught in the northern Pacific Ocean, in 1953. The hemagglutination and adsorption tests by sperm whale erythrocytes are shown in the Tables VII and VIII. It may be admitted from this table that this agglutinin is completely adsorbed away by the Sp type cells in no connection with the Pc₁Pc₂ system and is confirmed to be anti-Sp agglutinin. Its titer was about 8 or 16 times.

Table VII Agglutination of the anti-Sp agglutinin which was found in the No. 91 northern type sei-whale's serum against the each type of the sperm whale erythrocytes

Sperm v	whale erythrocytes]	Dilut	ion	of th	ne sei	-whal	e ser	um
No.	Blood group	1 1	$\frac{1}{2}$	1 4	1 8	$\frac{1}{16}$	32	<u>1</u> 64	$\frac{1}{128}$
10	$Pc_1Pc_2Sp_+$	##	##	#	+	+	_		-
12	$^{\cdot}$ Pc ₁ Pc ₂ Sp	+	. —	-	-	-	-	-	-
5	Pc_1Sp_+	#	##	#	+	_		_	_
3	Pc_1Sp	+	-		-	-		_	_
4	Pc_2Sp_+	#	##	#	+	_	_		_
13	$\mathrm{Pc_2Sp}$	+		-	-	-	-	_	-

Table VIII Adsorption test of the anti-Sp agglutinin which was found in the No. 91 northern type sei-whale's serum by the each type of the sperm whale erythrocytes

Sperm whale		erm whale	$_{ m Dilut}$	ion o	f the	sei '	whale	serum
erythrocytes for adsorption		hrocytes for glutination	$\frac{1}{1}$	$\frac{1}{2}$	$\frac{1}{4}$	1 8	16	$\frac{1}{32}$
	10	$Pc_1Pc_2Sp_+$	##	##-	++	+	+	_
No. 12	12	Pc_1Pc_2Sp		-	-	_	_	_
	5	Pe_1Sp_+	#	#	#	+	-	_
~	3	Pe_1Sp	_	-	_	_		-
Pc_1Pc_2Sp	4	Pc_2Sp_+	#	##	#	+	_	-
	13	$\mathrm{Pc_{2}Sp}_{-}$	-	-	_	_		-

Table VIII (cont.)

Sperm whale		erm whale	Dil	utio	n o	f the	sei	whale	serum
erythrocytes for adsorption		hrocytes for glutination		<u>l</u>	$\frac{1}{2}$	$\frac{1}{4}$	1/8	16	32
	10	$Pe_1Pe_2Sp_+$	+	#	#	#	+	+	_
No. 3	12	Pc_1Pc_2Sp		_	-	-	_	-	-
	5	Pe_1Sp_+	\· 4	+	₩	#	+	_	-
	3	Pc_1Sp	-	_	_	_	_		-
Pe_1Sp	4	Pc_2Sp_+	4	H	##	#	4-		-
	13	$\mathrm{Pe_2Sp}_{-}$		_	_		-	-	_
	10	$Pc_1Pc_2Sp_+$	+	#	#	#	+	+	-
No. 13	12	Pc_1Pc_2Sp		~	-	_		_	_
	5	Pe_1Sp_+	-	+	#	#	+		
	3	Pe_1Sp	-	-	-	-		_	
Pc_2Sp	4	Pc_2Sp_+	+	H	#	#	- -	-	-
	13	Pc_2Sp		_	-	-	-	-	
	10	$Pc_1Pc_2Sp_+$		_	_	_	_	_	-
No. 10	12	Pe_1Pe_2Sp		-		-	-		
	5	Pc_1Sp_+	_	-	_	_	-	_	
~	3	Pc_1Sp		_			-	-	'
$Pc_1Pc_2Sp_+$	4	Pc_2Sp_+		-		-		-	_
	13	$\mathrm{Pe_{2}Sp}_{-}$		-	_	-	-	-	-
	10	$Pc_1Pc_2Sp_+$				_	-	_	_
No. 5	12	Pc_1Pc_2Sp			-	-	-	-	-
	5	Pc_1Sp_+		-	_	_	_	-	-
	3	Pc_1Sp		-	-			-	-
Pc_1Sp_+	4	$Pe_{2}Sp_{+}$		-	-	_	_	-	-
	13	Pc_2Sp		-	_	-	-	_	-
	10	Pe ₁ Pe ₂ Sp ₊			_	_	_		_
No. 4	12	Pc_1Pc_2Sp	7 - 17	_	-	-	-		
	拉 [5]	Pe_1Sp_+	、黑尔奕	107	Ħ	丹丁	-	-	. —
	STIT 3	Pc ₁ Sp_	EANE	ES	E,A,F	CH	-	-	
$\mathrm{Pc_{2}Sp}_{+}$	4	$Pe_{2}Sp_{+}$.	-		-		_	-
	13	Pc_2Sp			-	_		-	_

Conclusion

1. (a) The existence of the two kinds of antigens and one antigen, which were found independently each other in the sperm whale erythrocytes, was affirmed positively by the immune antibodies obtained by

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the immunization on rabbits or the domestic fowls with sperm whale red cells. In consequence, the sperm whale bloods were classified into six groups, namely Pc₁Pc₂SP+, Pc₁Pc₂Sp-, Pc₁SP+, Pc₁Sp-, Pc₂SP+ and Pc₂Sp-.

- (b) By the same manner as stated on sperm whale, baired beaked whale blood was classified into six groups, namely Br₁Pb+, Br₁Pb+, Br₁Pb+, Br₂Pb+ and Br₂Pb-.
- 2. (a) The frequency of blood groups of sperm whales caught in the adjacent waters of Japan is as follows:

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Pc_1Pc_2Sp+: 19.3\%, Pc_1Sp+: 11.5\%, Pc_2Sp+: 15.3\%

Pc_1Pc_2Sp-: 11.5\%, Pc_1Sp-: 23.1\%, Pc_2Sp-: 19.3\%
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(b) The frequency of blood groups of baired beaked whales caught off Ayukawa, Miyagi Prefecture, is as follows:

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Br<sub>1</sub>Br<sub>2</sub>Pb+: 2.5%, Br<sub>1</sub>Pb+: 5.0%, Br<sub>2</sub>Pb+: 2.5%
Br<sub>1</sub>Br<sub>2</sub>Pb-: 2.5%, Br<sub>1</sub>Pb-: 85.0%, Br<sub>2</sub>Pb-: 2.5%
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- 3. Two examples of blood groups of the baired beaked whale foetus were examined. Their blood groups were already formed at the body length of 2.53 meters in one male and at 2.61 metres in one female and were just same as their mother whales' blood group, namely Br₁Pb—type.
- 4. Heterohemagglutinin against the Sp antigen of the sperm whale red cells was recognized in the serum of the No. 91 northern type sei whale caught in the northern Pacific Ocean in 1953. Its agglutinin titer was about 8 or 16 times.

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