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

By

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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-whales[1] belonging to the baleen whale and the dolphin[2] 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 Pc_1Pc_2 and Sp systems in the sperm and Br_1Br_2 and Pb systems in the baired beaked respectively.

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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 Pc_1- and Pc_2- sera: When a rabbit or fowl is immunized with the sperm whale erythrocytes which belong to Pc_1Sp-, the anti-Pc_1Sp- 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 Pc_2Sp- or Pc_2Sp- erythrocytes, the anti-Pc_1 immune agglutinin and hemolysin are obtained. The anti-Pc_2 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 Pc_1 and Pc_2 in both, were perfectly consistent with each other. Consequently, the sperm whale blood was classified into three kinds, namely Pc_1Pc_2, Pc_1 and Pc_2 groups.

(b) Anti-sperm-whale Sp-ferum: When a rabbit is immunized with such the Pc_1Sp- erythrocytes as contains Sp antigen, the anti-Pc_1Sp- 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 Pc_1Sp- erythrocytes, the anti-Sp antibodiers are obtained. Instead of the Pc_1Sp+ and Pc_1Sp-, using the Pc_2Sp+ and Pc_2Sp- 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 Pc_1Pc_2 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 Br_1- and Br_2- 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 Br_1Br_2, Br_1 and Br_2 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-Br_1, Br_2 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 Br_1Br_2 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-Pc_1 antibody is lower in the case of using rabbit than fowl as immune animal. While it seems that the sensitivity in rabbit against Pc_2 is higher than that in fowl.

The titers of anti-Pc_2 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-Pc_2 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 Pc_2 antigen. As regards the difference between sensitivities of a rabbit against Pc_1 and those against Pc_2, it is to be shown in (c) and (f) of Table I that the anti-Pc_2 antibody reached to a the higher titer than the anti-Pc_1 antibody when the rabbit is immunized with the mixture of erythrocytes of Pc_1Sp- and Pc_2Sp-. It will be seen from this fact that the rabbit seems to be more sensitive to Pc_2 than to Pc_1.

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_1 and Pc_2 immune sera

(a) Anti-Pc_1 agglutinin titer

Immune antigen	Immune animal			Erythrocytes for adsorption	Erythrocytes for agglutination		Dilution of antiserum									
	No., Sex	Serum type	A+ or A−		No.,	Blood-group	1/20	1/40	1/80	1/160	1/320	1/640	1/1280	1/2560	1/5120	1/10240
No. 2 Pc_1Sp-	No. 26 Rabbit Female	o′	A−	No. 7 Pc_2Sp-	No. 12	Pc_1Pc_2Sp-	##	##	##	+	−	−	−	−	−	−
					No. 3	Pc_1Sp-	##	##	##	+	−	−	−	−	−	−
					No. 9	Pc_2Sp-	−	−	−	−	−	−	−	−	−	−
No. 2 Pc_1Sp-	No. 14 Fowl Female	o′		No. 7 Pc_2Sp-	No. 12	Pc_1Pc_2Sp-	##	##	##	##	##	##	##	##	##	+
					No. 3	Pc_1Sp-	##	##	##	##	##	##	##	##	##	+
					No. 9	Pc_2Sp-	−	−	−	−	−	−	−	−	−	−

(b) Anti-Pc_2 agglutinin titer

Immune antigen	Immune animal			Erythrocytes for adsorption	Erythrocytes for agglutination		Dilution of antiserum									
	No., Sex	Serum type	A+ or A−		No.,	Blood-group	1/320	1/640	1/1280	1/2560	1/5120	1/10240	1/20480	1/40960	1/81920	
No. 7 Pc_2Sp-	No. 23 Rabbit Female	α′	A−	No. 3 Pc_1Sp-	No. 12	Pc_1Pc_2Sp-	##	##	+	+	−	−	−	−	−	
					No. 3	Pc_1Sp-	−	−	−	−	−	−	−	−	−	
					No. 9	Pc_2Sp-	##	##	##	+	−	−	−	−	−	
〃	〃	〃	〃	No. 3 Pc_1Sp-	No. 12	Pc_1Pc_2Sp-	##	##	##	##	##	##	##	##	+	
					No. 3	Pc_1Sp-	−	−	−	−	−	−	−	−	−	
					No. 9	Pc_2Sp-	##	##	##	##	##	##	##	##	+	
〃	No. 15 Fowl Female	o′		No. 3 Pc_1Sp-	No. 12	Pc_1Pc_2Sp-	##	##	+	−	−	−	−	−	−	
					No. 3	Pc_1Sp-	−	−	−	−	−	−	−	−	−	
					No. 7	Pc_2Sp-	##	##	+	−	−	−	−	−	−	

* 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.)

(c) Agglutinin titers of the anti-Pc_1 and Pc_2 antibodies obtained by the simultaneous immunization.

Immune antigen	Immune animal			Erythrocytes for adsorption	Erythrocytes for agglutination		Dilution of antiserum								
	No., Sex	Serum-type	A+ or A−		No.,	Blood-group	1/160	1/320	1/640	1/1280	1/2560	1/5120	1/10240	1/20480	1/40960
Pc_1Sp- Nos. 1 2, 3 and Pc_2Sp- Nos. 7 9, 13	No. 27 Rabbit Female	o′	A+	No. 7 Pc_2Sp-	No. 12	Pc_1Pc_2Sp-	##	##	+	−	−	−	−	−	−
					No. 3	Pc_1Sp-	##	##	+	−	−	−	−	−	−
					No. 7	Pc_2Sp-	−	−	−	−	−	−	−	−	−
				No. 3 Pc_1Sp-	No. 12	Pc_1Pc_2Sp-	##	##	##	##	##	##	##	##	+
					No. 3	Pc_1Sp-	−	−	−	−	−	−	−	−	−
					No. 9	Pc_2Sp-	##	##	##	##	##	##	##	##	+

(d) Anti-Pc_1 hemolysin titer

Immune antigen	Immune animal			Erythrocytes for adsorption	Erythrocytes for hemolysis		Dilution of antiserum								
	No., Sex	Serum-type	A+ or A−		No.,	Blood-group	1/5	1/10	1/20	1/40	1/80	1/160	1/320	1/640	1/1280	1/2560
No. 2 Pc_1Sp-	No. 26 Rabbit Female	o′	A−	No. 7 Pc_2Sp-	No. 12	Pc_1Pc_2Sp-	##	##	##	+	−	−	−	−	−	−
					No. 3	Pc_1Sp-	##	##	##	+	−	−	−	−	−	−
					No. 9	Pc_2Sp-	−	−	−	−	−	−	−	−	−	−
No. 2 Pc_1Sp-	No. 14 Rabbit Female	o′		No. 7 Pc_2Sp-	No. 12	Pc_1Pc_2Sp-	##	##	##	##	##	##	##	+	−	−
					No. 3	Pc_1Sp-	##	##	##	##	##	##	##	+	−	−
					No. 9	Pc_2Sp-	−	−	−	−	−	−	−	−	−	−

Table I (cont.)

(e) Anti-Pc_2 hemolysin titer

Immune antigen	Immune animal			Erythrocytes for adsorption	Erythrocytes for hemolysis		Dilution of antiserum									
	No., Sex	Serum-type	A+ or A−		No.,	Blood-group	1/5	1/10	1/20	1/40	1/80	1/160	1/320	1/640	1/1280	1/2560
No. 7 Pc_2Sp-	No. 23 Rabbit Female	α'	A−	No. 3 Pc_1Sp-	No. 12	Pc_1Pc_2Sp-	++	++	++	+	+	−	−	−	−	−
					No. 3	Pc_1Sp-	−	−	−	−	−	−	−	−	−	−
					No. 9	Pc_2Sp-	++	++	++	+	+	−	−	−	−	−
〃	〃	〃	〃	No. 3 Pc_1Sp-	No. 12	Pc_1Pc_2Sp-	++	++	++	++	++	++	++	++	+	+
					No. 3	Pc_1Sp-	−	−	−	−	−	−	−	−	−	−
					No. 9	Pc_2Sp-	++	++	++	++	++	++	++	++	+	+
〃	No. 15 Fowl Female	o'		No. 3 Pc_1Sp-	No. 12	Pc_1Pc_2Sp-	++	+	+	−	−	−	−	−	−	−
					No. 3	Pc_1Sp-	−	−	−	−	−	−	−	−	−	−
					No. 7	Pc_2Sp-	++	+	+	−	−	−	−	−	−	−

(f) Hemolysin titer of the anti-Pc_1 and Pc_2 antibodies obtained by the simultaneous immunization

Immune antigen	Immune animal			Erythrocytes for adsorption	Erythrocytes for hemolysis		Dilution of antiserum									
	No., Sex	Serum-type	A+ or A−		No.,	Blood-group	1/5	1/10	1/20	1/40	1/80	1/160	1/320	1/640	1/1280	1/2560
Pc_1Sp- Nos. 1,2,3 and Pc_2Sp- Nos. 7, 9, 13	No. 27 Rabbit Female	o'	A+	No. 7 Pc_2Sp-	No. 12	Pc_1Pc_2Sp-	++	++	+	+	+	−	−	−	−	−
					No. 3	Pc_1Sp-	++	++	+	+	+	−	−	−	−	−
					No. 7	Pc_2Sp-	−	−	−	−	−	−	−	−	−	−
				No. 3 Pc_1Sp-	No. 12	Pc_1Pc_2Sp-	++	++	++	++	++	++	+	+	+	−
					No. 3	Pc_1Sp-	−	−	−	−	−	−	−	−	−	−
					No. 9	Pc_2Sp-	++	++	++	++	++	++	+	+	+	−

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

(a) Anti-Sp agglutinin titer

Immune antigen	Immune animal			Erythrocytes for adsorption	Erythrocytes for agglutination		Dilution of antiserum									
	No., Sex	Serum-type	A_+ or A_-		No.,	Blood-group	1/5	1/10	1/20	1/40	1/80	1/160	1/320	1/640	1/1280	1/2560
No. 5 Pc_1Sp_+	No. 25 Rabbit Female	α'	A_-	No. 3	No. 10	$Pc_1Pc_2Sp_+$	##	##	##	##	##	##	##	#	+	−
					No. 12	$Pc_1Pc_2Sp_-$	−	−	−	−	−	−	−	−	−	−
					No. 5	Pc_1Sp_+	##	##	##	##	##	##	##	#	+	−
				Pc_1Sp_-	No. 3	Pc_1Sp_-	−	−	−	−	−	−	−	−	−	−
					No. 8	Pc_2Sp_+	##	##	##	##	##	##	#	#	+	−
					No. 7	Pc_3Sp_-	−	−	−	−	−	−	−	−	−	−

(b) Anti-Sp hemolysin titer

Immune antigen	Immune animal			Erythrocytes for adsorption	Erythrocytes for hemolysis		Dilution of antiserum									
	No., Sex	Serum-type	A^+ or A^-		No.,	Blood-group	1/5	1/10	1/20	1/40	1/80	1/160	1/320	1/640	1/1280	1/2560
No. 5 Pc_1Sp_+	No. 25 Rabbit Female	α'	A^-	No. 3	No. 11	$Pc_1Pc_2Sp_+$	##	##	##	#	#	+	−	−	−	−
					No. 12	$Pc_1Pc_2Sp_-$	−	−	−	−	−	−	−	−	−	−
					No. 5	Pc_1Sp_+	##	##	#	#	#	+	−	−	−	−
				Pc_1Sp_-	No. 3	Pc_1Sp_-	−	−	−	−	−	−	−	−	−	−
					No. 4	Pc_2Sp_+	##	##	##	#	#	+	−	−	−	−
					No. 13	Pc_2Sp_-	−	−	−	−	−	−	−	−	−	−

Table III Agglutinin titer and hemolysin titer of the anti-Br_1 and Br_2 immune sera

(a) Anti-Br_1 agglutinin titer

Immune antigen	Immune animal			Erythrocytes for adsorption	Erythrocytes for agglutination		Dilution of antiserum									
	No., Sex	Serum-type	A_+ or A_-		No.,	Blood-group	1/20	1/40	1/80	1/160	1/320	1/640	1/1280	1/2560	1/5120	1/10240
No. 23	No. 24			No. 34	No. 29	$Br_1Br_2Pb_-$	##	##	##	#	#	+	−	−	−	−
	Rabbit	α'	A_+		No. 26	Br_1Pb_-	##	##	##	##	#	+	−	−	−	−
Br_1Pb_-	Male			Br_2Pb_-	No. 34	Br_2Pb_-	−	−	−	−	−	−	−	−	−	−

(b) Anti-Br_2 agglutinin titer

Immune antigen	Immune animal			Erythrocytes for adsorption	Erythrocytes for agglutination		Dilution of antiserum									
	No., Sex	Surum-type	A_+ or A_-		No.,	Blood-group	1/20	1/40	1/80	1/160	1/320	1/640	1/1280	1/2560	1/5120	1/10240
No. 34	No. 22			No. 26	No. 29	$Br_1Br_2Pb_-$	##	##	##	##	##	##	##	#	+	−
	Rabbit	α'	A_+		No. 26	Br_1Pb_-	−	−	−	−	−	−	−	−	−	−
Br_2Pb_-	Female			Br_1Pb_-	No. 34	Br_2Pb_-	##	##	##	##	##	##	#	#	+	−

Table III (cont.)

(c) Anti-Br_1 hemolysin titer

Immune antigen	Immune animal			Erythrocytes for adsorption	Erythrocytes for hemolysis		Dilution of antiserum									
	No., Sex	Serum-type	A^+ or A^-		No.,	Blood-group	1/10	1/20	1/40	1/80	1/160	1/320	1/640	1/1280	1/2560	1/5120
No. 23	No. 24			No. 34	No. 29	$Br_1Br_2Pb_-$	##	##	##	+	−	−	−	−	−	−
	Rabbit	α′	A^+		No. 26	Br_1Pb_-	##	##	##	+	−	−	−	−	−	−
Br_1Pb_-	Male			Br_2Pb_-	No. 34	Br_2Pb_-	−	−	−	−	−	−	−	−	−	−

(d) Anti-Br_2 hemolysin titer

Immune antigen	Immune animal			Erythrocytes for adsorption	Erythrocytes for hemolysis		Dilution of antiserum									
	No., Sex	Serum-type	A^+ or A^-		No.,	Blood-group	1/10	1/20	1/40	1/80	1/160	1/320	1/640	1/1280	1/2560	1/5120
No. 34	No. 22			No. 27	No. 29	$Br_1Br_2Pb_-$	##	##	##	##	##	+	+	−	−	−
	Rabbit	α′	A^+		No. 27	Br_1Pb_-	−	−	−	−	−	−	−	−	−	−
Br_2Pb_-	Female			Br_1Pb_-	No. 34	Br_2Pb_-	##	##	##	##	##	+	−	−	−	−

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

(a) Anti-Pb agglutinin titer

Immune antigen	Immune animal			Erythrocytes for adsorption	Erythrocytes for agglutination		Dilution of antiserum									
	No., Sex	Serum-type	A^+ or A^-		No.,	Blood-group	1/5	1/10	1/20	1/40	1/80	1/160	1/320	1/640	1/1280	1/2560
No. 8 Br_2Pb_+	No. 28 Rabbit Female	α'	A^-	No. 34	No. 11	$Br_1Br_2Pb_+$	##	##	##	##	##	+	−	−	−	−
					No. 29	$Br_1Br_2Pb_-$	−	−	−	−	−	−	−	−	−	−
					No. 6	Br_1Pb_+	##	##	##	##	+	+	−	−	−	−
				Br_2Pb_-	No. 27	Br_1Pb_-	−	−	−	−	−	−	−	−	−	−
					No. 8	Br_2Pb_+	##	##	##	##	##	+	−	−	−	−
					No. 34	Br_2Pb_-	−	−	−	−	−	−	−	−	−	−

(b) Anti-Pb hemolysin titer

Immune antigen	Immune animal			Erythrocytes for adsorption	Erythrocytes for hemolysis		Dilution of antiserum									
	No., Sex	Serum-type	A^+ or A^-		No.,	Blood-group	1/5	1/10	1/20	1/40	1/80	1/160	1/320	1/640	1/1280	1/2560
No. 8 Br_2Pb_+	No. 28 Rabbit Female	α'	A^-	No. 34	No. 11	$Br_1Br_2Pb_+$	##	##	##	+	−	−	−	−	−	−
					No. 29	$Br_1Br_2Pb_-$	−	−	−	−	−	−	−	−	−	−
					No. 6	Br_1Pb_+	##	##	##	+	−	−	−	−	−	−
				Br_2Pb_-	No. 27	Br_1Pb_-	−	−	−	−	−	−	−	−	−	−
					No. 8	Br_2Pb_+	##	##	##	+	−	−	−	−	−	−
					No. 34	Br_2Pb_-	−	−	−	−	−	−	−	−	−	−

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 Br_1 than to Br_2, 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 Br_1 and that by Br_2 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.

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

Sex \ Blood group	Pc_1Pc_2-type			Pc_1-type			Pc_2-type			Total		
	Sp_+	Sp_-	To.	Sp_+	Sp_-	To.	Sp_+	Sp_-	To.	Sp_+	Sp_-	To.
Male	2	1	3	0	4	4	2	1	3	4	6	10
	(20.0)	(10.0)	(30.0)	(0.0)	(40.0)	(40.0)	(20.0)	(10.0)	(30.0)	(40.0)	(60.0)	(100.0%)
Female	3	2	5	3	2	5	2	4	6	8	8	16
	(18.8)	(12.5)	(31.3)	(18.8)	(12.5)	(31.3)	(12.5)	(24.9)	(37.4)	(50.0)	(50.0)	(100.0%)
Total	5	3	8	3	6	9	4	5	9	12	14	26
	(19.3)	(11.5)	(30.8)	(11.5)	(23.1)	(34.6)	(15.3)	(19.3)	(34.6)	(46.1)	(53.9)	(100.0%)

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

(a) Catch off Ayukawa, Miyagi Prefecture in 1951. The classification of Pb system had not been performed yet.

Sex \ Blood group	Br_1Br_2-type	Br_1-type	Br_2-type	Total
Male	2	3	2	7
	(28.6)	(42.8)	(28.6)	(100.0%)
Female	1	2	1	4
	(25.0)	(50.0)	(25.0)	(100.0%)
Total	3	5	3	11
	(27.3)	(45.4)	(27.3)	(100.0%)

Table VI (cont.)

(b) Catch off Ayukawa, Miyagi Prefecture in 1953

Blood group / Sex	Br_1Br_2-type			Br_1-type			Br_2-type			Total		
	Pb_+	Pb_-	To.	Pb_+	Pb_-	To.	Pb_+	Pb_-	To.	Pb_+	Pb_-	To.
Male	1	1	2	2	27	29	1	0	1	4	28	32
	(3.1)	(3.1)	(6.2)	(6.2)	(84.5)	(90.7)	(3.1)	(0.0)	(3.1)	(12.5)	(87.5)	(100.0%)
Female	0	0	0	0	7	7	0	1	1	0	8	8
	(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	1	1	2	2	34	36	1	1	2	4	36	40
	(2.5)	(2.5)	(5.0)	(5.0)	(85.0)	(90.0)	(2.5)	(2.5)	(5.0)	(10.0)	(90.0)	(100.0%)

(c) Blood groups of the foetus

Mother Whale				Foetus		
No.	Date, caught	Body length in ft.	Blood group	Body length in m.	Sex	Blood groups
7	July 14, '53	37	Br_1Pb_-	2.53	male	Br_1Pb_-
38	Aug. 6, '53	36	Br_1Pb_-	2.61	female	Br_1Pb_-

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 Pc_1Pc_2 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 whale erythrocytes		Dilution of the sei-whale serum							
No.	Blood group	1/1	1/2	1/4	1/8	1/16	1/32	1/64	1/128
10	$Pc_1Pc_2Sp_+$	⧺	⧺	⧺	+	+	−	−	−
12	$Pc_1Pc_2Sp_-$	+	−	−	−	−	−	−	−
5	Pc_1Sp_+	⧺	⧺	⧺	+	−	−	−	−
3	Pc_1Sp_-	+	−	−	−	−	−	−	−
4	Pc_2Sp_+	⧺	⧺	⧺	+	−	−	−	−
13	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 erythrocytes for adsorption	Sperm whale erythrocytes for agglutination		Dilution of the sei whale serum					
			1/1	1/2	1/4	1/8	1/16	1/32
No. 12	10	$Pc_1Pc_2Sp_+$	⧺	⧺	⧺	+	+	−
	12	$Pc_1Pc_2Sp_-$	−	−	−	−	−	−
$Pc_1Pc_2Sp_-$	5	Pc_1Sp_+	⧺	⧺	⧺	+	−	−
	3	Pc_1Sp_-	−	−	−	−	−	−
	4	Pc_2Sp_+	⧺	⧺	⧺	+	−	−
	13	Pc_2Sp_-	−	−	−	−	−	−

Table VIII (cont.)

Sperm whale erythrocytes for adsorption	Sperm whale erythrocytes for agglutination		Dilution of the sei whale serum					
			1/1	1/2	1/4	1/8	1/16	1/32
No. 3	10	$Pc_1Pc_2Sp_+$	++	++	+	+	+	−
	12	$Pc_1Pc_2Sp_-$	−	−	−	−	−	−
	5	Pc_1Sp_+	+	++	+	+	−	−
Pc_1Sp_-	3	Pc_1Sp_-	−	−	−	−	−	−
	4	Pc_2Sp_+	+	++	+	+	−	−
	13	Pc_2Sp_-	−	−	−	−	−	−
No. 13	10	$Pc_1Pc_2Sp_+$	++	++	+	+	+	−
	12	$Pc_1Pc_2Sp_-$	−	−	−	−	−	−
	5	Pc_1Sp_+	+	++	+	+	−	−
Pc_2Sp_-	3	Pc_1Sp_-	−	−	−	−	−	−
	4	Pc_2Sp_+	+	++	+	+	−	−
	13	Pc_2Sp_-	−	−	−	−	−	−
No. 10	10	$Pc_1Pc_2Sp_+$	−	−	−	−	−	−
	12	$Pc_1Pc_2Sp_-$	−	−	−	−	−	−
	5	Pc_1Sp_+	−	−	−	−	−	−
$Pc_1Pc_2Sp_+$	3	Pc_1Sp_-	−	−	−	−	−	−
	4	Pc_2Sp_+	−	−	−	−	−	−
	13	Pc_2Sp_-	−	−	−	−	−	−
No. 5	10	$Pc_1Pc_2Sp_+$	−	−	−	−	−	−
	12	$Pc_1Pc_2Sp_-$	−	−	−	−	−	−
	5	Pc_1Sp_+	−	−	−	−	−	−
Pc_1Sp_+	3	Pc_1Sp_-	−	−	−	−	−	−
	4	Pc_2Sp_+	−	−	−	−	−	−
	13	Pc_2Sp_-	−	−	−	−	−	−
No. 4	10	$Pc_1Pc_2Sp_+$	−	−	−	−	−	−
	12	$Pc_1Pc_2Sp_-$	−	−	−	−	−	−
	5	Pc_1Sp_+	−	−	−	−	−	−
Pc_2Sp_+	3	Pc_1Sp_-	−	−	−	−	−	−
	4	Pc_2Sp_+	−	−	−	−	−	−
	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

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 Pc_1Pc_2SP+, Pc_1Pc_2Sp-, Pc_1SP+, Pc_1Sp-, Pc_2SP+ and Pc_2Sp-.

(b) By the same manner as stated on sperm whale, baired beaked whale blood was classified into six groups, namely Br_1Br_2Pb+, Br_1Br_2Pb-, Br_1Pb+, Br_1Pb-, Br_2Pb+ and Br_2Pb-.

2. (a) The frequency of blood groups of sperm whales caught in the adjacent waters of Japan is as follows:

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%

(b) The frequency of blood groups of baired beaked whales caught off Ayukawa, Miyagi Prefecture, is as follows:

Br_1Br_2Pb+:	2.5%	Br_1Pb+:	5.0%	Br_2Pb+:	2.5%
Br_1Br_2Pb-:	2.5%	Br_1Pb-:	85.0%	Br_2Pb-:	2.5%

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 Br_1Pb- 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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