

SCHOOL OF BALEEN WHALES IN THE FEEDING AREAS

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From the ecological point of view, the school of the baleen whale is one of the most important theme although it has not been fully studied. The observations on the school of whales from the aircraft, ships and the marking cruise have been carried out (Chittleborough, 1953 : Clarke & Ruud, 1954 : Brown, 1957 : 1958 : Nemoto, 1959 : Clarke, 1962), however, these are descriptions on the constituent number of whales in schools in general.

Andrews (1914), Slijper, (1958) and Nemoto, (1959) discuss the schools of baleen whales considering the socionomic sex ratio, the affection, number of whales and the mutual help among whales in a school. Some studies and discussions on the ecological segregations in the migrations of certain baleen whales also have been done, (Mackintosh, 1942 : Fujino, 1960 : Laws, 1961 : Nemoto, 1959 : 1962b), but it may be generally accepted that there has been few ecological study on the school of baleen whales.

The catch data and the whale marking results of the whales in the North Pacific and the Antarctic waters give biologists many materials, and I examine here them chiefly in the feeding grounds. The number of baleen whales in a school and the sex ratio are checked in a first step. Sexual maturity in each member of a school is also important for this study, however, it is impossible to examine the whales observed in the marking cruise in the sea. The most reliable data on the sexual conditions of the baleen whales are obtained through the investigations carried out in the factory ships, in the whaling stations, in the North Pacific and in the Antarctic. It should be noted that the most part of the sexual conditions are obtained in the feeding areas, not in the breeding areas in the lower latitudes. I would think the schools of baleen whales should be examined also in the breeding areas, in which the meaning of the school of baleen whales is somewhat different from that of schools in the feeding areas.

The whaling has been oppressing whales and have the great influence on the conditions of baleen whales such as migrations, reproductions and formations of schools. Especially the whaling in the feeding grounds break up the schools by the catch, and this affects the data treated here too.

Several populations are considered both in the Antarctic and in the North Pacific, and individual numbers of baleen whales effect the schooling of them. But materials are treated here as a whole in each whaling areas, Antarctic, North Pacific, and adjacent waters to Japan. Futher consideration will be made in due course on these points.

The term 'school' of baleen whales is also said in other ways, pod, herd and group. 'School' and 'herd' are commonly used in the biology of whales, and I use here the word 'school' for the baleen whales. According to Clarke, (1956)

the old whalers distinguished 'pods' or 'gams' numbering up to about twenty whales, 'schools' or 'shoals' of some twenty to fifty, and the 'herd' or 'body of whales' comprizing some fifty to serveral hundred. The term 'herd' is used mostly for the land mammals ungulates, 'school' for fish, and group' is used for the general expression in the recent ecology.

MATERIALS

The materials treated here consist of two parts. One is the marking data in the North Pacific, adjacent waters to Japan and the Antarctic ocean. The another is the catch data in the North Pacific by the Japanese factory ships in 1955 and 1956. The marking data base on three groups described following.

North Pacific	1953.....1961
Adjacent waters to Japan and Bonin Islands	1949.....1955
Antarctic	1954.....1961

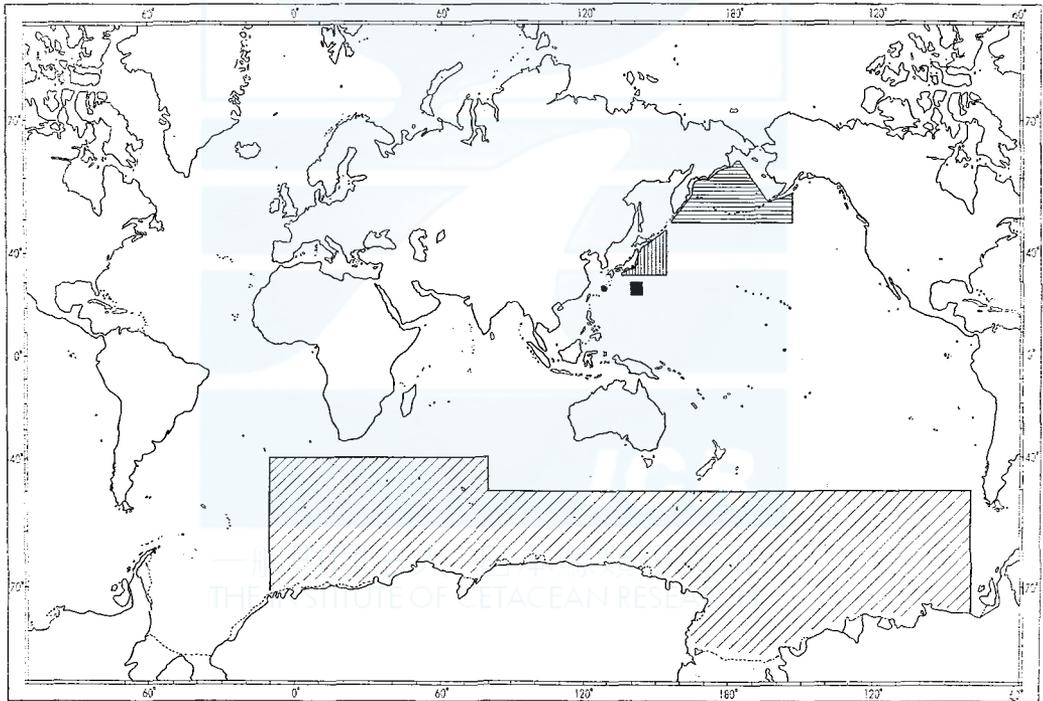


Fig. 1. The whaling grounds where the observations on the schools of baleen whales have been carried out. Lateral line—North Pacific pelagic: Straight line—Coast of Japan: Black circle—Okinawa, Black square—Bonin Island pelagic: Oblique line—Antarctic pelagic.

From the marking data, the number of whales in a school is discussed as well as the formations of the school of different species of baleen whales. The

socionomic sex-ratio and sexual conditions are mostly obtained from the biological data based on the whales caught in the North Pacific. The pair schools of cow and calf have been obtained through the marking research, and the variation in the number of baleen whales in a school from the marking and catch results both in the North Pacific and the Antarctic. These research areas are shown in Fig. 1.

SCHOOL OF BALEEN WHALES IN THE NORTH PACIFIC,
FIN WHALES (*BALAENOPTERA PHYSARUS*)

Number of fin whales in a school

The number of fin whales in a school has been discussed by Clarke & Ruud (1954) Nemoto (1959) and Clarke (1962). According to their reports and other descriptions (Chitterborough, 1953 etc), fin whales have been mostly found four or less in a school in the feeding areas. The schools consist of five or more whales are

TABLE 1. NUMBER OF FIN WHALES IN A SCHOOL
IN THE NORTH PACIFIC IN 1956

	Number of fin whales in a school									
	1	2	3	4	5	6	7	8	9	10~
June	62	88	32	17	8	3	2	—	—	—
July	178	204	100	72	32	9	5	10	—	18
Aug.	64	151	52	28	9	7	3	3	—	13
Sept.	1	2	—	—	—	—	—	—	—	—
Total	305	445	184	117	49	19	10	13	—	31

TABLE 2. SEASONAL OCCURRENCES OF SINGLE
FIN WHALES IN THE NORTHERN PACIFIC

	May		June		July		Aug.		Sept.		Total	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
1955	3	5	13	9	103	81	38	33	41	45	198	173
1956	—	—	26	36	78	100	28	36	—	1	132	173

TABLE 3. OCCURRENCES OF IMMATURE FIN WHALES
IN THE SINGLE SWIMMING FIN WHALE

	Mature		Imm.		Preg.	
	Mature	Imm.	Mature	Imm.	Mature	Imm.
1955	164	34	128	45	71 (55.5%)	
1956	110	22	141	32	62 (43.9%)	

comparatively scarce. The number of fin whales in a school in the North Pacific in 1956 is shown in Table 1 on 1298 fin whales. The number of fin whales in a school vary with the proceeding of the seasons, and the single swimming fin whale decreases in number in the late of summer (Nemoto, 1959).

This tendency is clearly shown in the Table 1 and Fig. 2. The one of the main reasons for the fact may be the leaving of the single swimming pregnant female to the breeding area as it has been considered (Mackintosh, 1942: Nemoto, 1959: Laws, 1961), however, July in the North Pacific must be the feeding season for fin whales and they come to the feeding areas in July successively. The forma-

tion of the school in the feeding areas also should be considered as suggested by the previous report (Nemoto, 1959).

Single swimming fin whale

From the observations in the catcher boats chasing fin whales are used for the examination. The seasonal occurrences of male and female in single swimming fin whales is given in Table 2 and 3 according to the data in 1955 and 1956. There is no consistent tendency in the occurrence of each sex, and no clear tendency in the occurrences of immature and pregnant whales too. It has been generally ac-

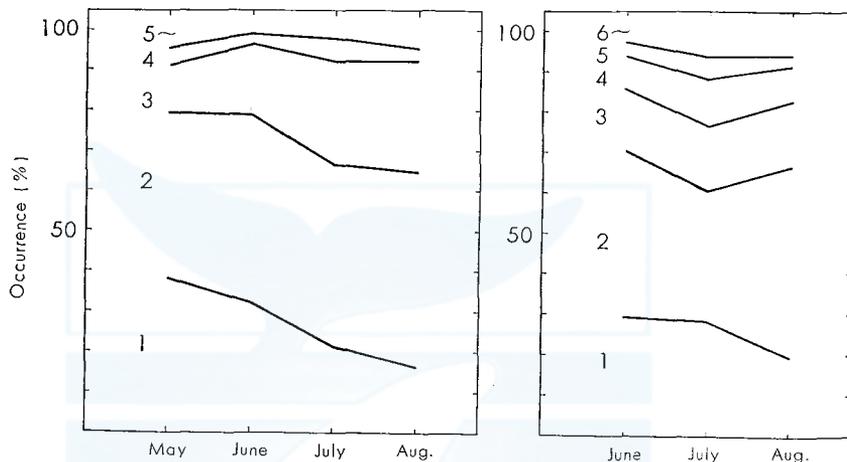


Fig. 2. Seasonal variations of the number of fin whales in a school in the North Pacific. Left—1954; Right—1956.

cepted that there are some ecological segregations in the baleen whales according to the sex and sexual conditions. But there is no peculiar feature in the characters of the fin whales in the data in 1955 and 1956. The pregnant ratio is also not so high or low comparing with other fin whales caught. Five lactating fin whales are present out of fifteen resting whales in 1955. The occurrence of the immature fin whales are also not so different from the total catch of the fin whale. This may partly be affected by the size regulation in the whaling. The shorter young fin whales may sometimes form a large school but they are saved from the catch. As a conclusion, single swimming fin whales in the feeding areas show no peculiar feature. But it will be re-examined by the further accumulated data in due course.

Pair fin whales

The catch data of the pair fin whales are not so large in number. Twenty-six pairs of fin whales in 1955 and sixty pairs in 1956 are caught by whaling, the occurrences of each sex of which are illustrated in Table 4. The combination of male and female is dominant among three combinations. Male and male combinations exceeds female and female combinations. This may be due to one reason of the affection between male and female from the school. The sexual conditions of

those pair fin whales are as follows. Although the number of cases is not so large, the immature combination of male and female is scarce. In the pair of female fin whales, the occurrences of the combinations of mature and immature females and immature combination are observed. Among the pregnant females in the pair of two female fin whales, there are two cases of the two female fin whales pregnant out of seven. Among the mature male and female pairs, four male and female combinations are pregnant out of nine in 1955. Twelve pairs out of twenty-five have the pregnant female and others are resting in 1956. From the above facts, it is considered that all these pairs of mature male and female fin whales are not the

TABLE 4. SEXUAL COMBINATIONS OF TWO FIN WHALES IN A SCHOOL IN THE NORTH PACIFIC (%)

	Female & Female	Female & Male	Male & Male	Total
1955	4(15.4)	16(61.5)	6(23.1)	26
1956	11(18.4)	33(55.0)	16(26.6)	60

TABLE 5. SEXUAL MATURITY IN TWO FIN WHALES IN A SCHOOL IN THE NORTHERN PACIFIC IN 1955 AND 1956

	F.* & F.	F. & M*.	M. & M.	F. & F.	F. & M.	M. & M.
Both Mature	1	9	4	6	25	12
Female Imm.	—	3	—	—	5	—
Male Imm.	—	2	—	—	2	—
One Imm.	3	—	2	2	—	3
Both Imm.	—	2	—	3	1	1

* M—Males, F—Females.

TABLE 6. OCCURRENCES OF MALE AND FEMALE FIN WHALES IN ONE FIN WHALE CAUGHT FROM A SCHOOL OF TWO FIN WHALES IN THE NORTH PACIFIC

	Female			Male		
	Mature	Imm.	Total	Mature	Imm.	Total
1955	95(57)	37	132	119	21	140
1956	127(56)	43	170	181	34	215

Numbers in bracket are pregnant females.

school from the breeding areas. Some of them may be formed in the feeding areas because these resting females are sometimes considered not to migrate to the breeding areas.

Three of female fin whales pairs are not pregnant, and other two cases have pregnant females in the pairs. Three cases of mature and immature fin whales out of five, the adult female fin whales are pregnant.

It seems that the more common pairs of fin whales in the feeding areas is composed of different sex fin whales, namely the pair of male and female. The tendency is confirmed by the catch of one fin whale from the pair of two fin whale's school. The number of fin whales caught as only one whale catch from the pair of two fin whale's school are shown in Table 6. The sex ratio is high in male both in 1955 and 1956. Generally speaking, the females are larger than males in *Ba-*

laenoptera whales, the selection may choose females better. But the contrary to this, the male is dominant. If the ratio of male and female fin whales is the same as it is seen in the former example in the pair of two fin whales, the probability of male from the pair fin whales is 0.539 in 1955 and 0.542 in 1956. The sex ratio of male is 0.515 in 1955 and 0.558 in 1956 which fairly coincide with the calculations. These combinations of the pair fin whales may be consistent both in two years in 1955 and 1956. The occurrences of immature fin whales do not differ from those of the catch of two fin whales in pair, however, the slight high maturity ratio is observed comparing with the single swimming fin whales. The pregnant ratios are 0.60 in 1955 and 0.44 in 1956 respectively which show no peculiar tendency.

Three fin whales in a school

The observation and chasing for three fin whales school are far less than the single and pair fin whales. There have been five cases in 1955 and only one in 1956. As shown in Table 7, one school is composed of all males, and three cases of two males and one female and one case of one male and two females. The three males in the male trio are sexually mature, however, one of which is just mature. Perhaps it is not the potential male and it may not play the active sexual behaviour considering the weight of the testis, 2.5 and 3.0 kg, (Nemoto, 1962).

TABLE 7. SEXUAL COMBINATION IN A SCHOOL OF THREE FIN WHALES IN THE NORTH PACIFIC IN 1955 AND 1956

	Sexual combination		
	3 males	2 males & 1 female	1 male & 2 females
1955	—	3	2
1956	1	—	—

TABLE 8. SEXUAL OCCURRENCES IN THE CATCH OF TWO FIN WHALES FROM THE SCHOOL OF THREE FIN WHALES IN THE NORTH PACIFIC IN 1955 AND 1956

	Sexual combination		
	Male & Male	Male & Female	Female & Female
1955	7	17	7
1956	14	15	5

One mature male and one mature but resting female and immature female make the school in one case, and one immature male, pregnant female and resting female make the another school of one male and two females. There are three cases of two males and one female. The mature males and one immature female are found in two cases, two mature males and a mature pregnant female are found in another case.

It is very difficult to get general tendencies about the school of three fin whales, however, it is interesting to note that two males and one female combinations occupy the first rank. The period of pregnancy is about a year in fin whales (Ohsumi, Nishiwaki & Hibiya, 1957; Laws, 1961), and the nursing may be about seven months. The number of males is dominant owing to above reason in schools as usually the cow and calf pair do not allow the joining of other male whales in the feeding areas.

There are rather many examples of the catch of two whales from the school of three fin whales. The occurrences of each sex are given in Table 8. The combination of male and female is dominant through the catch in 1955 and 1956, and two males' pair stands as the second. Especially fourteen pairs of males are caught out of thirty-four examples in 1956. As compared with the occurrences of three males school in 1956, it is the same tendency in the catch of the two fin whales from the schools of three fin whales. In 1955, seventeen pairs of male and female are caught

TABLE 9. SEXUAL CONDITIONS IN THE CATCH OF TWO FIN WHALES FROM THE SCHOOL OF THREE FIN WHALES IN THE NORTH PACIFIC IN 1955 AND 1956 EXCLUDING UNKNOWN PAIRS

	Sexual combination					
	Male & Male		Male & Female		Female & Female	
	1955	1956	1955	1956	1955	1956
Both mature	5	11	11	10	5	3
Mature & Immature	2	2	—	—	1	1
Both immature	—	—	1	2	1	—
Male mature & Female immature	—	—	4	3	—	—
Female mature & Male immature	—	—	1	—	—	—

TABLE 10. SEXUAL COMBINATIONS IN THREE FIN WHALES CAUGHT FROM THE SCHOOL OF FOUR FIN WHALES IN THE NORTH PACIFIC IN 1955 AND 1956

	1955	1956
Three males	—	1
Female & Two males	1	3
Two females & One male	1	—

TABLE 11. SEXUAL OCCURRENCES IN THE CATCH OF FIN WHALES FROM THE SCHOOL OF MANY FIN WHALES MORE THAN FIVE IN THE NORTH PACIFIC IN 1955

	2/5*	3/5	2/6	3/6	4/6	2/7	3/7	2/8	2/10	2/12	2/10-15	2/20**	2/50**
Number	13	3	7	3	1	2	1	2	4	1	1	1	1
Male & Male	5	—	3	—	—	—	—	1	—	—	—	1	—
Male & Female	6	—	4	—	—	1	—	1	3	1	—	—	1
Female & Female	2	—	—	—	—	1	—	—	1	—	1	—	—
Male & Two females	—	—	—	2	—	—	—	—	—	—	—	—	—
Three males	—	1	—	1	—	—	1	—	—	—	—	—	—
Two males & One Female	—	1	—	—	—	—	—	—	—	—	—	—	—
Three males & One female	—	—	—	—	1	—	—	—	—	—	—	—	—
Three females	—	1	—	—	—	—	—	—	—	—	—	—	—

* The lower shows the number of fin whales in a school and the upper shows number of whales caught.

** These schools are somewhat doubtful, possibly shoals of schools.

and there are seven pairs two males and two females respectively. The sexual conditions of those fin whales are as follows. Among the seven pairs of male and male, five cases are both mature and one mature in two cases. This may be affected by the size regulation for the catch as stated in the former part. In those groups, the pairs of mature male and immature female are more than the one of immature male and mature female in general, which is already pointed out in the case of two fin whales' school. Eleven pairs of males are sexually mature and two pairs are

composed of one mature male and another immature male in 1956. There are ten combinations of mature one male and another female fin whales, two combinations are sexually immature in both whales. Mature males and immature females form three cases but there is no case of immature male and mature female fin whales in 1956.

School composed of more than four

There is none of the record of the perfect catch of the school composed of more than four, but there are considerable number of the chasing for the school of many fin whales more than four. Two cases in 1955 and four ones in 1956 are found catching three fin whales from the school of four fin whales as illustrated in Table 10. It is very interesting to note that the males are dominant in the catch in spite of the size selection by catcher boats.

Especially the immature males are scarcely observed in those cases. If the size selection is effective for the catch of those fin whales, the number of female fin whales might be dominant. It is suggested the dominant catch of males show these school are composed of more males than females.

The example of the catch of fin whales from the schools of many fin whales is found in 1955. The occurrences of males and females are given in Table 11. Male fin whales are found more than female in general and if the size selection affect the catch it should be reverse to the facts. This tendency may confirm the general feature of schools of fin whales in the feeding grounds. In the land mammals, the socionomic sex ratio is high in females in their group and herd (Ito, 1959), the fact of which is the reverse to the fin whales.

It is interesting that the catch of immature males and females are observed from the comparatively large schools. Two fin whales are caught from the school of five fin whales in 1955, and both males are sexually immature. The body lengths are 53 and 50 feet and other fin whales in the same school are estimated as the same length. The catch of two fin whales from the school of five whales show those two females are immature, the body length of which are 58 and 59 feet respectively. These two cases show to some extent the young agers assemblage and sexual assemblage in fin whales as it is supposed up to this time.

Andrews also recognizes such assemblage in grey whales (Andrews, 1914). There have been sometimes found the school of fin whales more than ten, however, these schools may be the congregation of many schools especially in the feeding area to take the shoal of euphausiids. It is generally accepted the schools of many fin whales have been observed in their migration route to and from the feeding and breeding areas. Brown (1958) reports the greatest numbers of orquals observed by ships are about fifty and thirty in the north Atlantic.

BLUE WHALE (*BALAENOPTERA MUSCULUS*)

In the North Pacific, blue whales are ocean denizen and their main schools never penetrate into the Bering sea (Nemoto, 1959). The number of blue whales observed in the data is also small, and there still remains some question for the reliability of the samples.

Single swimming blue whales are dominant among the schools in the data, and thirty-six blue whales out of thirty-eight schools in 1955, and fifty-eight blue whales out of sixty-seven schools in 1956 are observed to be single in the feeding areas. In 1955, those single swimming blue whales are of more males than females and this is the same in 1956 too. Sexual maturity conditions are given in Table 12 but it is difficult to get any conclusion from the table because the number is rather limited.

The chasing and the catch are done for one school in 1955 and nine schools in 1956 which consist of two blue whales in a school. Two blue whales in a school are caught in 1955, one of which is male, sexually mature, and another is also male but it is considered it just attains sexual maturity. In 1955, two blue whales are

TABLE 12. SEXUAL CONDITIONS OF BLUE WHALES CAUGHT IN THE NORTH PACIFIC IN 1955 AND 1956

		Number of whales in a school			
		1		2	3
		Mature	Immature	Mature	Mature
1955	Male	22	4	2(2/2*)	2(2/3*)
	Female	7	3	—	—
1956	Male	28	2	8(1/2*)	—
	Female	21	7	1(1/2*)	—

* Upper shows the catch number and the lower shows the number of whales in a school.

caught from the three blue whales' school, which are sexually mature and just matured ones. I have nine cases of the capture that only one blue whale is caught from the two blue whales' school in 1956. All eight males are sexually mature and one sexually mature female blue whales is pregnant. It is suggested two blue whales' schools are composed of more males than female like the cases in 1955. But it is also considered the male sex ratio in single swimming blue whales is high, and the female blue whales swimming with calf escape the chasing by catcher boats.

The one reason that the number of blue whales in a school is rather small, is attributable to the relative abundance of blue whales in the North Pacific. Comparatively large schools of blue whales had been observed in the Antarctic in the former age of the whaling, when blue whales were dominant.

SEI WHALE (*BALAENOPTERA BOREALIS*)

There have been considerable differences among the annual catches of sei whales. The general tendency has not been obtained as for the school of sei whales, but three sei whales have been found in a school both in 1955 and 1956 as the maximum number. The school of six sei whales is reported in the previous report (Nemoto, 1959), however, the most common schools are up to three sei whales in a school. Generally speaking, the number of sei whales are comparatively small in a school comparing with other fin and humpback whales.

In 1955, ten males and nine females are caught from single swimming sei whales.

Four males and two females of them are sexually immature. But two immature sei whales have been caught from the school of two sei whales. Although the sample is rather scarce, it may be considered that immature sei whales sometimes swim alone to feed more often than the sexually mature sei whales. The sei whales caught in 1956 also show such tendency that the sexually mature whales form the school of two or more whales

The cases of two sei whales caught from two whales' school are observed both in 1955 and 1956. One case in 1955 and five cases in 1955 respectively. All sei whales are sexually mature and all females are pregnant, the compositions of which

TABLE 13. NUMBER OF SEI WHALES IN A SCHOOL CHASED BY CATCHER BOATS IN THE NOTH PACIFIC IN 1955 AND 1956

	Number of sei whales in a school		
	1	2	3
1955	19	11	2
1956	4	5	1

TABLE 14. SEXUAL COMBINATIONS IN SEI WHALES CAUGHT IN THE NORTH PACIFIC IN 1955 AND 1956 IN RELATION TO NUMBER IN THE SCHOOL

	2/2*			2/3*		3/3*
	M & M	M & F	F & F	M & M	M & F	M, F & F
1955	1	—	—	1	1 (Female pregnant)	—
1956	3	1 (Female pregnant)	1 (Both pregnant)	—	—	1 (Both females pregnant)

* Upper shows the number of sei whales caught from a school and the lower shows the number of whales in a school. M—Male, F—Female.

are given in Table 14. Although the number is rather small, the male pair is dominant among the schools, and there are one combination of male and female, and another of both females respectively. Three sei whales are caught from three whales' school in 1955. Two pregnant females and one sexually mature male are present in the school. There have been two cases of the catch of two sei whales from the school of three sei whales, and one is the pair of male and female sei whales, and two males are another.

Owing to the small number of the examples as repeated, there has been no clear tendency in the schooling of sei whales. It is suggested only that the two males' school is more than female combination in the school of two sei whales like the case in fin whales.

HUMPBACK WHALE (*MEGAPTERA NOVAEANGLIAE*)

The number of humpback whales caught in 1955 and 1956 is not so large as fin whales. In 1956, single swimming humpback whales are observed in nineteen cases and two humpback whales in a school eight cases. Three or more whales

found in a school are rather scarce, and humpback whales are observed up to seven in a school. The same tendencies are found in the data in 1955, when single humpback whales and schools composed of two humpback whales are dominant among them. Especially many pair humpback whales in a school are reported in 1955 as shown in Table 15.

TABLE 15. NUMBER OF HUMPBACK WHALES IN A SCHOOL IN THE NORTH PACIFIC IN 1955 AND 1956

	Number of whales in a school						
	1	2	3	4	5	6	7
1955	27	31	2	1	—	—	—
1956	19	8	1	1	1	—	1

TABLE 16. SEXUAL COMBINATIONS IN THE PAIR HUMPBACK WHALES IN THE NORTH PACIFIC IN 1955 AND 1956

	Sexual combination		
	Male & Male	Male & Female	Female & Female
1955	1	3	—
1956	1	1	1

TABLE 17. SEXUAL CONDITIONS OF HUMPBACK WHALES' SCHOOLS IN THE NORTH PACIFIC IN 1955 AND 1956

	1/1*				1/2*			
	1955		1956		1955		1956	
	Male	Female	Male	Female	Male	Female	Male	Female
Mature	10	8	7	5	7	6	1	2
Immature	—	9	2	5	—	4	1	1
(Pregnant)	—	(5)	—	(3)	—	(3)	—	—
Total	10	17	9	10	7	10	2	3

* Upper shows the number of whales caught and the lower shows the number of sei whales in a school.

TABLE 18. SEXUAL COMBINATIONS IN HUMPBACK WHALES IN THE NORTH PACIFIC IN 1955 AND 1956

	2/3*	2/4*	3/4*	2/5*	1/7*
Male	1	2	2	—	—
Female	1	—	1	2	1

* Upper shows the number of catch and the lower shows the number of whales in a school.

From the biological data collected on the whaling factory ships, comparatively many immature humpback whales have been found as the single swimming whale. The termination of two whales in a school is done in four cases in 1955 and three in 1956, the occurrences of each sex of which are given in Table 16. The pair of male and female is dominant among the schools although the school number is rather small. It is interesting the sexually immature male or female humpback whales are present in the pairs in five cases, and only two cases composed of sexually mature whales. This tendency has not been observed in other baleen whales.

The sexual conditions of one whale from the pair are illustrated in Table 17.

The catch of humpback whales from three or more party is far less compared with said cases. Three whales are caught from four humpback whales in a school in 1955 which composed of one resting mature female and one mature male and immature male. The occurrences of each sex in those catches from schools composed of three or more whales are given in Table 18.

The humpback whales in the breeding area seem not to form groups of many whales, Chittleborough (1953) describes only up to three adults in a school in the coasts of Australia, and Brown (1957:1958) describes that seven is the greatest number and other observations are all of single or very small parties in the north of the equator in the Indian ocean. About twelve whales are found in the coast of Australia in two of the four records in his report, however, the number of the observations on humpback whales in the area is rather scarce and these observations do not reliably sample the coastal areas of Australia as discussed by Brown. The sexual segregation in humpback whales in migration is very typical, and those results should be examined by further materials. In the breeding areas of the North Pacific, there is also very few data on the schools of humpback whales.

RIGHT WHALE (*EUBALAENA GLACIALIS*)

The observations, marking and biological research on right whales have been rather scarce both in the Antarctic and in the North Pacific. The observations on right whales in the North Pacific are given in Table 19. The single swimming right whale is dominant among the schools and four right whales is at most in a school. Japanese investigations on right whales have caught eleven right whales in recent years with special permission by government. And those right whales have been all single swimming right whales but one case, which consists of two right whales. When the one puberty female is caught (Kasuya, 1962. personal communication), it is said the another right whale comes back again after a little while and swims around the captured right whale.

TABLE 19. NUMBER OF RIGHT WHALES IN A SCHOOL
IN THE NORTH PACIFIC

		Number of whales in a school			
		1	2	3	4
1941-1957*	Coast of Japan	53	15	2	—
	North Pacific	58	30	4	2
1961-1963	North Pacific	21	8**	4	—

* Omura (1958).

** Including one cow and calf.

Other ten right whales consist of seven males and three females. Among seven males, three whales are sexually immature, and two females are also sexually immature out of four females. Two pregnant females are caught in 1963, when they are swimming as the single in the feeding areas in the North Pacific.

GREY WHALE (*ESCHRICHTIUS GLAUCUS*)

According to Gilmore (1958), grey whales are not a highly social animal, and the most commonly integrated social groups are the pair, and the trio. He considers the trio is made up usually a female and two males, and is also somewhat imparmanent. Scammon (in Andrews, 1914) writes also the case of the school, composed of a female, her calf and a male will go to the northward to the feeding. The observation of schools of grey whales are also found in the papers by Andrews (1914), Nasu (1960) and Pike (1962), which suggest the school of grey whales is sometimes containing many whales. As a important notice, the leadership by the female in the school of grey whales should be noted in relation to the land mammals such as deers. But the discussion by Andrews is a preliminary one, and these ecological points should be examined on more detail characteristics.

The available observations on the school of grey whales are rather few. In 1955, Japanese marking ship found grey whales feeding in the north-west sea of St. Lawrence Is. in Bering sea. In the descriptions, one to three groups of grey whales are mostly found. Two grey whales, 41 feet and 37 feet long are found in a school at 63-34N and 172-48W on 2th August. Other two pairs of grey whales, 40 and 36 feet, and 37 feet, and two trio (36 and 37 feet trio) are reported in the neighbouring waters and the most schools are single, pairs and trios.

In recent observations, Wilke and Fiscus (1961) describe eight grey whales in scattered pairs were seen moving toward narrow Kodiak and Ugak Is on 11th May in 1957, and two grey whales were seen from the 'John N. Cobb' feeding near 67-40N, 167-12W on 19th August in 1959, and on 20th Aug. three others are feeding. These observations confirm the comparatively small unit in schooling of grey whales in the feeding areas, although they sometimes form the huge congregations in the feeding areas in the narrow place.

DISCUSSION AND RESULT BY MARKING RESEARCH

The general observations on the school of whales chased in the marking research have been carried out in the North Pacific and the Antarctic, and the catch log on the recaptured marked whales usually refer the behaviour of the whales including other whales in the same school. From these materials, very interesting consideration on schools of baleen whales are deprived.

One of the most interesting example is found in the marking for the pair of cow and calf of fin whales in the North Pacific. In 1955, two cows with calves were marked on 18th July and 26th July. These adult females are caught in 1957, when they are feeding in the North Pacific solitary. Further, these two whales are pregnant. The patterns of the whales may be summerized as follows. In the summer of 1955, these two mother whales were feeding with their calves, and their calves were within two years after the birth, perhaps yearling, considering their body length (Ohsumi, Nishiwaki & Hibiyu, 1958 : Laws, 1961). The larger calf might be feeding on the planktons with his mother, as the body length is about 46 feet which is estimated

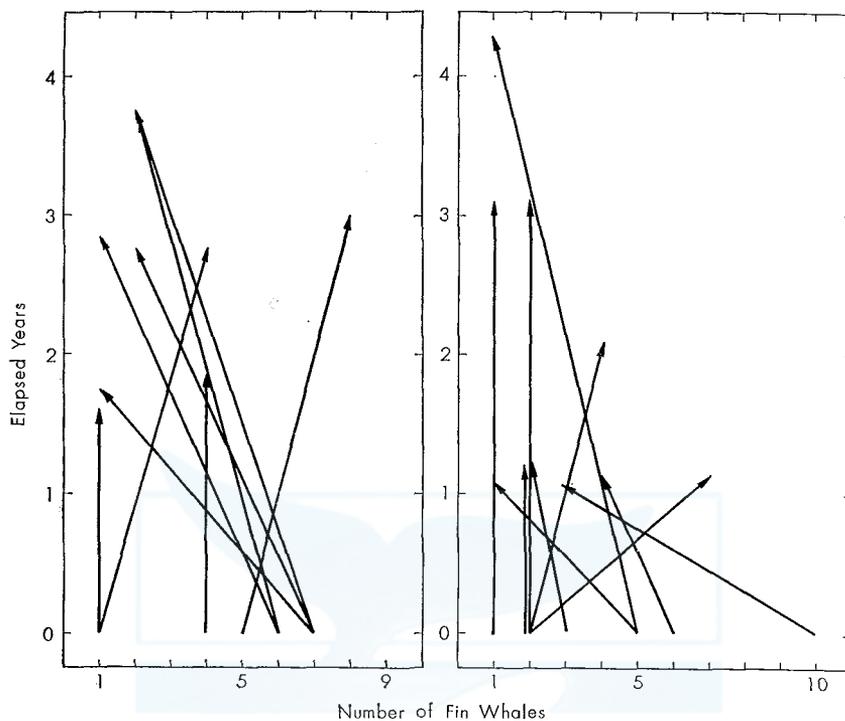


Fig. 3. Formation and separation in the number of whales in the school of fin whales in the Antarctic (Left) and North Pacific by the marking research.

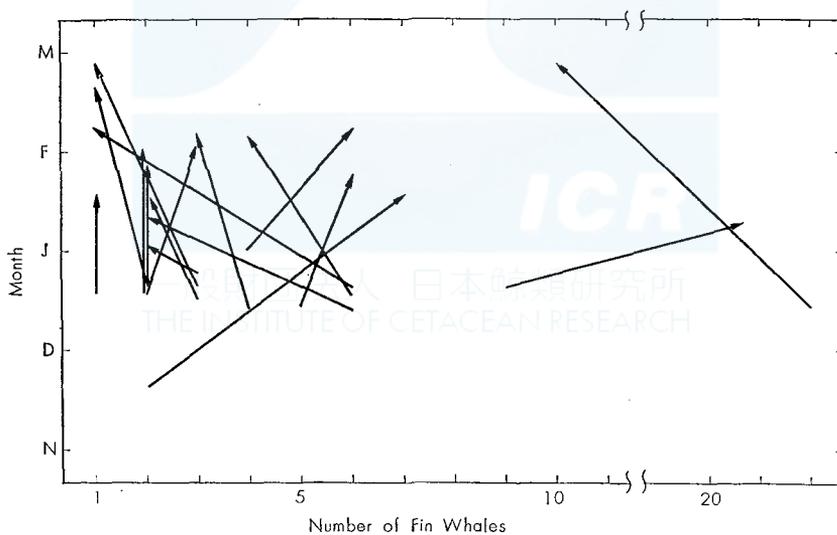


Fig. 4. Formation and separation in the school of fin whales in the Antarctic by the marking research. The marks are recovered within the summer Antarctic season of each case.

after the weaning. When the mother fin whales recaptured in the feeding areas in summer, they have five and nine months' fetuses calculated from the body length (Ohsumi, Nishiwaki & Hibiya, 1958). They must have copulated five and nine months in the late winter respectively. January and October are the possible breeding months for them and the grown calves might be free from the mother fin whales before the time of those copulations because there are few cases of the other whales joining in the pair of cow and calf schools. The fin whales separated with males after copulation between the fertilization and being caught.

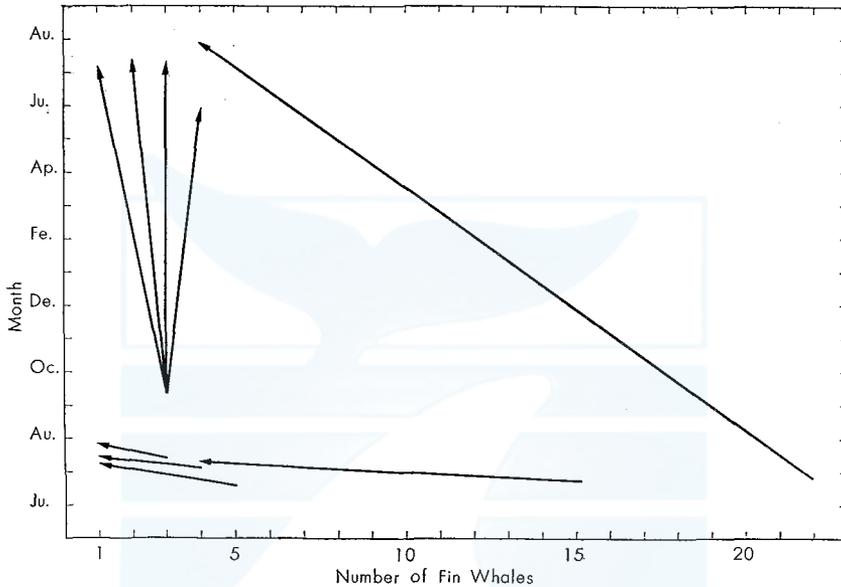


Fig. 5. Formation and separation in the number of whales in the school of fin whales in the North Pacific by the marking research. The marks are recovered within the season of each case.

The number of baleen whales in a school has been examined by the marking research too. As it is discussed in the former part, the single swimming fin whales are considered to decrease with the proceeding of the summer season in the observation of the catch log. But the marked fin whales in a school of many whales part with the parties, and they are found in the schools of smaller number. This would clearly show the breaking down of the school of fin whales in the feeding areas in the summer season too. Considering these two facts together, the school of fin whales may be inconstant in the feeding areas in the summer. It is not clear which is more important factor from the ecological point of view. The clear tendency to form the school of male and female pairs and some peculiar sex ratio should be considered again as one of the significant points in the school of fin whales in the feeding grounds.

If it is supposed that fin whales migrate south to breed, the formation of schools in the feeding areas may be very useful. On the other hand, the se-

peration of the sexually mature fin whales from the other younger whales in the school may break the school. It is considered to be natural that mutual affection is one reason to form or break the schools among the sexually mature fin whales. This type of the separation in the school of fin whales in the feeding grounds has been observed in the Antarctic too. The case of the formations in the school also have been observed, however, available examples are less than those of the separations.

To make up the gap of the above described results by the observations by catch log and the marking research, further accumulations of the materials are necessary. And it should be considered that the pregnant females, sometimes feeding alone in the feeding areas as discussed in the former part, leave the north sea feeding area earlier than other whales (Laws, 1959). The schools consist of many fin whales may separate and form each party by some reasons such as affections, and younger agers assemblage keep their schools still in the feeding grounds. These schools consist of comparatively many small whales are sometimes observed in the marking research in the North Pacific and the Antarctic.

The variation of the number of the whales in a school for a long time also has been checked by the marking the results of which are shown in Fig. 3, In these examinations, many schools of fin whales decrease the number of the party in the schools, but some schools have the participants, between the time being marked and caught.

Besides fin whales, the marking data on the schools of other baleen whales are rather scarce. In the North Pacific, a school of three blue whales is observed on 20th July and one of them, the marked whale, is found solitary after twelve days, on 24th July.

Five blue whales observed in a school in the Antarctic on 13th Dec. and they have six members in the next year, namely 22nd January, after the lapse of nineteen days. One of a pair of blue whales marked on 19th December in 1958 is caught on 8th February 1959 when the blue whale is swimming solitary.

There is one case of humpback whales in 1958. The pair of humpback whales marked on 25th December in the Antarctic and found in the next year in the same number pair of two on 1st February.

The ecological habit such as the forming or the breaking of schools must be connected with the very characteristic feeding migration in baleen whales. The solution of this origin and history may be one key to the problem (Marr, 1962).

SCHOOL OF DIFFERENT WHALE SPECIES

School of blue and fin whales

Sometimes baleen whales swim with different species of whales in the same school. Gunther (1949) describes the case of one blue whale swimming with four fin whales in a school in the Antarctic. From the data collected in the Antarctic from the year 1957 to 1958, it is reported five cases composed of blue and fin whales (Nemoto, 1959). In that paper, that the sexually immature blue whales swim with the sexual-

ly mature fin whales and the number of blue whales are always less than fin whales or the same number, is described. The followings discuss the problem chiefly according to the marking and the catch results.

School composed of fin and blue whales

There are eleven schools composed of fin and blue whales up to these days as given in Table 20, five of which were already reported in the previous paper (Nemoto, 1959). The number of blue whales are the same or less than fin whales, and the body length estimated by the crew of catcher boats shows the possible sexual immaturity as described by me. The school composed of less fin and more blue whales in number has not been observed in the records yet.

TABLE 20. THE OCCURRENCES OF THE SCHOOL COMPOSED OF FIN AND BLUE WHALES OBSERVED BY JAPANESE WHALE MARKING CRUISE IN THE ANTARCTIC FROM 1954 TO 1961

	Blue	Fin	Blue	Fin	Blue	Fin	Blue	Fin	Blue	Fin
Number of whales	1	1	1	1	1	2	1	2	1	3
Estimated body length in feet	62	71	70	68	73	60-63	78	?	72	63-65
Total number of whales in a school	2		2		3		3		4	
	Blue	Fin	Blue	Fin	Blue	Fin	Blue	Fin	Blue	Fin
Number of whales	1	4	1	4	1	5	2	4	2	Ca 10
Estimated body length in feet	?	?	80	65-67	70	65-70	73	64-65	?	50-65
Total number of whales in a school	5		5		6		6		8	

TABLE 21. THE OCCURRENCES OF THE SCHOOL COMPOSED OF FIN AND SEI WHALES IN THE FEEDING GROUNDS

	Antarctic		North Pacific		Fin		Sei	
	Fin	Sei	Fin	Sei	Fin	Sei	Fin	Sei
Number of whales	2	2	2	4	1	2	1	2
Estimated length of whales in feet	60	45	56-57	45-48	58	?	58	?
Total number of whales in a school	4		6		3		3	

School of fin and sei whales

There have been three cases of fin whales swim with sei whales in the records. In 1960, a school of two fin and two sei whales is observed in 56-32 S, 77-06W in the Antarctic, and two cases observed in the North Pacific. The latter cases are composed of two fin and four sei whales in one and one fin and two sei whales in another case. The body sizes of fin whales are comparatively small, and they are estimated to be sexually immature or just matured. On the contrary to this, the body length of sei whales are large and possibly sexually mature. I would consider this is the same tendency with the case of blue and fin whales and that the larger baleen whales sometimes swim with the different smaller species of baleen whales in the case that they are sexually immature and the number is the same or the less. The sexual potentiality may be the one reason to join a school

of different baleen whales in the feeding areas. This tendency is considered common in *Balaenoptera* whales both in the Antarctic and the North Pacific.

School of sei and bryde's whales

A school of sei and bryde's whales is observed in the adjacent waters to Japan in 1961. About 180 miles from Kinkazan, the north-east part of the Pacific coast of Japan, one mature male bryde's whale, testis of which are both 1.6 kg, is found swimming with a immature sei whale and those two whales are caught by catcher boat.

School of fin and little piked whales

A little piked whale (*Balaenoptera acutorostrata*) is observed in a school of fin whales on 13th Dec. in 1959, 59-17S, 82-52W in the Antarctic. But it may be accepted that the little piked whale only follows the school of fin whales a little while.

There has been no record of the school composed of *Balaenoptera* and *Megaptera* whales. Sometimes it is observed that humpback whales feed with *Balaenoptera* whales in the same feeding areas in the very near place and seem to be in the same school, but they are split into respective species after a while by the chasing. The swimming speed and the general diving depth may have the relation with the formation of schools in the case. And frequent turning in humpback whales is also one reason of the separation too.

Mackintosh (1942) and others (Matthews, 1938; Nemoto, 1959; 1962b) point out that the peculiar migrating time to the feeding areas and segregation in the distribution in the feeding areas both in the southern and the northern waters is observed in each baleen whale species. One example in the North Pacific is shown in Fig. 6. There are differences among the distributions of baleen whales according to species, and the primary preferences of their foods is considered as the first reason for their distributions. Blue whales feed only on euphausiids, and sei whales prefer copepods especially *Calanus plumchrus*, but they rarely take *Calanus cristatus* in these waters (Nemoto, 1959). Fin whales feed on euphausiids as well as copepoda, *Calanus cristatus*, but they rarely take *Calanus plumchrus* (Nemoto, 1959).

These selections of foods and different oceanographic conditions for each food species may form such distributions, however, the feeding range in each species of baleen whales and the occupation is considered if it is fixed within a certain time. Thus the two types of ecological segregations (Miyaji & Mori, 1953) are recognized in these distributions. In the previous report (Nemoto, 1959), I suggest the possible biological strength, numbers and migration time between two baleen whales cause some segregations in the feeding grounds. The case that the habit of feeding is affected also by the number of each species is pointed out by Elton on the land animal Buffalo (*Bos caffer*) in Africa (Elton, 1927).

These types of the segregations in the feeding grounds have been observed between blue and fin whales, fin and sei whales. In recent years, the distributions of fin whales become different from the former days, and sei whales also penetrate into the Antarctic high latitudes and waters of pack ice. This is partly attributed

able to the numbers of individuals and biological strength among baleen whales as suggested by Nemoto (1959). These biological strength may be confirmed by the presence of the school of different species as discussed in the former part.

There is another explanation for the fact that the different species baleen whales of the same size may sometimes swim together in the feeding grounds. But considering the number of baleen whales in a school, that the larger whales are usually less than the smaller species, the former is more suitable explanation for the problem.



Fig. 6. Distributions of baleen whales in the North Pacific in July in 1960, showing the different patterns in distributions of baleen whales by species. Open circle—Fin whales: Black circle—sei whales: Cross—Blue whales.

COW AND CALF PAIR

It seems rather rare that the pair of cow and calf swims with other whales even in the same species. Gunther (1949) describes a case that a cow and a calf swim with other whales but it is only one case in his report. Slijper (1958) also states the maintenance of the family in blue and right whales, however, the sources of which are not indicated.

Both in the Antarctic and North Pacific, the cases that the pair of cow and calf is found with other whales are rather scarce as illustrated in Table 22. But in humpback whales, the calves sometimes are accompanied not only by their mother whales but also other adults (Chittleborough, 1953).

In the *Balaenoptera* whales, only females give protections to their calves after their parturition. The new born calves in *Balaenoptera* whales can swim perfectly with their mother but the family of *Balaenoptera* whales consists only of females and

their calves in general. Those pregnant whales in feeding grounds might migrate to the south single or with other whales but they will be alone after their parturition.

Chittleborough (1953) observes two cases of cow and calf pairs of fin whales but no other whale in them in the waters off Australia in the lower latitudes.

TABLE 22. THE SCHOOL OF COW AND CALF PAIR AND OTHER WHALES FOUND WITH THE PAIR IN THE FEEDING GROUNDS

	Number of Cow & calf	Number of other whales with the pair						
		+1	+2	+3	+4	+5	+6	+9
Antarctic								
Blue whales	6	—	—	—	—	—	—	—
Fin whales	14	1	—	—	—	—	1	—
Humpback whales	9	4	1	2	—	1	—	1
North Pacific								
Blue whales	3	—	—	—	—	—	—	—
Fin whales	16	1	—	—	—	—	1	—
Sei whales	2	1	1	—	—	—	—	—
Humpback whales	9	1	—	1	—	—	—	—
Bryde's whales	8	—	—	—	—	—	—	—

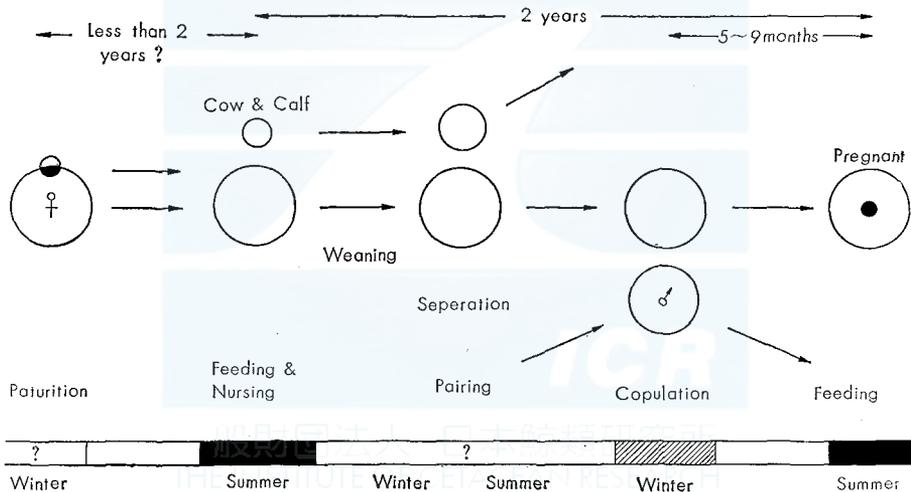


Fig. 7 Schema of the cycle of cow and calf fin whales in the North Pacific by the marking research. The marks were hit in 1955 and recovered in 1957 both in summer seasons.

The pair of cow and calf in humpback whales sometimes swims with other adult whales. This tendency is given in Table 22 too. Chittleborough (1953) also describes that a calf usually accompanies a single adults, but sometimes two adults were present. This confirms the results in the Antarctic area in Table 22. If the starting of the pair of cow and calf to the south only by themselves, the formation of the school may be done in the route or in the feeding areas where the range in

the distribution is rather small and they may contact with each other more often than other baleen whales. The companionship is built in their migration and feeding, however, the sex of the members are still unknown.

The pair of cow and calf have been observed in a considerable number in the feeding areas. But it is very rare to be found with other whales besides the family. Namely cow and calf form the family by themselves. The nursing duration is about seven in fin whales, and fin whales usually do not form the school of many whales with the family within it, as a conclusion.

It is clear from above facts, that *Balaenoptera* baleen whales do not accept the family (cow and calf) in their school although the calf of *Balaenoptera* is able to swim with their mother and adults.

SUMMARY

The preliminary consideration on the school of baleen whales in the feeding areas are made based on the Antarctic and the North Pacific baleen whales caught by the Japanese whaling and the whale marking data. The important points are as follows.

1. The number of baleen whales in a school is examined on fin, blue, sei, hump-back, right and grey whales. The seasonal change in the number of fin whales in a school is suggested.
2. The sex ratio and sexual combinations are studied on the school of baleen whales especially in fin whales. From the catch of the pair fin whales, the combination of male and male, and male and female fin whales are more than the one of both females. The sexual combinations of members of the trio and other schools of fin whales are also investigated.
3. Based on the marking research, the following up to the number of baleen whales in a school is done both in the Antarctic and in the North Pacific. The number of fin whales in a school varies and the breaking up of the school is observed in the feeding grounds. Two pregnant fin whales are caught which had been marked when they swam with calves, and they are feeding solitary, suggesting one type of the formation and separation of breaking the school in fin whales.
4. The peculiar feature of the school of different species of baleen whales are described. These schools are observed in fin and blue whales, fin and sei whales, and sei and bryde's whales. Among these combinations, the larger species of whales are the same or less in number than the smaller baleen whales in a school. The estimated body lengths of the blue whales in the school of fin and blue whales are comparatively short, and fin whales also small in the school of fin and sei whales and the possible reason, sexual potentiality, is suggested for the combination of different whale species.
5. The family of fin whales, cow and calf, is examined. It seems that the fin whales do not accept the family (cow and calf) into the school, and this tendency may be generally observed in *Balaenoptera* baleen whales.

REFERENCES

- ANDREWS, L.C. (1914). Monographs of the Pacific cetacea. 1, The California gray whale (*Rhachianectes glaucus* Cope). *Mem. Amer. Mus. Nat. Hist.*, N.S. 1(5): 231-84. 9pls.
- BROWN, S.G. (1957). Whales observed in the Indian Ocean. Noted on their distribution. *Marine Obs.*, London, 27: 157-65.
- (1958). Whales observed in the Aitlantic Ocean. *Marine Obs.*, 28(181) & (182): 142-6, 209-16.
- CHITTLEBOROUGH, R.G. (1953). Aerial observations on the humpback whale *Megaptera nodosa* (Bonnaterre), with notes on other species. *Aust. J. Mar. Freshw. Res.*, 4(2): 219-26. 2pls.
- CLARKE, R. (1962). Whale observation and marking off the coast of Chile in 1958 and from Ecuador towards and beyond the Galapagos Islands in 1959. *Norsk Hvalfangst-Tid.* 51(7): 265-87.
- CLARKE, R. & RUUD, J.T. (1954). International co-operation in Antarctic whale marking the voyage of the Enarn to the Antractic 1953. *Norsk Hvalfangst-Tid.* 43(3): 128-46.
- ELTON, C. (1927). *Animal ecology*. London
- FUJINO, K. (1960). Immunogenetic and marking approaches to identifying subpopulations of the north Pacific whales. *Sci. Rep. Whales Res. Inst.*, 15: 85-142.
- GILMORE, R.M. (1958). *The story of the gray whale*.
- GUNTHER, E.H. (1949). The habits of fin whales. *Discovery Rep.*, 25: 113-42.
- IMANISHI, K. (1951). *Ningen izen no Shakai*. [Society before the man.] Tokyo.
- (1959). *Dobutsu no Shakai to Kotai*. [Society and individual in animals.] Tokyo.
- ITO, Y. (1959). *Hikaku Seitaiigaku*. [Comparative ecology.] Tokyo.
- LAWS, R.M. (1959). The foetal growth rates of whales with special reference to the fin whales, *Balaenoptera physalus* Linn. *Discovery Rep.*, 29: 281-308. 1pl.
- (1961). Reproduction, growth and age of southern fin whales. *Discovery Rep.*, 31: 327-486. 4pls.
- MACKINTOSH, N.A. (1942). The southern stock of whalebone whales. *Discovery Rep.*, 9: 67-158.
- MARR, J.W.S. (1962). The natural history and geography of the Antarctic krill (*Euphausia superba* Dana). *Discovery Rep.*, 32: 33-464. 1pls.
- MATTHEWS, L.H. (1938). The sei whale, *Balaenoptera borealis*. *Discovery Rep.*, 17: 183-290. 2pls.
- MIYAJI, D. & Mori, K. (1953). *Dobutsu Seitaiigaku*. [The animal ecology.] Tokyo.
- NEMOTO, T. (1959). Food of baleen whales with reference to whale movements. *Sci. Rep. Whales Res. Inst.*, 14: 149-290. 1pl.
- (1962a). A secondary sexual character of fin whales. *Sci. Rep. Whales Res. Inst.*, 16: 29-34. 1pl.
- (1962b). Food of baleen whales collected in recent Japanese Antarctic whaling expeditions. *Sci. Rep. Whales Res. Inst.*, 16: 89-103.
- OHSUMI, S., NISHIWAKI M. & HIBIYA, K. (1957). Growth of fin whales in the northern Pacific. *Sci. Rep. Whales Res. Inst.*, 13: 97-134.
- PIKE, G.C. (1962). Migration and feeding of the grey whale (*Eschrichtius gibbosus*). *J. Fish. Res. Bd. Canada*, 19(5): 815-38.
- SLIJPER, E.J. (1958). Das Verhalten der Wale (Cetacea). *Handbuch der Zoologie*. 8Bd. 15 Lief., 14 Teil, 14 Beit., 1-32.
- WILKE, F. & FISCUS, C.H. (1961). Gray whale observation. *J. Mamm.*, 42(1): 108-9.