AGE CHARACTERISTICS OF EAR PLUGS OF WHALES

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INTRODUCTION

In the course of investigation of the sound conductivity in the Cetacea, especially in the fin whale, P. E. Purves found the lamination of the wax plug fitted in the external auditory meatus. This fact was described in the *Discovery Reports* Vol. XXVII published in March, 1955. To Purves's study many respects are paid by this author, and he supported that the lamination of the wax plug has periodicity very closely connected with age.

Purves further reported on the relation between age and body length at the sexual maturity. But his explanation did not seem quite satisfactory. Afterward Purves with R. M. Laws stated about the ear plug of the North Atlantic fin whale and supplemented the forementioned report. It is not very appropriated that the samples cited in their reports contain more males than females.

On board F/F " Tonan-maru " in the 1955/56 Antarctic whaling season, the author collected several ear plugs from the fin whales mainly females. The lamination of ear plug of these samples was compared with other age-determination data in this report.

Greatful thanks are due to the Nippon-Suisan Co. for help in the collection of the materials on board of the F/F " Tonan-maru ". Acknowledgement is especially due to Mr. Kohtaro Ono who assisted the author in collecting ear plug, and it is also due to Mrs. Kazuko Morita who prepared the materials for observation.

MATERIALS AND METHOD OF OBSERVATION

The data of the materials of this report are shown in Table 1. In the collection of samples it so devised that samples as many as available be collected excepting unusual data. On the factory ship, however, every possible care must be taken not to curtail the efficiency of flensing work of collection. To this end the materials were collected only by the author himself and a specified person. This man had no experience of ear plug collection and he carried out this collection as a side work. Next season more samples should be collected to make the data available for age determination of whales taken.

The materials were divided into halves; one part was dried in the air, and the other part was preserved in 10% formalin.

TABLE 1. OBSERVATIONS ON WHALES CAUGHT IN THE ANTERCTIC SEASON 1955/56

Serial No.	Species	Sex	Body length (feet)	Number of lamination	Length of core (mm)	Number of corpora albicantia	Foetus	Weight of testis (kg)	Age-group from baleen	Absorption of crystalline lens	Ossification of vertebra
10T 285	F	F	60	4	13	0 0 0 0	−		III	94	
〃 286	〃	〃	74	44	42	0 15 0 12	+		V	79	T6:A
〃 363	〃	〃	68	20	31	1 1 0 2	+		IV	86	
〃 364	〃	〃	73	53	71	1 17 0 15	+		VI	83	
〃 376	〃	〃	73	45	57	1 8 0 9	+		V	82	
〃 397	〃	〃	59	7	20	0 0 0 0	−		II	93	
〃 485	〃	〃	73	49	48	1 5 0 5	+		VI	77	
〃 498	〃	〃	73	31	54	1 7 0 5	+		V	84	T6:N
〃 499	〃	〃	76	23	54	1 6 0 3	+		VI	85	T10:N
〃 534	〃	〃	62	12	29	1 0 0 0	+		IV	92	
〃 535	〃	〃	70	41	68	1 6 0 5	+		V	87	T3:a, T6:a T10:A, L1:A
〃 567	〃	〃	74	65	44	1 20 1 18	+		V	74	
〃 585	〃	〃	69	41	55	1 6 0 8	+		V	84	T7:a
〃 776	〃	〃	53	6	17	0 0 0 0	−		II	93	
〃 837	〃	〃	74	64	87	1 15 0 16	+		VI	78	
〃 924	〃	〃	74	61	85	1 11 0 15	+		VI	80	T7:a
〃 958	〃	〃	70	18	64	1 3 0 2	+		VI	85	
〃 1022	〃	〃	72	55	61	0 7 0 15	−		VI	78	
〃 1028	〃	〃	72	32	37	1 3 0 10	+		VIII	83	
〃 1058	〃	〃	72	70	70	1 17 0 22	+		VI	75	
〃 1069	〃	〃	65	9	16	0 0 0 0	−		IV	91	
〃 1320	〃	〃	73	37	52	1 8 0 13	+		VI	86	
〃 1400	〃	〃	70	29	71	1 3 0 3	+		VI	82	T7:n
〃 1431	〃	〃	72	50	63	1 8 0 15	+		VI	78	
〃 1440	〃	〃	70	13	38	1 2 0 1	+		VI	90	

TABLE 1. (*Continued*)

Serial No.	Species	Sex	Body length (feet)	Number of Lamination	Length of core (mm)	Number of corpora albicantia	Foetus	Weight of testis (kg)	Age-group from baleen	Absorption of crystaline lens	Ossification of vertebra
10T1471	F	F	62	10	27	0 0 0 0	–		IV	91	
〃 1522	〃	〃	72	23	53	1 2 0 4	+		VI	88	T7:N L1:n
〃 1551	〃	〃	72	17	34	1 1 0 2	+		V	89	
〃 1585	〃	〃	71	56	90	0 9 0 10	–		VI	82	
〃 1613	〃	〃	70	28	33	1 5 0 2	+		V	86	
〃 1705	〃	〃	62	13	34	0 0 0 0	–		IV	86	
〃 1755	〃	〃	72	86	85	1 21 0 31	–		VII	72	
〃 1780	〃	〃	75	37	63	1 12 0 6	+		VI	80	
〃 1820	〃	〃	62	9	29	0 0 0 0	–		IV	90	
〃 131	〃	M	58	17	31			1.7 1.6	III	90	
〃 319	〃	〃	62	33	49			over 10.0 〃 10.0	III	81	
〃 1023	〃	〃	62	29	46			10.0 10.0	IV	88	
〃 1025	〃	〃	64	34	26			4.7 4.5	IV	82	
〃 1352	〃	〃	66	25	37			over 10.0 〃 10.0	V	87	
〃 603	B	F	81	10	25	1 0 0 0	+		V	88	
〃 605	〃	〃	85	12	26	0 1 0 2	–		VI	85	
〃 1162	〃	〃	80	8	26	0 1 0 0	–		VI	90	
〃 628	H	〃	47	20	34	1 2 0 5	+		IV	84	
〃 727	〃	〃	41	25	84	1 5 0 3	+		V	79	T6:N L1:N

Species: F=fin whale; B=blue whale: H=humpback whale.
Sex: F=female; M=male.
Ossification: T=thoracic; L=lumbar; A=ankylosed, no sign of join; a =ankslosed, but a sign of join visible; n=not ankylosed, thin cartilag; N=not ankylosed, thick cartilage.

The lamination of ear plug was observed by two method. As the first step the lamination was read by X-ray photographs. In this case the lamination of the dried materials could be observed clearly than the formalin preserved materials. In the young viz. thick lamination materials were read easily, but in the aged viz. very thin lamination mate-

rials were hard to read according to the two preservation methods. The other method was to grind down the ear plug to the level of the longitudinal axis. The lamination was observed with a magnifying-glass or a dissecting-microscope. In this case the dried materials with thin lamination were defective, because they were broken into drops. The formalin preserved materials were suitable for grinding down, because they had moderate stickness and hardness. But the young viz. soft materials were not suitable for grinding down by the two methods. It was thought that they would be better to be observed by X-ray.

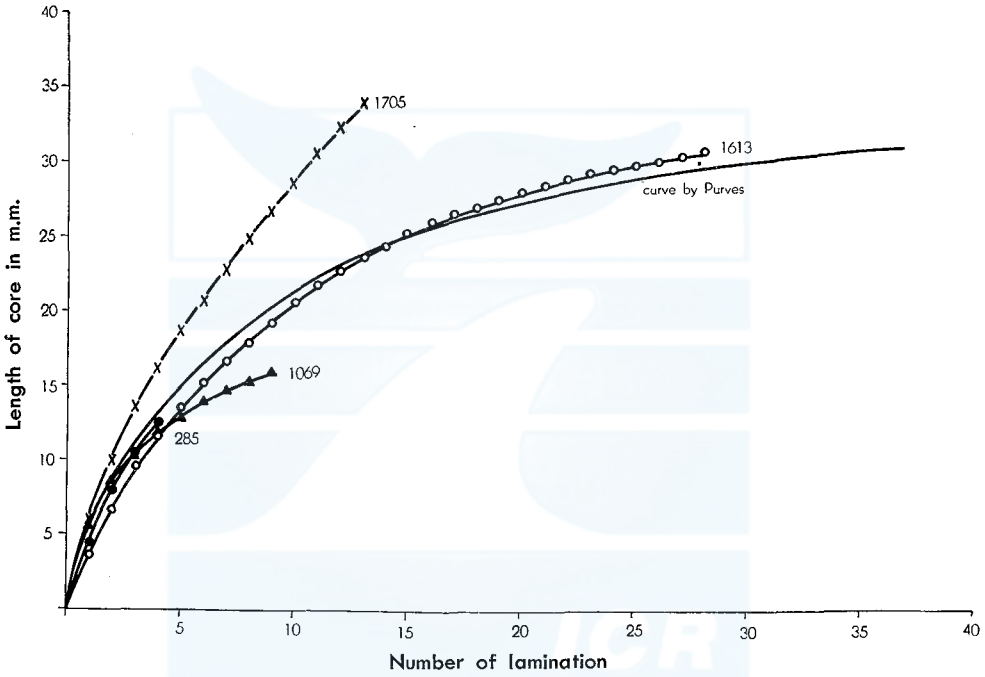

Fig. 1. Growth curve of the core of the ear plug in several fin whales.

DISCUSSION

Purves illustrates the growth curve of the core of wax plug in respect to a male specimen from the southern hemisphere with the same number of laminations as Lillie's specimen. On the right side of his illustration, he writes down the body length corresponding to the age shown by the number of laminations. In the impression from this figure is that the growth curve is very systematicaly and that the number of laminations may be presumed from some length of core. And further more, it seems that some rule may exist between the length of core and the body length.

As shown in Fig. 1, a sample (10T1613=No. 1613 whale of 10th "Tonan-maru" expedition), which has almost the same growth curve illustrated by Purves, was collected. Some samples (10T285, 10T1069) in young stage viz. few number of laminations showed nearly the same growth with Purves's curve. These samples were measured regarding the thickness of each lamination according to the method of Purves. On the other hand, it was quite different in the case of the length of core which is the sum of the thickness of each lamination. These data are shown in Fig. 2. Each sign is plotted against the length of core

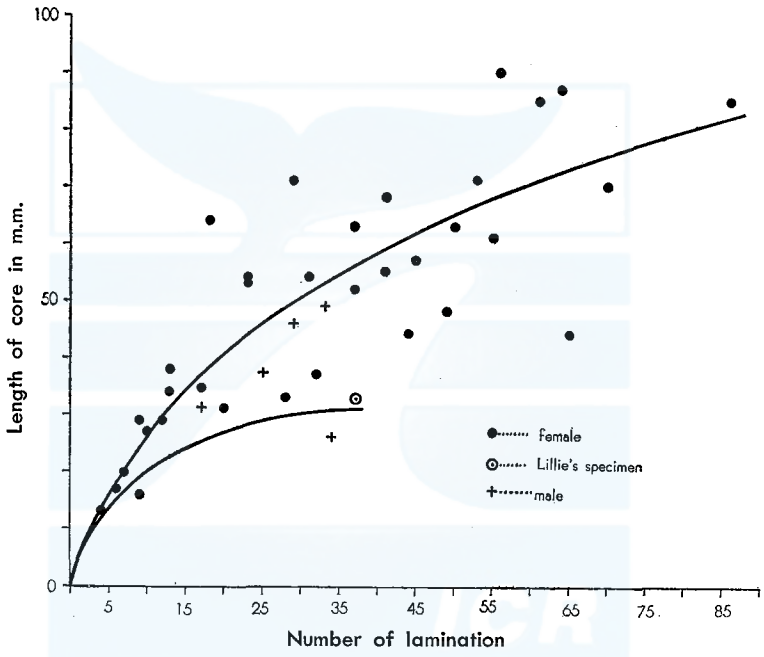

Fig. 2. Variation of core length in different ear plug.

of ear plug in individual whales according to the number of laminations. There are many variances in these plotted points, and big individual variations are found in the increase of the thickness of lamination. Then, the example of the same number of laminations as in Lillie's specimen shown by Purves seems to be an example of the least growth. This fact is clarified in *The Norwegian Whaling Gazette* No. 1 of 1956 by examples of H. W. Symons (Symons exampled only length of plug, except length of core or number of lamination).

The relation between the number of lamination and the number of corpora albicantia is shown in Fig. 3, The straight line in the figure shows an average. The variances are relatively small and the relation

is settled well. Marks (+) in the figure are the data from Laws and Purves. These data are limited and on young stages only, so they do not seem to explain the aspect, but they are in the approval limit of the average line. From Fig. 3 it is considered that 10 laminations are evenly matched to 1 corpus albicans. If the explanation of Purves refers to 10 laminations, that will take 4-5 years just to reach the sexual maturity. This age does not coincide with the principle of Mackintosh which was cited in the report of Purves, but coincides which the age of sexual maturity in the report of the author formerly published.

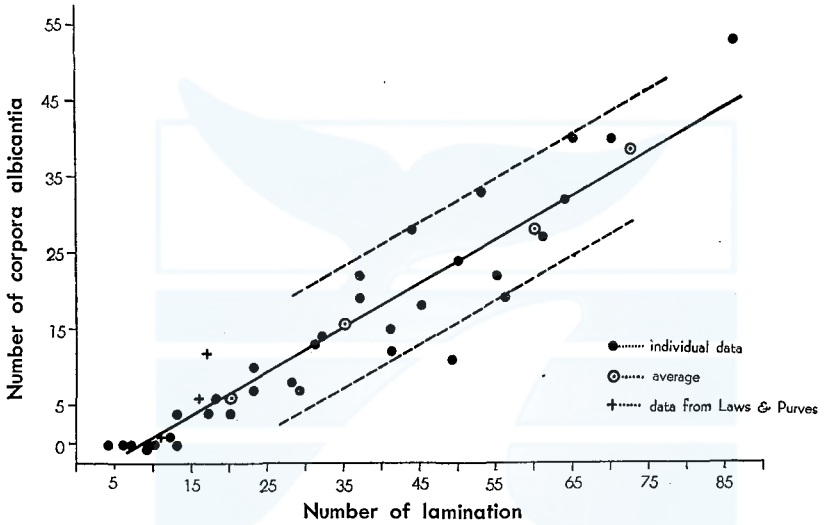

Fig. 3. Relation between number of corpora albicantia and number of lamination in the ear plug.

If the two laminations grow up in a year, on the average line of this figure the ovulation is formed at the average rate of 2.4 per one breeding season. This fact almost coincides with the present studies in this field. Next regarding the body length according to the number of corpora albicantia (in Fig. 4) and the number of laminations (in Fig. 5), it was expected that the co-ordinates of the number of corpora albicantia and the number of laminations would be placed by the average rate in Fig. 3. But they are not the same in these figures. Owing to the shortage of data, it might exaggerate the fact, but, the average line is much the same in Figs. 4 and 5. In Fig. 4, nothing of corpora albicantia is minimum, so it is impossible to prepare the immature females. On the other hand, Fig. 5 shows that the immature females may be possible to be classified according to the number of laminations (or in some age groups). It is very useful that male's data can be compared in the female's figure with the same values. In the other study, it was observed

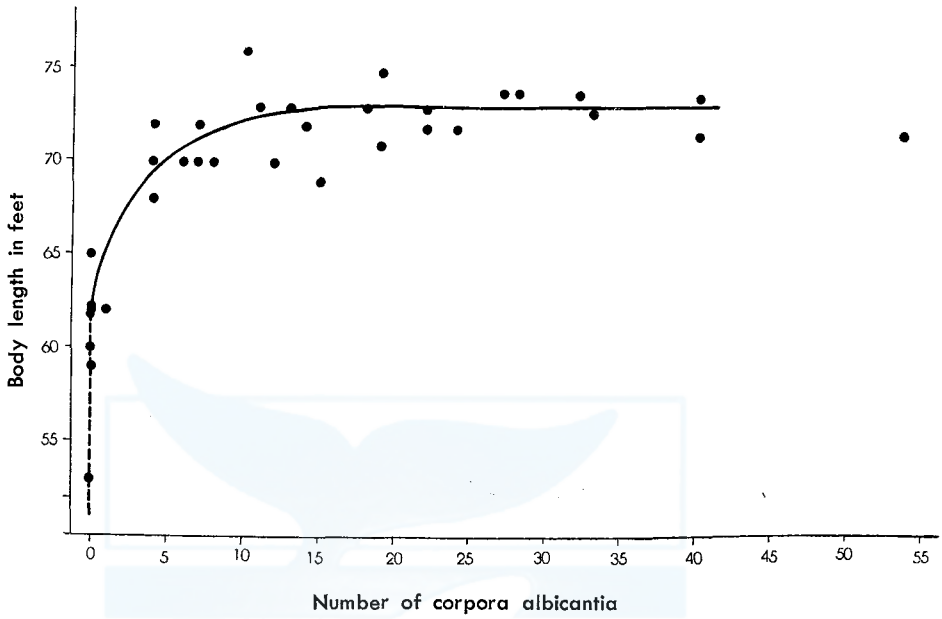

Fig. 4. Increase of body length according to number of corpora albicantia.

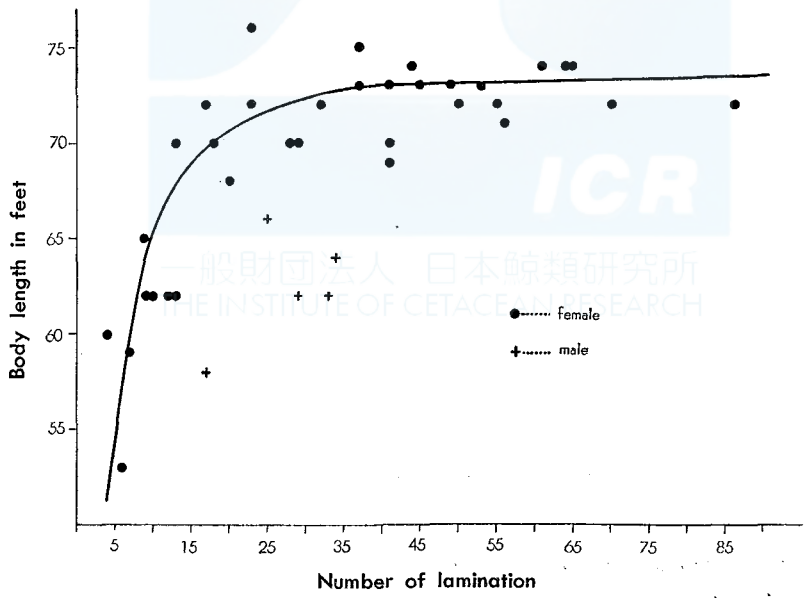

Fig. 5. Increase of body length according to number of lamination in the ear plug.

that the female fin whale of the southern hemisphere attained to the sexual maturity in 64 feet of body length and reached the physical maturity at 14–15 of corpora albicantia numbers. On the average line

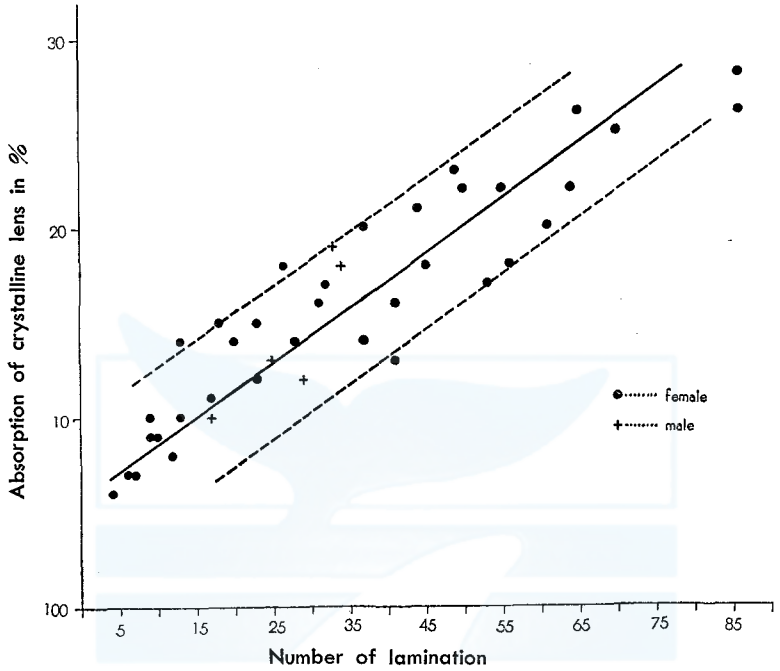

Fig. 6. Relation between light absorption of crystalline lens and number of lamination in the ear plug.

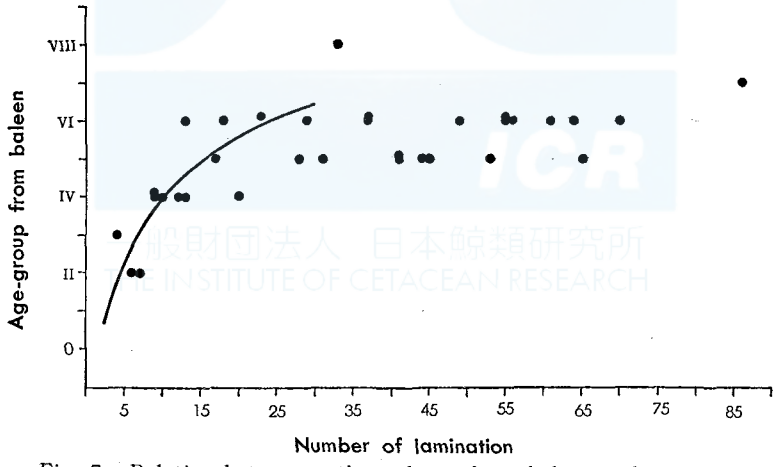

Fig. 7. Relation between estimated age from baleen and number of lamination in the ear plug.

of body length in these figures, the body length at sexual maturity is just the same as that study. It is considered that the number of lamination at the sexual maturity is 10, and that the age is 4–5 years.

The points sidling along the average lines of these figures are considered to show their attaining to the physical maturity, and they at 14–15 of corpora albicantia and 30–35 of laminations viz., 15–17 years. The data shown by Laws and Purves are not quoted here because the growth rate of the fin whale body length is considered to have some differences between northern and southern hemisphere.

In the previous study of the author, he stated that the absorption of crystalline lens was also increased with age. Now the relation between the number of lamination and the absorption of crystalline lens is shown as a straight line as in Fig. 6. But the variance is larger than the relation by number of corpora albicantia. The author suggested in his previous reports that the absorption of crystalline lens would be possible to compare the data of males and females with same values. But now since the ear plug has proved to furnish more accurate data. If these fact are correct, the observation of the absorption of crystalline lens would not be needed in future.

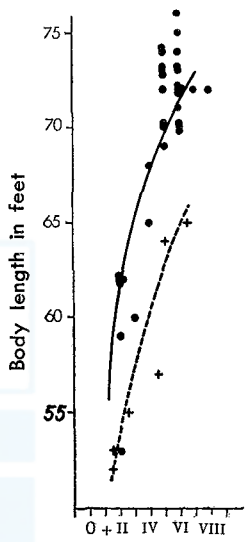

Fig. 8. Increase of body length according to age estimated from baleen.

The data of the age group from baleen plates are shown in Fig. 7 with the number of lamination. The regular relation is expected make a rectilineal change. But with advance in age from baleen the growth curve shows a sidling rightward curve. This is by because the tip of baleen plate is chipped, and does not show the regular age. As stated in the previous report, there are large individual variations in the age when the tip of baleen begins to chip away. The growth curve of body length according to age-group from baleen is shown in Fig. 8. But its accuracy is not so high as others. The data of Laws and Purves as shown in dotted line do not coincide which may show the difference of the fin whale body length between the northern and southern hemi-spheres. The important characters of the age data from baleen plates are concerned with the period where the plates does not chip away (under III or IV). The data of this period and the number of laminations are considered to constitute important subjects of future study.

CONCLUSION

This report is an introduction of the joint study on the ear plug observations which will begin in the near future.

1. The materials can be collected easily on a factory ship.
2. Keeping in 10% formalin solution is the best method for preservation of the ear plug.
3. It is easy to grind down the aged or hardened materials, but the best observation method of the young or soft materials is to take X-ray photograph.
4. The age characteristics of the ear plug are found clearily in the number of laminations, but there are considerable variations in the length of ear plug, the length of core and the weight of ear plug.
5. The female fin whales of the southern hemisphere reach their sexual maturity in 4–5 years, then their ovulation is formed at the average rate of 2.4 per one breeding season.
6. They attain to their physical maturity in 15–17 years.
7. The absorption of crystalline lens is comparatively difficult to survey, and does not offer the better data than the lamination of the ear plug.
8. It is considered necessary to make studies on the ear plug of the whales whose baleen plate have not yet chipped away.

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