A NOTE ON THE AIR-SAC OF RIBBON SEAL

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ABSTRACT

Investigations on the air-sac of seals were carried out by us, using twelve males and three females of the ribbon seal (*Histriophoca fasciata* ZIMMERMANN) and two males of the Okhotsk harvor seal (*Phoca vitulina* LINNAEUS), which were caught off Rausu of the Shiretoko Peninsula, Hokkaido, Japan, in the middle of March and April, 1966. In the rear part of the trachea of the ribbon seal, the cartilage rings are broken to form a slit, 25–46 mm long, which leads to an air-sac on the outer side. The two ends of the broken rings form long and slender valvular projections. The fore part of the air-sac is developed beneath the sternomastoid muscle, and the rear part is between the pectoralis superfacies and the costae. In adult males, the sac is large, but it is smaller in young individuals. Young females have a pair of valvular projections but no air-sac. Even in adult females, development of the air-sac is very poor or entirely absent. The role played by the air-sac is not known. The cartilage rings of harbor seal are broken at the rear part of the trachea, but the break does not form a slit and hence air-sac is not developed.

INTRODUCTION

Studies on the morphology and ecology of the ribbon seal, *Histriophoca fasciata* ZIMMERMANN, have been relatively few, and even the dental formula of this animal had been little known until recently (SCHEFFER, 1960).

The present writers have observed that the ribbon seal has an air-sac branching out of the trachea. An outline of the observation is reported here.

Valuable specimens of the ribbon seal for this study were offered by Mr. Ichimatsu Nedefuji, Misaki-machi, Rausu-cho, Menashi-gun, Hokkaido, who also took care of the lodging for the writers during the period of investigation. We wish herewith to express their sincere gratitude to Mr. Nedefuji. They are also indebted to many persons for helpful suggestions.

DISCOVERY OF AIR-SAC

Two of us, Wada and Hasegawa, visited Rausu-cho from March 15 to 17, 1966 for the purpose of investigating seals. On March 15, when a male ribbon seal, captured off Rausu by Mr. Nedefuji, was being dissected, Wada noticed a bladder-like membranous sac in the thorax, and surmised if it might be an air-sac. On the following day, four more males and one female were captured. Hasegawa examined them and noted that the sac seemed to occur only in males, its position being located always on the right side of the body, and that the size of the sac was considerably variable according to individuals. However, he could not get sufficient data on this subject as the time was limited.

Later, from April 12 to 14, Abe visited Rausu and made more precise observation of seven males and two females of *H. fasciata* and two males of *Phoca vitulina* LINNAEUS (Okhotsk harbor seal). He examined in particular the size and position of the air-sac and the difference between male and female, as well as the relationship between the length of the body and the development of the air-sac. Later, he cut off the tracheae attached with the sac, preserved them in alcohol, and brought them back to the laboratory for further observation of details.

POSITION AND STRUCTURE OF AIR-SAC

1) Male

In the first half of the trachea, the tracheal cartilage forms complete rings without any break, whereas in the latter half, the cartilage rings are broken on the dorsal side of the trachea as illustrated in Fig. 2, III-IX. On the outer side of the both ends of the broken rings, there is a more or less membranous wall, which is developed particularly on the right side, so as to form an air-sac (Fig. 1, I-V; Fig. 2, V-VIII). Accordingly, the break in the rings serves as a passage to the air-sac. This slitlike passage starts at about 50–60 mm from the diverging point of the bronchi and extends forward (toward the neck) (see Pls. 1 and 2). In general, the slit becomes longer as the animal grows up (Table 1).

The sac occurs as a bulge of the relatively thick muscular membrane on the right outer side of the slit in the early stages of the development (Fig. 1, I). The sac grows larger, decreasing the thickness of membrane, and extends forward until it reaches the neck of the animal; it also stretches rearward (toward the hind legs) and, when fully developed, it becomes to cover the whole right ribs (Pl. 1, II; Fig. 1, V). As the sac grows larger, the membrane becomes thinner and translucent. Also, the larger the sac, the better is its rearward development. For example, in Specimen No. 6 the length between the foremost end of the sac and the starting point of the slit is 120 mm, and from there to the rear end of the sac it is 70 mm long. In Specimen No. 7 the measurement by the same method reveals that the sac is 150 mm long in its fore part and 230 mm long in the rear part.

The fore part extends forward, passing through the underside of the sternomastoid muscle. If the sac is small it is concealed by the muscle, but when it

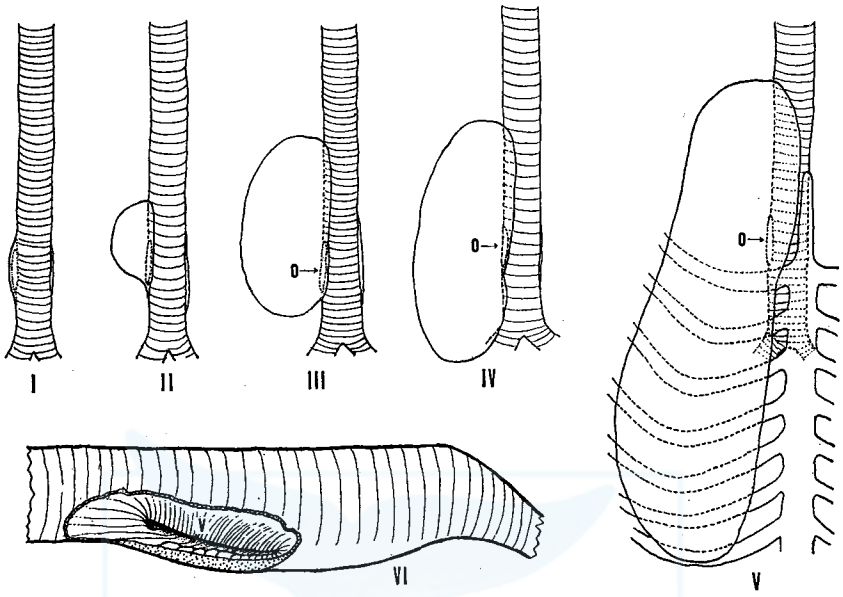


Fig. 1. Developmental precesses of male air-sac and its opening part on the trachea of the ribbon seal. I : No. 1 specimen in Table 1, II : No. 3, III : No. 5, IV : No. 6, V : No. 7, " 0 " in III to V indicates the opening of the sac. VI : rear half of trachea on the right side (No. 5 specimen), showing the opening and the valve (V) of the air sac which in this figure the membraneous sac has been removed. Lower side in the figure VI is the dorsal side, the right tapering part is the bronchus.

grows larger its fore end appears ahead of the muscle. The rear part of the sac is found between the pectoralis superfacies and the costae. Therefore, the existence of the sac would be hardly noticed when the seal is only skinned.

On the right and left sides of the slit, part of the trachea forms a long and narrow valve, with its rear end starting from the diverging point of the bronchi. The valve has a slender crescent shape, being widest at the middle. The right valve is larger than the left in both length and width. The distance between the two valves is largest at the slit (Table 1; Fig. 2 IX). The left valve does not seem to be functional at all, but the right valve, which is widest at the slit, is considered to conduct the important role for taking the air in and out of the sac (Pl, 1, II and III). To clarify the function of these valves, further study is required from the standpoint of histology and ecology.

2) Female

The fundamental features of the sac are identical with those of male. A valvular projection is observed at the dorsal inner side of the rear part of the trachea. However, development of a sac is poor in female, and even in a fully grown stage of the animal the sac is of nearly the same size as that of a small male (Pl, 2, IV;

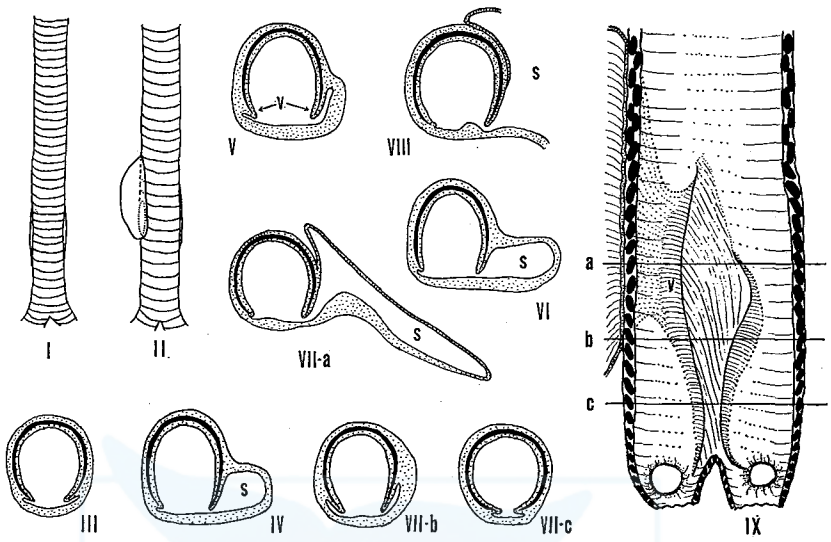


Fig. 2. Developmental processes of air sac of ribbon seals, and cross and longitudinal sections of the sac and trachia. I: No. 10 specimen; II: No. 11; III: cross section at the central part of the valve in No 10 female; IV, V, VI, VII-a and VIII indicate the cross sections at the central part ("a" line on IX) of valve in specimens 11, 1, 3, 5, 7, respectively; VII-b and VII-c: cross sections at "b" and "c" lines in IX. Lower side in the figures is the dorsal side of trachea; V and S: valve and air sac; IX: longitudinal section showing the dorsal inner side of the opening part of trachea.

TABLE 1. TOTAL LENGTH OF BODY, CONDYLOBASAL LENGTH OF SKULL AND DIMENSION OF AIR-SAC (in mm)

species name				air-sac			right valve		left valve	
specimen's number	sex	total length of body	condylobasal length of skull	length	width	slit length	length	max.-width at non-slitted area	length	max.-width
Histriophoca fasciata Z.										
1	M	1260	—	—	5	—	86	14	82	5
2	M	1230	—	40	15	27	82	9	73	5
3	M	1300	—	55	37	25	92	9	71	4
4	M	1130	177.7	70	35	35	—	11	—	4
5	M	1370	180.7	130	70	40	80	11	68	5
6	M	1360	178.8	190	75	42	—	11	—	4
7	M	1500	201.9	380	110	46	102	13	82	7
8	M	—	—	105	55	—	—	—	—	—
9	M	—	—	430	120	—	—	—	—	—
10	F	1310	178.4	—	—	—	80	8	70	7
11	F	1560	204.6	70	20	40	84	14	80	6
Phoca vitulina L.										
12	M	1450	203.5	—	—	—	24	3	—	—
13	M	1600	222.8	—	—	—	—	—	60	7

— broken and unmeasured.

Fig. 2, I-IV). Hasegawa examined a pregnant individual but could not confirm the existence of the sac. In females, the sac, if any, may not be functional.

COMPARISON WITH OKHOTSK HARBOR SEAL

We dissected two males of Okhotsk harbor seal, which were captured together with the above-mentioned ribbon seals, and examined their trachea for comparison with that of ribbon seals. In that species, too, the cartilage rings are broken in the rear part of the trachea, that is, immediately before the bronchil they diverge. However, the valvular projection is entirely different from that of ribbon seal, as it occurs only on one side. One of the examined specimens had it on the right side (Fig. 3), but the other had it on the left side. Specimen No. 11 is supposedly a relatively large individual, but it had no air-sac nor its trace.

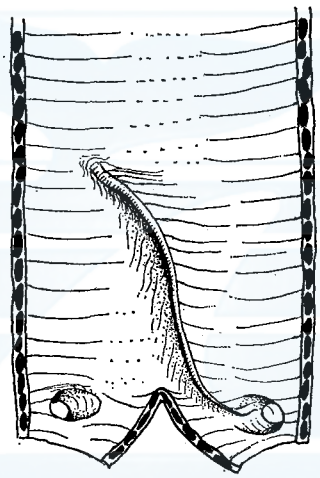


Fig. 3. The longitudinal section of the rear part of trachea of *Phoca vitulina* (adult male).

CONSIDERATION

As to the role played by the sac, we can say nothing more than a conjecture. It is evident, however, that the sac is connected with the trachea through a simple functional valve, and there remains little doubt that the sac serves as an air-sac. The size of the sac differs markedly between male and female, and also varies with the age of individual. These facts may indicate some differences in habit and behavior of individual seals. According to certain hunters, ribbon seals, when chased, would stay under the water for a long time; another hunter, however, says he has experienced no such occasion. Thus, the hunters' comments cannot be relied upon. In fact, the riddle of the sac would remain unsolved until scientific investigations are made on the ecology of ribbon seals.

It is of a special interest that the sac is located on the right side of the body,

stretching beneath the sternomastoid muscle or between the pectoralis superfacies and the costae, and that the sac grows larger along with the animal's growth. To give reasonable explanation for these features, anatomical and ecological studies of not only the ribbon seal but also other kinds of seals must be carried out in the future. This is why the present writers refrain possible explanations of the role of the sac.

REFERENCES

SCHEFFER, V. B., 1960. Dentition of the ribbon seal. *Proc. Zool. Soc. London*, 135(4) : 579–585.

* We have found recently that SLEPTSOV'S paper (*Zool. Zhurn.* 19(3) : 379–385, 1940) had described the outline of the air-sac of this seal.

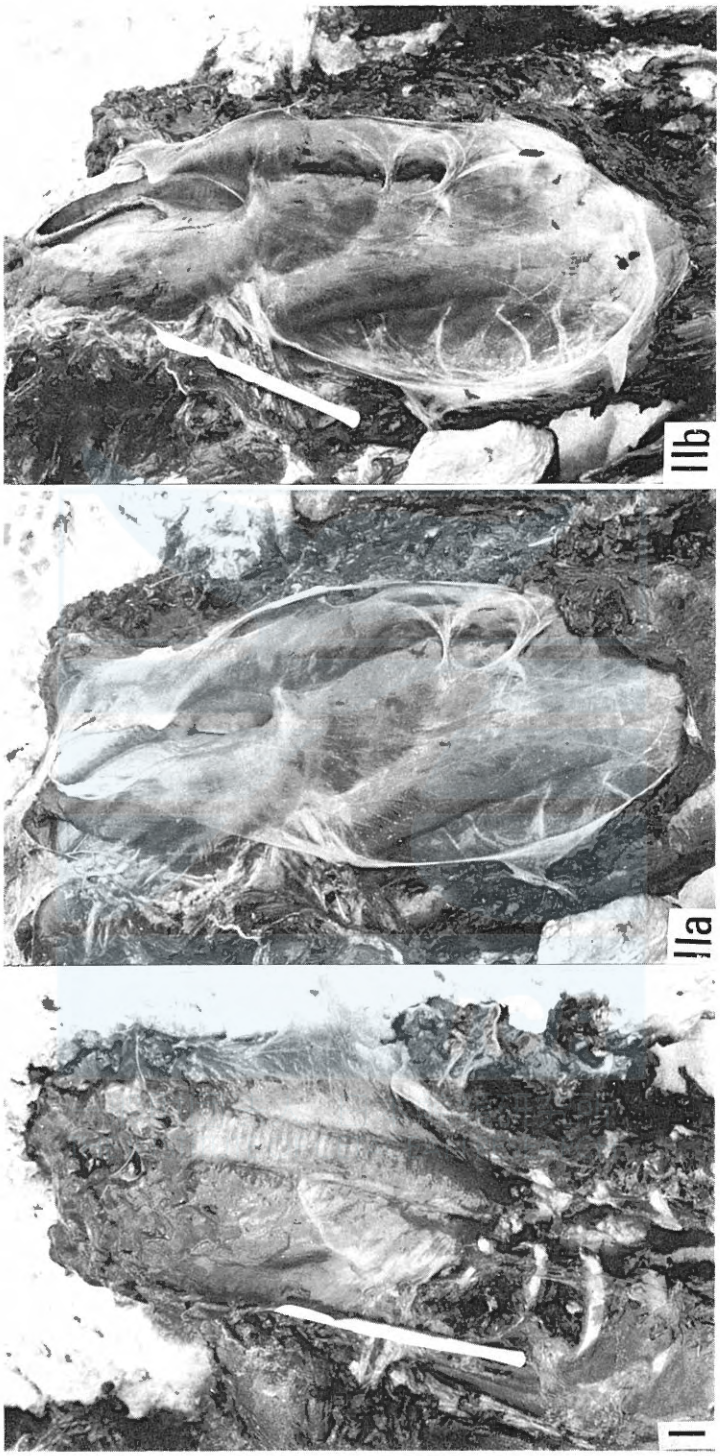
EXPLANATION OF PLATES

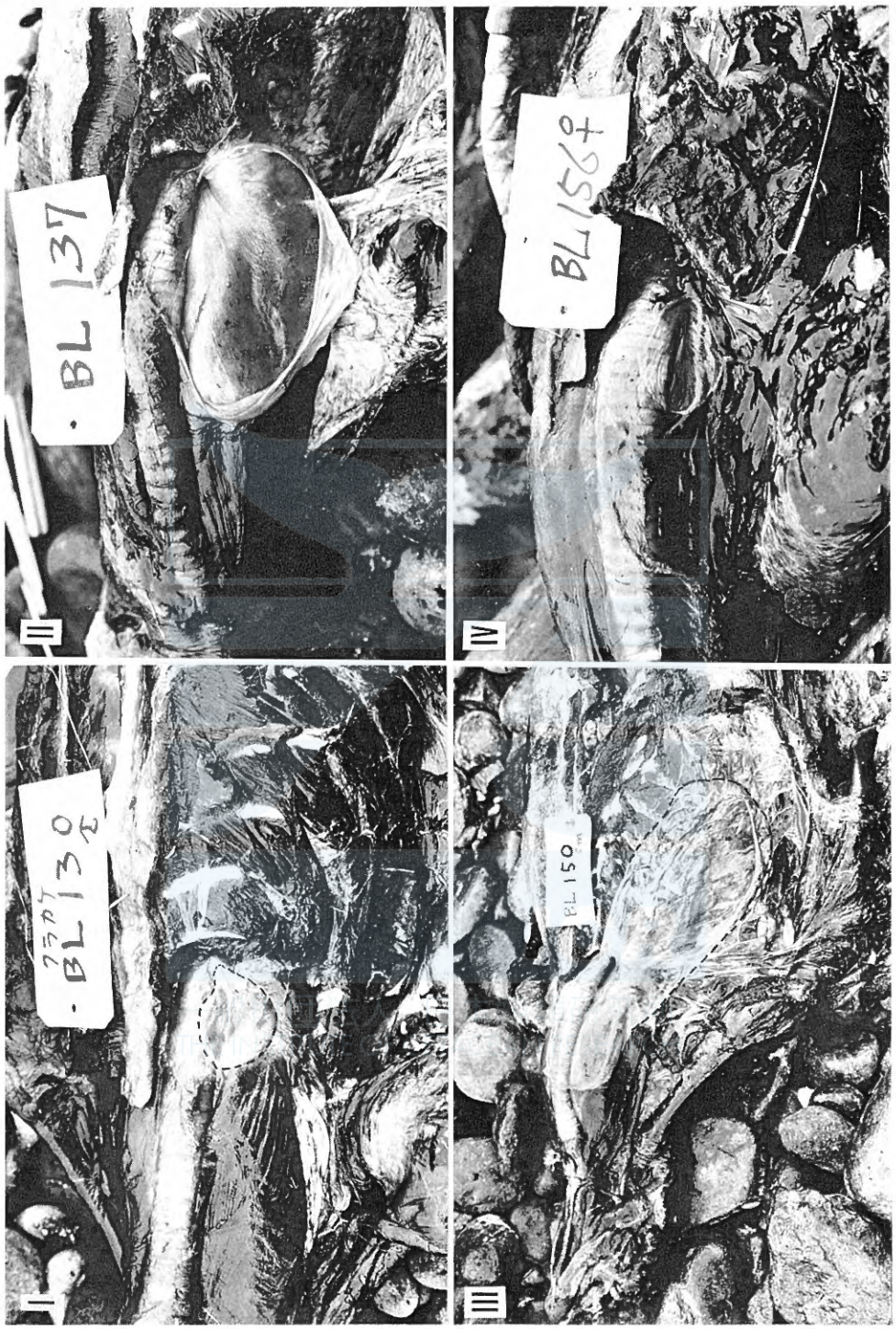
PLATE I

I: Sac of young male (8 in Table 1). IIa and IIb: Sac of adult male (9 in Table 1). Notice the valve closed (a) and opened (b).

PLATE II

Development of male sac (I-III) and primitive small sac of an adult female (IV). I-IV show those of specimens 3, 5, 7, respectively. Sacs of II to IV have been dissected to show the inside and the opening.


IIb
IIa
I


II
· BL 137
IV
· BL 1560
I
· BL 1300
III
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