

## THE AIR SACS.

The air sacs in every species of Penguin which I have examined are nine in number. Of these four pairs are placed symmetrically on either side of the middle line, while the ninth is single and occupies the middle line of the body. The first four pairs, from their relations to neighbouring organs, may be named the hepatic, the pericardiac, the abdominal, and the cervical, while the ninth or azygos air cell may be termed the inter-clavicular.

The following description is drawn up from a special dissection of *Eudyptes chrysocome*, but apart from dimensions, is equally applicable to the other species examined :—

The first, or hepatic air sac, extends from the axilla, where it is bounded in front by the subclavian artery, backwards as far as midway between the last rib and the anus. On the outer side it is in contact with the ribs and intercostal muscles, while on the inner side it is bounded from before backwards by the heart and pericardium, by the outer side of the liver, and by the transversalis abdominis muscle. The wall of this sac is attached to the whole length of the thoracic surface of the sternum internal to the sternal notch. The sac itself is divided incompletely into two parts by means of a transversely-disposed septum. This septum is situated opposite the posterior border of the lung. The hepatic air sac derives its air directly from the lung, by means of an aperture which is situated on the inner surface of the lung, close to the inferior border of that organ behind the septum above described. The posterior extremity of this sac intervenes between the obliquus externus and transversalis abdominis muscles.

The second, or pericardiac sac, lies below the pericardium. It is bounded below by the anterior half of the thoracic surface of the sternum, and above by the heart and pericardium, while on the inner side it is in contact with its fellow of the opposite side. It does not communicate directly with the lung, but receives its air through the intervention of the hepatic sac, by means of an aperture which, in *Aptenodytes*, is of sufficient size to admit of the passage of two fingers.<sup>1</sup> This aperture of communication is situated directly above the external or costal process of the sternum. Thus the pericardiac sac only communicates indirectly with the bronchial tubes.

The third and largest of the air sacs is the abdominal. It extends from the posterior

<sup>1</sup> According to Milne-Edwards (*Leçons sur Physiologie et l'Anatomie Comparée*, vol. ii. p. 353,) the pericardiac air sac (le réservoir diaphragmatique antérieur of that author) receives its air directly from the lung in the majority of birds. Such, so far as I could ascertain, is not the case in any species of Penguin. At the same time it is right to observe that in the majority of the birds dissected the means used in preserving the specimens occasioned considerable difficulty in the recognition of the various apertures of communication between the lungs and the air sacs. The existence of five distinct apertures in the lung of most of the species examined certainly leads to the conclusion that in the Penguins, as in other birds, each of the air sacs communicates with the lung by means of a separate aperture.

In the work quoted will be found a very complete list of authors who have directed their attention to the respiratory organs of birds. That list I do not think it necessary to repeat here.