

A SYSTEMATIC STUDY OF THE MAIN ARTERIES IN THE REGION OF THE HEART—AVES V—SPHENISCIFORMES

PART I¹

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During 1941 and 1942 the writer had the opportunity of carrying out studies on the arrangement-patterns of the main arteries in the neck and thorax of five species of Penguins. This study was greatly facilitated by materials made available to him by the Division of Birds, United States National Museum, and the Department of Ornithology, Royal Ontario Museum of Zoology.

The materials for this study included single specimens of the Rock-hopper Penguin *Eudyptes crestatus* (Miller), the "Johnny" Penguin *Pygoscelis papua* (Forster), Humboldt's Jackass Penguin *Spheniscus humboldti* (Meyen), the Galapagos Penguin *Spheniscus mendiculus* (Sundevall), and one immature and two adult specimens of the Black-footed Penguin *Spheniscus demersus* (Linné).

Routine dissections and diagrams of the arterial arrangement in the neck and thorax were made. The information thus obtained is set forth in the following observations.

OBSERVATIONS

The basic arrangement-pattern of the Spheniscidae is exemplified by *Eudyptes crestatus* (Miller), and *Spheniscus demersus* (Linné), (Figure 1).

The aortic root (1) arises in the left ventricle of the heart, passes anteriorly and to the right before it divides to form the left and right innominate arteries (2) which in turn pass anteriorly and laterally to give rise to the subclavian (9) and common carotid (8) arteries. Shortly after the bifurcation of the aortic root, the right innominate artery sends off the right systemic (4th aortic) arch (3) which passes dorsally and posteriorly to join the right radix aortae (4). The radix aortae then passes diagonally posteriorly toward the central axis of the body where it continues as the dorsal aorta (23). At the point of junction between the radix and the dorsal aorta, the ligamentous vestige of the left radix aortae (ligamentum aortae) (5) may be found passing anteriorly and diagonally toward the left pulmonary artery.

In some species of birds (Beddard; Glenny, 1939, 1940, 1942a, 1943) the left radix aortae presents a lumen which can be injected for some of its length. For the most part, however, it remains as the ligamentum aortae (5) (Glenny, 1942b, 1943) which may or may not maintain its anterior connection with the pulmonary artery (7).

As has already been noted in an earlier paper (Glenny, 1943) the left ligamentum botalli almost or completely atrophies after the left radix aortae anastomoses with the left pulmonary (6th aortic) arch during middle embryogeny (the time of anastomosis varies in different species of birds). The right ligamentum botalli (6), therefore, alone remains as the vestige of the distal portion of the embryonic 6th aortic arch. This vestige lies along the ventral or ventro-lateral face of the right radix and generally maintains its proximal and distal connections.

The subclavian arteries (9) give rise to the coracoid major (10), axillary (11), intercostal (12), and two pectoral (13) arteries in order. The coracoid major (10) gives rise to a short sterno-tracheal (24) artery, and the axillary artery (11) sends off the coracoid minor (25) artery. The intercostal artery branches to form the

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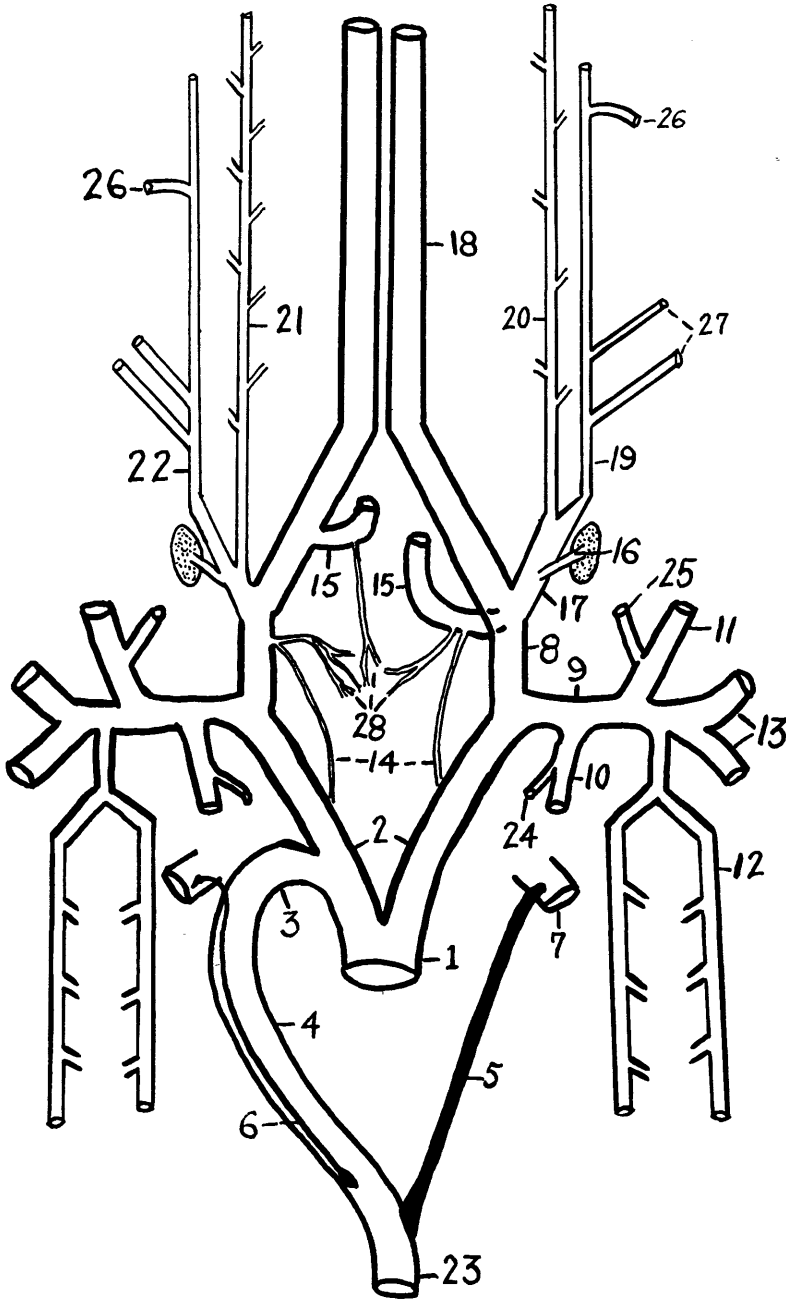


FIG. 1. Diagrammatic representation of the arrangement of arteries in the neck and thorax of *Spheniscus demersus* (Linné). Ventral view.

Key to Abbreviations of Fig. 1: 1, aortic root; 2, innominate arteries; 3, right systemic arch; 4, right radix aortae; 5, ligamentum aortae; 6, ligamentum botalli; 7, pulmonary artery; 8, common carotid artery; 9, subclavian artery; 10, coracoid major artery; 11, axillary artery; 12, intercostal artery; 13, pectoral arteries; 14, ductus shawi; 15, vertebral arteries; 16, thyroid artery; 17, superficial cervical artery (root); 18, internal carotid artery; 19, dorso-lateral cervical artery; 20, ventro-lateral cervical artery; 21, ascending-oesophageal artery; 22, dorso-lateral cervical artery; 23, dorsal aorta; 24, sterno-tracheal artery; 25, coracoid minor artery; 26, subscapular artery; 27, basi-cervical arteries; 28, tracheo-oesophageal arteries.

ventral and lateral rami. The ventral intercostal usually lies along or near the line of articulation between the ribs and sternum, while the lateral intercostal lies more dorsally (midway) along the inner surface of the ribs.

Anteriorly, the common carotid arteries (8) give rise to the thyroid (16), vertebral (15), internal carotid (18), and superficial cervical arteries. The thyroid arteries arise in the region of the carotid junction at which point the common carotid divides to form the internal carotid, vertebral, and superficial cervical arteries. The ductus shawi arises either from the common carotid or from the vertebral artery near its origin on the common carotid. Both left and right ductus shawi pass posteriorly, dorsal to the heart, sending off branches to the trachea, syrinx, oesophagus, and fascia of the thorax dorsal to the heart. The superficial cervical root divides into two smaller branches, a ventro-lateral branch which supplies the lymphatic glands and musculature on the left side, and the oesophagus, lymphatics, and musculature on the right side of the neck; and a more dorsal vessel which sends off several branches to the base of the neck (27), and a subscapular artery (26) before passing anteriorly to supply the cervical musculature. Both left and right internal carotid arteries (18) enter the hypophysial canal and the condition is referred to as bicarotidinae normales (Garrod). As these vessels pass anteriorly they send off small segmental arteries and finally divide to form the several branches of the internal and external carotid arteries in the region of the head.

In *Eudyptes crestatus*, the left radix aortae remains as the ligamentum aortae (Glenny, 1943). The distal portion of the right 6th aortic arch presents a small lumen for about three-fourths of its length (may be due to immaturity of the specimen) while the rest remains as the occluded vestige.

Pygoscelis papua presents the same basic pattern as *Eudyptes* with but slight differences. The distal portion of the left radix aortae remains patent for most of its length. The right ductus botalli becomes atrophied and remains as the ligamentum botalli.

Although one specimen was but four days old, *Spheniscus demersus* presents a similar arrangement to *Eudyptes*. In each of the three specimens studied, the distal portion of the left radix aortae and right ductus botalli remain as ligaments.

The arrangement of these arteries in *Spheniscus mendiculus* is the same as in the other species studied. The distal portion of the right 6th aortic arch remains as a ductus botalli (probably a juvenile specimen), while the left radix becomes atrophied and persists as the ligamentum aortae.

It is readily seen that the species of Penguins studied show the same basic arrangement-pattern of neck and thoracic arteries, and that all of these present at least ligamentous vestiges of the left radix aortae and right ductus arteriosus. It may also be reasoned that, since a lumen is found to be present in at least two specimens, atrophy of the left radix and right ductus botalli probably occurs only during the latter part of their embryonic development.

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