

PRESENCE OF THE LIGAMENTUM BOTALLI IN THE  
GOLDEN EAGLE *AQUILA CHRYSAËTOS* (L.), THE  
RED-TAILED HAWK *BUTEO BOREALIS BORE-*  
*ALIS* (GMELIN), AND THE COMMON  
PIGEON *COLUMBA LIVIA* (L.)

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INTRODUCTION

During the preparation of a series of studies on the main arteries in the region of the heart of birds (3), the writer had the opportunity to observe a ligament to which no direct reference had been made in the better known references on avian morphology.

As the writer has already noted in other discussions on avian morphology (2 and 3), little work of a serious nature has been undertaken in the study of bird arteries since the close of the 19th century.

Recently, during a study of the arteries of the Golden Eagle (*Aquila chrysaëtos*), the Red-tailed Hawk (*Buteo borealis borealis*), and the common pigeon (*Columba livia*), it was the writer's good fortune to observe a peculiar ligamentous structure lying along the ventral surface of the right 4th aortic arch. Careful removal of the fascia which surrounded the aortic arch revealed this structure to be a separate ligament and not part of the aortic arch.

OBSERVATIONS

An unrecognized ligament was found to be attached to the aortic arch just anterior to the junction of the ligamentous left 4th aortic arch and the dorsal aorta in each of the three species studied. The ligament passed anteriorly along the ventral surface of the right 4th aortic arch until it reached a point near the right pulmonary artery—just posterior to the bend of the right 4th aortic arch and the subclavian artery. The ligament formed an anterior attachment with the pulmonary artery just before it entered the lung.

A ligamentous vestige of the left 4th aortic arch was located in the normal position in each of the three species of birds.

The ligament of *Aquila* possessed a minute lumen from which a small amount of blood was obtained. It appeared to have served as a functional blood vessel during the late embryonic stages in this species. In contrast to this condition, the ligament of both *Columba* and *Buteo* entirely lacked any evidence of a lumen and no blood could be obtained.

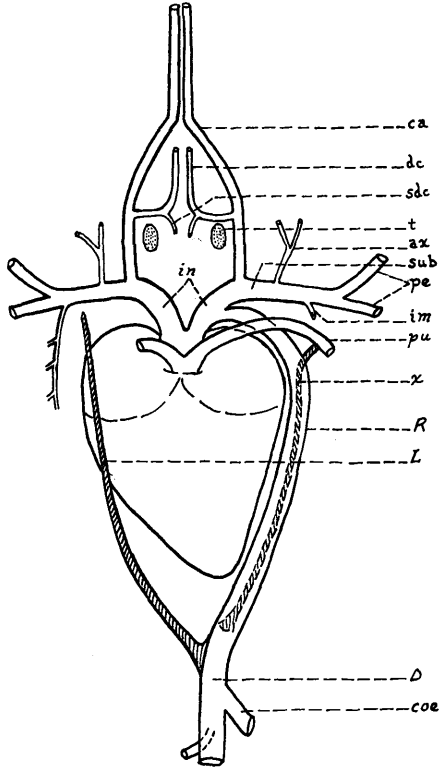


Diagram of the main arteries in the region of the heart of *Columba livia*. Dorsal view.

ax, Axillary artery; ca, internal carotid artery; coe, coeliac artery; dc, external carotid artery; im, internal mammary artery; L, ligamentous vestige of the 4th left aortic arch; D, Dorsal aorta; pe, pectoral artery; pu, Pulmonary artery; R, 4th right aortic arch; sdc, superficial branch of the external carotid artery; sub, Subclavian artery; t, Thyroid gland; x, Ligamentum Botalli; in, Innominate artery.

#### DISCUSSION

All of the commoner references to the 6th aortic arches of birds indicated that the primitive or embryonic connections with the dorsal aorta were completely atrophied during the late

embryonic development of the bird,<sup>1</sup> and especially after the connections with the lungs had been established.<sup>2</sup> This is not entirely the case, as has been shown in the above evidence.

Since the posterior end of the ligament was inserted in the dorsal aorta at about the position expected in the embryo, and since the anterior attachment was made with the pulmonary artery, it was finally concluded that this ligament was a vestige of the embryonic 6th aortic arch. Once this had been established, it was a simple matter to recognize the ligament as a vestige of the *ductus arteriosus* or *ductus Botalli* (5 and 6). The *ductus Botalli* is reported in the Urodeles and the embryonic stages of the amniota. Among the higher vertebrates, including mammals, a ligamentous vestige of the ductus arteriosus has been reported (4 and 5).

The writer could find no reference to the occurrence of this ligament in birds. From the above evidence, however, its occurrence and persistence in certain species of birds has been established.

It is the writer's opinion that this ligament should be referred to as the *Ligamentum Botalli* since it has its origin in the *ductus arteriosus* or *ductus Botalli*.

#### CONCLUSIONS

It may be concluded, from the above evidence, that this ligament is a persistent vestige of the embryonic 6th aortic arch. Furthermore, it may be concluded that, although this structure is reported from but three species of birds at the present time, the vestigial portion of the 6th aortic arch may be found in still other species of birds, and may be anticipated in still other species of Raptores.

It is the writer's opinion that the persistence of this ligament represents a primitive avian condition, and helps to bear out the writer's contention in a previous paper (3) that the arrangements of the arteries in the region of the heart may later be used to show certain fundamental natural relationships among the various families of birds.

<sup>1</sup>"Der dorsale Abschnitt des 6. Bogens (des Pulmonalis bogens) fällt beiderseits völligem Schwund anheim, nachdem er kurze Zeit während des Embryonallebens als Ductus Botalli die Lungenarterie mit der dorsalen Aorta verbunden hat." (6).

<sup>2</sup>"With the development of lungs a pair of pulmonary arteries are developed from the 6th pair of arches on the ventral side of the pharynx. These grow back into the lungs, while the rest of the arch, dorsal to their origin, becomes reduced to a small vessel, the *Ductus arteriosus* (d. Botalli) in some Urodeles, and persists occasionally vestigially in higher vertebrates. Elsewhere it entirely disappears." (5).

## SUMMARY

1. The *Ligamentum botalli* was observed in *Aquila chrysaetos*, *Buteo borealis borealis*, and *Columba livia*.

2. The *Ligamentum Botalli* represents the vestigial portion of the embryonic 6th aortic arch which forms the attachment to the radix aorta.

3. The ligament was attached posteriorly to the radix aorta and anteriorly to the pulmonary artery.

4. Fundamental natural relationships may be established by the presence of such vestigial structures in the various species of birds, at least within the various orders and families of birds.

## REFERENCES

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