

# A SYSTEMATIC STUDY OF THE MAIN ARTERIES IN THE REGION OF THE HEART. AVES XVI

## CHARADRIIFORMES. PART 2<sup>1</sup>

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Further studies on the arteries in the neck and thorax of the Charadriiformes (9) were made possible by alcoholic specimens loaned to the writer by the United States National Museum and the Chicago Natural History Museum. The writer wishes to express his gratitude to Dr. Alexander Wetmore, Dr. Herbert Friedmann, and Mr. Dwight D. Davis for their help in making these materials available for study.

Twenty specimens, representing thirteen species, were dissected and diagrams of the arrangement of the arteries of the neck and thorax prepared.

### MATERIAL<sup>2</sup>

Except where otherwise indicated, single specimens were dissected and diagrams of the arterial arrangement-patterns prepared.

#### Suborder CHARADRII

##### Family Jacanidae:

- Actophilornis africana* (Gmelin) #291474 USNM
- Hydrophasianus chirurgus* (Scopoli) #19912 USNM
- Jacana spinosa* (L.) #61352 & #61489 USNM

##### Family Rostratulidae:

- Rostratula benghalensis* (L.) #100500 & #19577 USNM
- Nycticryphes semicollaris* (Vieillot) #227167 USNM
- (*Rostratula semicollaris*) *Nycticryphes semicollaris* (Vieillot) #227601 USNM

##### Family Haematopodidae:

- Haematopus o. ostralegus* (L.) #292354 USNM

##### Family Scolopacidae:

- Totanus [Tringa] flavipes* (Gmelin) #106050 CNHM

##### Family Recurvirostridae:

- Recurvirostra americana* (Gmelin) #106062 CNHM

##### Family Glareolidae:

- Glareola maldivarum* J. R. Forster #19574 & #20223 USNM

##### Family Thinocoridae:

- Thinocorus rumicivorus* Eschscholtz #227599 & #227977 USNM

##### Family Chionididae:

- Chionis minor* Hartlaub #70350 & #70351 USNM

#### Suborder LARI

##### Family Laridae:

- Larus hyperboreus* (Gunnerus) #97308 CNHM

##### Family Rynchopidae:

- Rynchops n. nigra* L. #320240 & #346680 USNM

<sup>1</sup>Contributions from Blue Sea Lake Biological Laboratory, Messines, P. Q.

<sup>2</sup>Numbers refer to catalogue numbers of alcoholic specimens:

USNM=United States National Museum.

CNHM=Chicago Natural History Museum.

## OBSERVATIONS

The basic ordinal arrangement-pattern for arteries in the neck and thorax of the Charadriiformes appears to be fairly consistent, and is as follows: bicarotidinae normales; ligamentum aortae persistent; ligamentum botalli (right) variable; subclavian series (medial to lateral)—*coracoid major*, with sternotracheal branch normal, *axillary*, *intercostal* (single or bifurcated), and two *pectoral* arteries; syringo-tracheal arteries usually arise as branches of the *ducti shawi* which in turn are usually produced as derivatives of the common carotid arteries *a priori* origin of the superficial cervical and internal carotid (trunk) arteries. Rarely the ductus shawi may arise as a branch of the cervico-vertebral or superficial cervical arteries. The thyroid glands are supplied by short branches from the central or lateral face of the common carotids near the normal origin of the ductus shawi.

Presence of an accessory oesophageal artery (9, Fig. 1) is variable as previously indicated. Retention or persistence of the right ligamentum botalli varies among the species within a family, and the rate of atrophy may likewise be a variable factor (3, 4, & 6). In some of the species, it appears that this vestigial structure tends to fuse with the ventral face of the right radix aortae and, as a result, tends to lose its individual identity as a separate structure in the adult.

It is likewise true that further progressive atrophy may occur in the case of the vestigial left ligamentum aortae. This structure, however, tends to become intimately associated with the connective tissue of the pleural cavity. It should be noted that atrophy of the ligamentum aortae may proceed at a rate entirely independent from that of the ligamentum botalli, and that while the right ligamentum botalli may be completely atrophied or fused to the functional radix aortae, the ligamentum aortae may persist as a very prominent vestige. On the other hand, in several forms already studied, there are several instances in which a relatively small or greatly reduced ligamentum botalli was observed along with a very small, much reduced ligamentum aortae.

*Jacaniidae*: In *Actophilornis africanus*, *Hydrophasianus chirurgus*, and *Jacana spinosa* the ductus shawi arises from the common carotid artery, but in *Hydrophasianus* the accessory oesophageal artery appears to arise from the left ductus shawi near its origin from the common carotid, while in both *Actophilornis* and *Jacana* this vessel has an independent origin from the common carotid near the point of origin of the superficial cervicals. Vertebral and lateral superficial cervical arteries usually have a common origin (cervico-vertebral) from the common carotid in both *Actophilornis* and *Hydrophasianus*, while both of these vessels have separate points of origin in *Jacana*.

In each of these three species, the ligamentum aortae is present, but much reduced; the ligamentum botalli fuses with the functional radix aortae and persists only as a very fine white line on the ventral face of the radix. The subscapular arteries arise as branches of the superficial cervical arteries.

In *Actophilornis* there is an extreme dorso-lateral displacement of both the trachea and oesophagus. The lower two-thirds of the trachea is laterally displaced with the oesophagus. In *Hydrophasianus* there is only a slight lateral displacement of the trachea.

*Rostratulidae*: The ligamentum aortae is large and prominent in both *Rostratula benghalensis* and *Nycticryphes semicollaris*; the ligamentum botalli is usually completely atrophied in the adult of *Rostratula* and remains as a thin, incomplete ligament in *Nycticryphes*. The ductus shawi follows the normal ordinal pattern, while an accessory oesophageal artery from the left side appears to be lacking, or is at least much reduced, in both species.

In *Rostratula* the vertebral and superficial cervical arteries arise separately from the common carotid, while in *Nycticryphes* at least a short cervico-vertebral artery arises from the common carotid. After running a very short course, the

cervico-vertebral artery divides to form the vertebral and superficial cervical arteries. The right superficial cervical artery of *Rostratula* appears to bifurcate into lateral and ventral branches which afford a better distribution of blood to the oesophagus.

The trachea is somewhat laterally displaced in both *Rostratula* and *Nycticryphes*; this is accompanied by a somewhat dorso-lateral displacement of the oesophagus.

Details in the arrangement-pattern of USNM specimens #227601 and #227167 are identical and should be assigned to *Nycticryphes semicollaris*.

*Haematopodidae*: Arteries of the lower cervical region of *Haematopus o. ostralegus* are well-developed and serve to afford considerable blood supply to the tissues of the neck, including the oesophagus. Origin of the ductus shawi is normal; the accessory oesophageal artery arises as a branch of the left ductus shawi near the point of origin of the latter from the common carotid artery. The cervico-vertebral artery sends off the ventral superficial cervical and vertebral arteries before forming the scapulo-cervical which gives rise to the subscapular artery and then passes anteriorly as the lateral superficial cervical artery. The right ventral superficial cervical serves as the primary ascending oesophageal artery. The lateral superficial cervicals are comparable to the *comes nervi vagi* of Beddard and others.

The ligamentum aortae is a large prominent vestige which may retain its connection with the pulmonary artery as does the smaller ligamentum botalli of the right side.

The carina is deep, and on it are produced well-developed pectoral muscles.

*Scolopacidae*: The arrangement of arteries in *Totanus flavipes* is quite similar to that in *Oxyechus v. vociferus* (9, Fig. 1), but there are certain minor differences in details.

The vertebral and superficial cervical arteries usually arise separately, but in the same region, from the common carotid, and do not appear to unite to form a cervico-vertebral artery. In individual cases, however, this might occur due largely to the close association of these two vessels. The accessory oesophageal artery arises as a branch of the left superficial cervical artery, and the subscapular arteries arise as branches of the cervicals.

In *Totanus flavipes*, the ligamentum aortae is a much reduced and very thin ligamentous vestige, while the ligamentum botalli is entirely obliterated in the adult.

Both the oesophagus and the trachea are dextro-laterally displaced in *Totanus* along the major length of the neck.

*Recurvirostridae*: *Recurvirostra americana* is interesting for its several minor differences in arrangement-pattern. The ductus shawi and syringo-tracheal arteries arise not directly from the common carotid but from the cervico-vertebral arteries which give rise to the vertebral, subscapular, and superficial cervical arteries at a common point of origin. The superficial cervical arteries further divide into ventral and lateral vessels. The main oesophageal and tracheal blood supply is afforded by the cervical arteries of the right side. The intercostal arteries bifurcate into lateral and dorso-lateral branches. The ligamentum aortae remains as a significantly prominent vestige, while the basal or distal portion of the ligamentum botalli is readily visible, tapering to a very thin white ligament at its proximal end.

There is a dextro-lateral displacement of the oesophagus and trachea in *Recurvirostra*.

*Glareolidae*: *Glareola maldivarum* is similar to *Nycticryphes semicollaris* in arrangement, except that an accessory oesophageal artery is present, and this vessel arises as a branch of the left common carotid artery. The cervical and vertebral arteries form a common vessel to join the common carotid. A small

ventro-lateral cervical artery may be present, in addition to the normal superficial cervical artery, on the right side. The ligamentum aortae is reasonably large and prominent, while the ligamentum botalli is so greatly reduced as to be almost completely obliterated.

*Thinocoridae*: *Thinocorus rumicivorus* is simple in arrangement, but shows some variation in point of origin of the vertebral and cervical arteries. Generally, however, it would appear that the vertebral and cervical arteries tend to arise separately from the common carotids, although they may occasionally join to form a common vessel. The accessory oesophageal artery arises as a branch of the left superficial cervical artery.

In the above respects, *Thinocorus* closely resembles *Totanus flavipes*. The thyroid arteries arise as short branches of the left and right superficial cervical arteries. The ligamentum aortae is prominent, but the ligamentum botalli is entirely lacking.

*Chionidae*: Both the ligamentum aortae and ligamentum botalli are present and prominent in *Chionis minor*. The intercostals arise more laterally in *Chionis* and appear to branch from the base of the posterior pectoral artery.

The right common carotid gives rise to the ascending oesophageal artery which sends off the thyroid arteries, the lateral superficial cervical artery which gives off the subscapular artery, the vertebral artery, and finally the internal carotid (trunk) artery. The left common carotid produces a cervico-oesophageal artery which then divides to form the left superficial cervical artery from which the left subscapular arises as a branch as does the accessory oesophageal artery which sends off small branches to the thyroid gland, a vertebral artery, and finally the left internal carotid (trunk) artery. The left vertebral artery was observed to send off cervical segmental arteries.

*Laridae*: *Larus hyperboreus* is similar in basic arrangement to *L. argentatus* (9, Fig. 2). Minor differences appear, however, in the origin of the vertebral arteries (these may join with the superficial cervicals to form a common vessel or they may arise separately from the common carotids), and in the presence of an accessory oesophageal artery which arises as a branch of the left accessory superficial cervical artery. Both accessory cervical arteries send off small branches to the ventral collis before giving rise to several small vessels along their course along the ventro-lateral cervical region. The right accessory cervical vessel appears to function as an ascending oesophageal artery.

Both the ligamentum aortae and ligamentum botalli are quite prominent vestiges and appear to maintain their embryonic attachments.

*Rynchopidae*: *Rynchops n. nigra* is similar in arrangement to *Hydrophasianus chirurgus* except that the accessory oesophageal artery arises separately from the common carotid near the point of origin of the cervico-vertebral artery. The right superficial cervical artery serves as the primary ascending oesophageal artery.

The ligamentum aortae is prominent distally but becomes quite thin proximally. The ligamentum botalli is very much reduced along its entire length.

Both the oesophagus and trachea of *Rynchops* are dextrolaterally displaced with the result that the trachea does not lie along the ventral medial cervical line as is the case with most orders of birds.

#### DISCUSSION

It may be seen from the above observations that within both the families and species, herein represented, there are minor differences in the arrangement-pattern of cervical arteries, along with differences in the degree of atrophy of both the ligamentum aortae and ligamentum botalli. Such differences may be accounted for on the basis of specific phylogenetic divergences. The group included in this study exhibited a relatively narrow range of variation, however, and it will be

noted that the essential differences result from various combinations in origin of the vertebral, cervical, and accessory oesophageal arteries.

It is of especial interest to note that the basic ordinal arrangement-pattern is constant, and that it shows close similarity to the basic arrangement-patterns of Anseriformes (5), Ciconiiformes (7), and Gaviiformes (8). Greater variation in the origin of the thoracic vessels, along with wider range in arterial arrangement in the cervical region, is found in several other orders of *aves bicarotidinae normales*.

Observations *a propos* variability in degree of retention of the ligamentum aortae and ligamentum botalli might lead one to believe that certain unknown factors of growth and development are involved in the various rates of atrophy as well as levels of atrophic degeneration. Since atrophy of several of these embryonic vestiges appears to operate on gradient levels—from left to right—factors involved in control of rates of atrophy might be referred to as *Atrophic Gradient Factors*. These factors appear to operate in conjunction with, but somewhat independent of, each other under normal conditions, and may account for some differences in retention of certain embryonic vestiges among several species within a family or order of birds.

It is not inconceivable that each structure which has definite embryonic functions and which subsequently becomes morphologically and functionally altered may have growth or developmental factors controlling rates and extent of structural and functional modification along with factors responsible for initiation of a chain of events ultimately resulting in the adult condition. It is evident that these initiating and gradient factors do not always function properly. Results of such malfunctioning have been observed in several instances (1, 2, 3).

#### SUMMARY

Thirteen species of Charadriiformes, representing ten families, were dissected, and diagrams of the arterial arrangement-patterns prepared. An uncomplicated basic ordinal arrangement of thoracic and cervical arteries was observed. Some minor individual or family differences were observed and noted. The range of differences was limited, and tended to lie within the range of normal ordinal phyletic deviation. It would appear that the Charadriiformes show a fairly stable ordinal arterial arrangement, not always observed in various orders of birds.

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