MAJOR ARTERIES NEAR THE HEART IN THE WHOOPING CRANE

By HARVEY I. FISHER

The basic pattern of the arterial system in birds has been well known for some time, but ordinal, familial, and specific differences were little known until Fred H. Glenny started his investigations some 15 years ago. Even now we have no knowledge of the circulatory systems of perhaps two-thirds of the species of birds. Many of the data for a species have been based on but single specimens. Therefore, it seems important to record even fragmentary bits of information about species whose circulatory systems are entirely unknown.

Until Glenny's papers of 1945 and 1947, the thoracic and cervical arteries of gruiform species were largely unstudied. Du Verney (1733) noted that the tracheal artery accompanied the trachea into the sternum in the "Grue d'Afrique." Rathke (1850) dissected "*Grus cinerea*" and apparently found the usual bicarotid condition; he did not specifically state this, but he did not include this species in his list of exceptions to the characteristic double carotids. In 1873 Garrod found both carotids in *Grus antigone* and wrote that this condition was constant within a single genus. Gadow (1891:777) concluded that gruiform birds had two "carotides profundae" but did not have two "carotides profundae conjunctae," a "carotid superficialis sinistra," a "carotid profunda dextra," or two "carotides superficiales." Gadow's conclusions were seemingly based in large part on dissections of "*Grus cinereus*," although one cannot be certain. In his study of the cerebral arteries of birds, Beddard (1905) discussed *Anthropoides*. Glenny (1945) described and figured the thoracic arteries of *Grus antigone, Anthropoides paradisea, Fulica americana,* and in 1947 *Rhynochetos jubatus*.

The purpose of this study is to record the major arteries found in three Whooping Cranes, *Grus americana*. The origin of these specimens is given by Fisher and Goodman (1955). We can not expect many specimens of this rare and nearly-extinct species; therefore, study of all organ systems was attempted. Work on the blood vessels was difficult, for no special vascular injection had been made, and the specimens were variously preserved (in alcohol, frozen, or in formalin) before I received them.

There is little need for detailed descriptions which in large part would duplicate Glenny (1945). Comparison with his descriptions will be used to point out apparent differences between the species, between the individual Whooping Cranes, and even between the two sides of the same Whooping Crane. Figure 1 is of crane number 1; figures 2 and 3 depict the left and right sides of crane number 2. Crane number 3 showed no features not present in one of the illustrations, but the arteries in this bird were not identical to those of the other specimens.

Grus antigone and all specimens of *Grus americana* agree in the basic origin and interrelationships of the innominate arteries and the right aortic arch (fig. 1) and in the division of each innominate trunk to form the common carotid and subclavian arteries. *G. antigone* apparently has a definite section of artery which can be termed the subclavian trunk. The subclavian arterial trunk is not uniformly present in *G. americana*. Figure 3 shows the subclavian present and well developed on the right side of Whooping Crane number 2; the left side of the same bird (fig. 2) demonstrates the opposite extreme, the innominate ending abruptly in four distinct branches. Bird number 1 (fig. 1) and the third crane also indicate this asymmetry; the subclavian artery is better developed on the right than on the left side.

The subclavian artery gives rise to the axillary, coracoid major, pectoral, and intercostal arteries. However, the position of origin of the branches in *G. americana* is dif-

ferent from that in *G. antigone*. In all specimens of *G. americana* the sequence from anterior to posterior is axillary, coracoid major, pectoral, and intercostal. Glenny (1945: fig. 1) gave the series in *G. antigone* as axillary, pectoral, intercostal, and coracoid major. In order of origin from proximal to distal the series in *G. antigone* is coracoid major, coracoid minor, axillary, intercostal, and pectoral. In *G. americana* all may arise at the same place (fig. 2) or the sequence may be axillary, coracoid major, intercostal, and pectoral. No coracoid minor artery was found in *G. americana*. It may be that this artery arises from the axillary as Glenny (1945:267) described for *Anthropoides paradisea*, but it is also possible that it comes from the coracoid major artery, all the branches of which I could not trace. In the Whooping Crane the relative points of origin of the

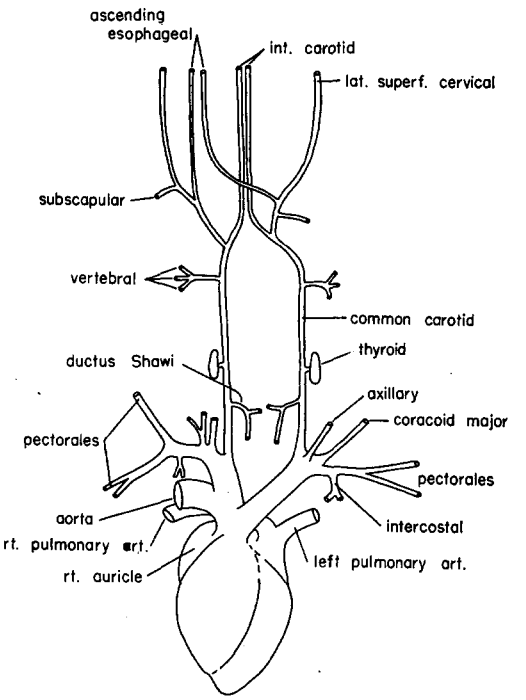

Fig. 1. Ventral view of the heart and proximal arteries of a Whooping Crane (bird no. 1).

major arteries branching from the subclavian varied individually and between the two sides of the same bird (compare fig. 1 with figs. 2 and 3, and compare origins shown in fig. 2 with those in fig. 3). These variations seem to be correlated with differences in the development of the subclavian trunk. The axillary artery is always a separate vessel, but the coracoid major may come off the subclavian artery near the base of the axillary (fig. 2) or farther distad, near the origin of the intercostal and pectoral arteries (fig. 3). On four of the six sides dissected, the intercostal arteries can be said to arise directly from the subclavian (figs. 1 and 3); on the other sides the intercostals originate as medial branches of an arterial trunk which continues ventrally to form the main pectoral arteries (fig. 2).

The axillary artery divides typically into two trunks—the brachialis and the humeralis. These arteries could be traced in only one of the Whooping Cranes, but there was

considerable variation in the distribution of the branches. On the left side of this specimen (fig. 2) the brachialis artery sent two distinct branches to the biceps muscle and one to the coracobrachialis anterior muscle. On the right side (fig. 3) the major vessel to the biceps came off the humeralis artery, and M. coracobrachialis anterior was supplied by a branch of the coracoid major artery. On the right side a branch of the brachialis artery carried blood to M. deltoideus minor, but on the left side this muscle was supplied by an artery arising from the coracoid major artery. Other distributions of branches of the humeralis artery were identical on the two sides of this crane.

The coracoid major artery divides shortly after it arises. One artery always supplies the supracoracoideus muscle; the other, smaller twig goes to the subcoracoideus and deltoideus minor muscles (fig. 2) or to the sternocoracoideus and coracobrachialis posterior muscles (fig. 3). In figure 2 note that these latter muscles are served by an artery coming off the intercostal artery.

As Glenny described for *Grus antigone* and *Anthropoides paradisea*, the intercostal and pectoral arteries in *Grus americana* divide almost immediately after their origin.

No trace of the ligamentum aortae or of the right ligamentum botalli was found in any of the Whooping Cranes. An intensive search was made, and this region was fairly well preserved in the specimens. Glenny (1945:267–268) reported both these ligaments

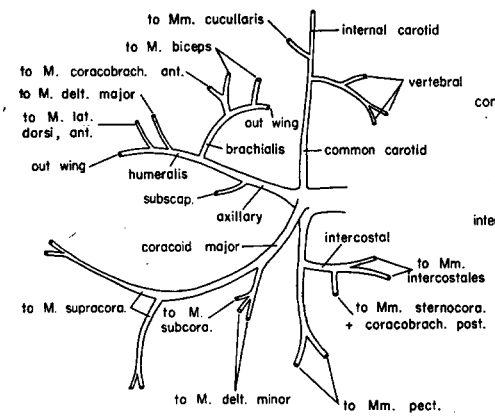

Fig. 2. Dorsal view of the proximal arteries of the left side of a Whooping Crane (bird no. 2).

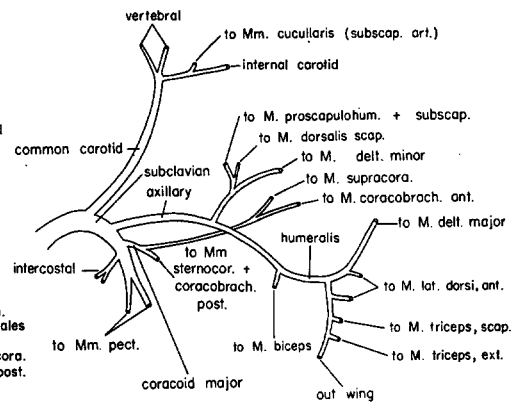

Fig. 3. Dorsal view of the proximal arteries of the right side of a Whooping Crane (bird no. 2).

"present and prominent" in *Grus antigone* but only the ligamentum botalli in *Anthropoides paradisea*. Both are present in *Fulica*. Presence or absence or relative development of such transient, embryological structures is perhaps of little significance.

Although the term "common carotid" is used in the illustrations to denote a definite trunk or vessel, it should be noted that probably only the base of this trunk constitutes the common carotid. Just how far the common carotid extends distally from the original embryological arch is open to question. In any event, the right and left carotid trunks send off small ductus shawi vessels (fig. 1), the posterior ends of which were not traceable. The medial twigs from the ducti represent some of the syringotracheal arteries. Small vessels go to the thyroid, and still farther anteriorly one or more vertebral arteries arise from the carotid trunk. All three Whooping Cranes were the same as regards these details of the carotid.

Only one of my specimens was suitable for tracing all the major anterior branches of the internal carotid trunk. However, this specimen differs from the species of cranes described by Glenny. In *Grus americana* the vertebral arteries are produced from the carotid artery proximal to the origin of any of the esophageal or cervical arteries. In *G. antigone* and in *Fulica* the vertebrals arise anterior to these latter arteries. In *A. paradisea* the vertebral vessels come off the carotid between the origins of the superficial cervical and the accessory ascending esophageal arteries.

The ascending esophageal artery in the Whooping Crane comes from a common trunk which also gives rise to the subscapular (scapular) artery and the lateral or superficial cervical artery. The left ascending esophageal artery passes over the ventral surfaces of the internal carotids to go anteriorly alongside its counterpart of the right side. This esophageal artery of the right side is apparently absent in the cranes dissected by Glenny or is represented by his accessory superficial cervical artery which is present only on the right side in *Grus antigone*.

Glenny (1945:267) found that the scapular artery arises from the superficial cervical artery in *G. antigone*. This was also the case in one Whooping Crane (fig. 1); in another Whooping Crane the scapular came directly from the internal carotid (figs. 2 and 3, labelled "to Mm. cucullaris").

SUMMARY

The limited results of this study demonstrate that there is considerable interspecific variation in the arteries near the heart in cranes. But it is thought that much of what appears to be interspecific variation may really be individual variations, such as that shown in the Whooping Cranes here described. The Whooping Crane typically shows the bicarotidinae normales condition postulated as characteristic of the order Gruiformes by Garrod, Gadow, and Glenny. However, this species is not like *Grus antigone* or *Anthropoides paradisea* in the manner of origin of the accessory ascending esophageal and vertebral arteries. Both these origins, as described by Glenny, were considered by him to be characteristic of birds of the order Gruiformes. The bifurcated intercostal arteries are apparently characteristic of all cranes thus far dissected.

LITERATURE CITED

Beddard, F. E.
1905. A contribution to the knowledge of the arteries of the brain in the class Aves. Proc. Zool. Soc. London, 1905:102–117.

Du Verney, J. G.
1733. Observation sur la tracheé-artére de la grue d'Afrique. Mem. del Acad. Sci. Paris, 2:6–7.

Fisher, H. I., and Goodman, D. C.
1955. The myology of the whooping crane, *Grus americana*. Illinois Biol. Monographs, in press.

Gadow, H.
1891. Vögel. *In* Bronn's Klassen und Ordnungen des Thier-Reichs, 6(4):767–778.

Garrod, A. H.
1873. On the carotid arteries of birds. Proc. Zool. Soc. London, 1873:457–472.

Glenny, F. H.
1945. A systematic study of the main arteries in the region of the heart—Aves XIV. Gruiformes, part 1. Auk, 62:266–269.
1947. A systematic study of the main arteries in the region of the heart—Aves XIV. Gruiformes, part 2. Auk, 64:407–410.

Rathke, H.
1850. Uber die Carotiden der Krokodile und der Vögel. Archiv. für Anat. Physiol., 1850:184–192.

Department of Zoology, University of Illinois, Urbana, Illinois, April 30, 1955.