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THE PERSISTENCE OF A PATENT DUCTUS ARTERIOSUS IN AN ADULT SPECIMEN OF THE TORTOISE *TESTUDO GRAECA*.—In the reptilian embryo the connection of the aorta and pulmonary artery by the dorsal portion of the 6th aortic arch, the ductus arteriosus, permits extra-cardiac blood shunting from the pulmonary to the systemic circulation. However, the ductus arteriosus persists into adulthood in few species of reptiles, *Sphenodon* being a notable exception (O'Donoghue, 1921). Typically, only the ligament of Botallus or arterial ligament remains as a connective tissue vestige of this embryologically functional vessel. Thus, in most Chelonia and Squamata shunting of venous blood into the systemic circulation or recirculation of pulmonary venous return in the pulmonary circulation, depending on the relative resistances of the pulmonary and systemic circuits, is strictly an intra-cardiac phenomenon allowed by the anatomical continuity of the cavum venosum and cavum pulmonale of the ventricle (White, 1968; Shelton and Burggren, in press). The persistence of a patent

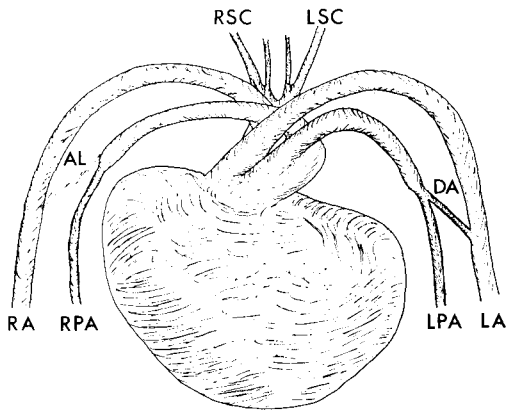

Fig. 1. A diagramatic representation of the major arteries leaving the heart of *Testudo graeca*. The auricles have not been illustrated for clarity. Note the normal positioning of the right arterial ligament and the location of the left ductus arteriosus retained in this aberrant specimen. AL, arterial ligament; DA, ductus arteriosus; LA, left aorta; LPA, left pulmonary artery; LSC, left subclavian artery; RA, right aorta; RPA, right pulmonary artery; RSC, right subclavian artery.

ductus arteriosus in a mature specimen of a terrestrial chelonian has not previously been reported in the literature, although other cardiovascular anomalies in reptiles have been described (Woodbury and Robertson, 1942; Adams, 1962; Brockman and Kennedy, 1962).

The circulatory system of a specimen of *Testudo graeca*, a male weighing 1025 g with a plastron length of 26 cm, was examined immediately after sacrifice and a well developed anastomosis between the left pulmonary artery and the left aorta was observed (Fig. 1). This anastomosis, 1.0 mm in diameter and 12.0 mm long, arose from the left pulmonary artery (diameter 2.1 mm) 20 mm from the bifurcation of the pulmonary trunk and joined the left aorta (diameter 3.0 mm) 44 mm from its point of emergence from the ventricle. The left aorta and left pulmonary artery complete with the anastomosis were excised from the tortoise and cannulated. Perfusion of the left aorta with a dye in saline revealed patency of the left pulmonary artery and the left aorta via the anastomosis. A relatively low arterial wall distensibility (approximately 5%/cm/H_2O) similar to that of the distal extrinsic pulmonary artery and a well developed cholinergic constrictor response of the anastomosis (Gillespie and Rae, 1972 for technique) suggested that its vascular tissue was of pulmonary rather than of aortic origin. In view of these highly characteristic pulmonary properties of the anastomosis and its location where the arterial ligament is normally found, it seems reasonable to conclude that this anastomosis represents the embryological ductus arteriosus. Apart from the retention of this dorsal portion of the 6th aortic arch, the anatomy of the ventricular chambers, the arterial outflow tracts and the arteries leaving the heart of this specimen as well as the location and composition of the right arterial ligament appeared identical to that of 20 normally developed specimens of *Testudo* which were also examined.

Although no respiratory or circulatory data were collected before the sacrifice of this specimen, blood pressure measurements which we have made on unanaesthetized normally developed specimens of *Testudo* without the retention of a patent ductus arteriosus can be utilized to interpret the possible consequences of this anastomosis. Throughout almost the entire cardiac cycle there exists a pressure gradient from the aorta to the pulmonary artery, ranging from 1 cm H_2O at systole to 15 cm H_2O at diastole. If this fluctuating pressure gradient was not completely negated by the presence of the anastomosis in this aberrant specimen, then blood flow from the left aorta through the ductus arteriosus into the left pulmonary artery could occur, producing a left-to-right extracardiac shunt and subsequent re-circulation of some portion of the systemic arterial blood through the pulmonary vascular bed. Unfortunately, in the absence of data on the actual magnitude of the systemic-pulmonary pressure gradient in this animal accurate estimates of blood flow through the anastomosis can not be made.

Why this specimen of *Testudo* retained the embryological ductus arteriosus into maturity is unknown, although such anomalies in other animals suggestive of both ontogeny and phylogeny are not unduly rare. Blood flow diversion due to pathological stenoses of the aortic or pulmonary outflow tracts can maintain and enlarge embryological anastomoses that would otherwise revert to their vestigial form in the normal adult animal. Perhaps of significance is the fact that the contraction of the chelonian pulmonary outflow tract during systole has been demonstrated to produce an active and often large resistance to pulmonary blood flow (Woodbury and Robertson, 1941; Shelton and Burggren, in press). A pathological stenosis of the pulmonary outflow tract of a neonate tortoise

might be especially important in favoring retention of an embryological anastomosis by severely compounding active resistance during systole at this site.

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