APPENDIX - II

ILLUSTRATIONS AND ABBREVIATIONS ON HETEROPHLEUSTES FOSSILIS

PLATE 5

Fig. 9 A cross section of the heart showing nerve fibres in between the sinous venosus and atrium (x675)

Fig. 10 Photomicrograph of the dorsal wall of the right atrium showing innervation (x500)

PLATE 6

Fig. 11 A cross section of the heart, showing the nerve supply to the atrioventricular valves (x500)

Fig. 12 A horizontal longitudinal section of the heart showing the position of conducting purkinje muscles in the atrioventricular wall (x675)

PLATE 7

Fig. 13 Photomicrograph of the wall of the ventricle, showing nerves and bulb like nerve endings (x1000)

Fig. 14 A coronal section of the heart showing nerve fibres in the bulboventricular wall (x450)

PLATE 8

Fig. 15 Photomicrograph of the heart showing valves at the junction of the ventricle with the bulbus arteriosus (x450)

Fig. 16) Coronal section of the heart showing the bulboventricular valves with innervation at their bases (x675)

ABBREVIATIONS

A Atrium
ABVV Anterior bulboventricular valve
AMB Atrial muscle band
ANF Atrial nerve fibres
AR Atrial ridge
ANS Atrial nerve strand
AVJ Atrioventricular junction
BA Bulbus arteriosus
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>BNE</td>
<td>Bulb like nerve ending</td>
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<tr>
<td>CAVV</td>
<td>Cephalic atrioventricular valve</td>
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<tr>
<td>CK</td>
<td>Conducting muscles</td>
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<tr>
<td>NF</td>
<td>Nerve fibres</td>
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<tr>
<td>PBVV</td>
<td>Posterior bulboventricular valve</td>
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<tr>
<td>PF</td>
<td>Purkinje fibres</td>
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<tr>
<td>PNS</td>
<td>Posterior nerve strand</td>
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<tr>
<td>SV</td>
<td>Sinus venosus</td>
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<tr>
<td>V</td>
<td>Ventricle</td>
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(c) CARDIOVASCULAR CONDUCTING SYSTEM OF RANA HEXADACTyla

I. PARASYMPATHETIC EXTRINSIC CARDIAC NERVES

(a) Vagus contribution

The vagus nerve (Fig. 17) originates from the hind brain and its cardiac branches innervate the heart and other vascular structures of the thorax and abdomen. The right and left vagus cardiac nerves may be termed as dextral and sinistral vagal cardiac nerves respectively. In the thoracic region the vagal cardiac nerve bifurcates to form two branches. One branch is delicate and small, while the other branch is relatively stout and long. These may be distinguished as superior vagal cardiac nerve and inferior vagal cardiac nerve respectively. The former continues dorsally reaching up to the rostral parietal surface of the heart, merging with the anterior cardiac plexus. The inferior vagal cardiac branch extends towards the cardiac flanks and splits into two branches. The anterior branch supplies to the carotid labyrinth and carotid arteries. The other branch is posteroventral and innervates the ventral and posterior cardiac plexus. The inferior vagal cardiac nerve immediately before its bifurcation has a small ganglionic swelling, from which a bunch of minute nerve arises and disappears in the muscles of this region. Some fibres contribute in the formation of the cardiac plexus and even innervate heart muscles. The inferior vagal cardiac nerve and the posterior cardiac plexus are joined by the nerve fibres from the sympathetic nervous system. The vagal cardiac nerves and their branches also innervate the parietal surface of the heart, blood vessels and intrinsic cardiac muscles.
A delicate branch running closely to the vagus nerve is seen in most cases. This branch appears to innervates the carotic labyrinth and seems to originate in the fibres of the glossopharyngeal nerve. In some animals this nerve was observed on the left side while in the others on the right side.

II. SYMPATHETIC EXTRINSIC CARDIAC NERVES

The two sympathetic nerves (Fig. 17) in the abdominal region extend closely applied to the aorta dorsalis. These sympathetic nerves are ganglionated forming a chain. On the either side of the coeliacomesenteric artery, several abdominal nerves and their branches form the two solar plexuses. Branches from the solar plexus innervate the branchial arteries and enter close to the posterior margin of the lungs of their side into posterior cardiac plexus.

In the thoracic region the sympathetic nerves extend almost close to the systemic trunks. There are three relatively well marked ganglia in the thoracic region. The sympathetic trunks in the thoracic region send branches, arising from the thoracic sympathetic ganglia which innervates the heart and the vessels. Many branches from the sympathetic trunks extensively branch while supplying to the anterior and posterior cardiac plexuses. The anterior sympathetic cardiac branch joins the anterior cardiac plexus while the posterior sympathetic cardiac branch contributes in the formation of the posterior cardiac plexus and innervates the ventricle.

Fibres arising from the sympathetic system join the branches from the inferior vagal cardiac nerves. Sympathetic innervation is also observed in the distal part of the caval veins.
III. CARDIAC PLEXUSES

There are two cardiac plexuses in the vicinity of the heart. The anterior cardiac plexus lies at the rostral end of the heart abutting the left atrium. The posterior cardiac plexus lies on the dorsal side over the ventricle. Both the cardiac plexuses have parasympathetic and sympathetic elements. The anterior cardiac plexus is formed by the fibres from the thoracic sympathetic and superior vagal cardiac nerves. The posterior cardiac plexus is mostly formed by the sympathetic nerve fibres and fibres received from the inferior vagal cardiac nerve. The anterior cardiac plexus sends nerves to the left atrium and coronary vessels. Some fibres from the anterior cardiac plexus also innervate the arterial trunks at their bases. The posterior cardiac plexus mostly innervates the ventricle and also the posterior caval vein.

IV. INTRINSIC CARDIAC INNERVATION:

The sinus venosus is a thin walled sac. The dorsal and most of the ventral wall of the sinus venosus is practically devoid of nerve fibres. The sinoatrial aperture is beset with two valves which hang freely in the right atrium. The caudal sinoatrial valve at its base is feebly supplied with interwoven nerve fibres.

The two atria are partitioned by an interatrial septum. The right atrium is distinctly spacious than the left atrium. The ventral wall of the sinus venosus, posterior to the sinoatrial aperture is greatly pushed towards the right atrium and reaches close to the interatrial septum. In this deeply impushed wall of the sinus venosus lies the specialised tissue, the sinoatrial node (Fig.1B). The right atrium is innervated by the superior vagal cardiac nerve and also by fibres from the anterior cardiac plexus. The nerve fibres ramify
in between the cardiac myocardium mostly in the anterolateral wall and then enter in the interatrial septum. In the sinoatrial node the innervation is copious with nerve fibres probing the conducting muscles and specialised cells at their outer edges and often encircling a group of cells. There is a prominent ganglion in the substance of the nodal tissue. In the posterior part of the right atrial wall, the nerve supply is meagre except in the portion which lies adjacent to the base of the conus arteriosus.

The interatrial septum is folded at several places leaning towards the atria. The innervation in the interatrial septum is mostly from the nerves going to the right atrium and anterior cardiac plexus. There are only a couple of ganglia and the nerve fibres traverse in the posterior direction (Fig. 19). In the mesial and hinder parts of the interatrial septum lie the specialised masses of conducting cells and muscle fibres representing the atrioventricular node and atrioventricular bundle respectively. There is an oval shaped nerve mass, enclosed within a membrane at the posterior end of the septum. Nerve fibres and ganglia are spread in between the conducting cells (Fig. 21 and 22) and muscle fibres.

The left atrium receives the nerve supply from the anterior cardiac plexus and to a lesser extent from the vagal branch. At the outer anterior margin of the left atrium, the nerve supply is plentiful. Beaded or spirally twisted nerve fibres form a distinct patch. Some of the nerve fibres travel transversely towards the interatrial septum. Several ganglia (Fig. 20) are observed in the wall of the left atrium in this region. Fibres and nerve cells from
one of the ganglia innervates the coronary blood vessels.

Inside the ventricle the nerve supply is mainly from the posterior cardiac plexus and partly through the nerves reaching from the atrioventricular junction. In the left anterior portion of the wall of the ventricle lies a ganglionic mass which innervates the epicardium and myocardium to an appreciable extent. Several relatively small ganglia lie in the lateral wall of the ventricle. In the posterior part of the ventricle there is however, paucity of the nerve supply.

V. SPECIALISED CONDUCTING AND CONNECTING MUSCLES-

The sinus venosus of the heart is formed by the confluence of the two pre caval and one post caval veins. At the junctions of the veins with the sinus venosus, there are neither specialised tissues nor connecting muscles. The sinoatrial node (Fig.13) is a mass of specialised cells and thick muscles and lies on the mesial inferior surface of the sinus venosus. Since this part of the sinus venosus lies impushed towards the right atrium, the conducting tissue also appears inside the right atrium. The cells of the specialised conducting atrioventricular node have distinct nuclei and clear perinuclear spaces around them. Connecting muscle fibres extend from the sinoatrial node towards the interatrial septum.

In the mesial part of the interatrial septum is located a small mass of the conducting cells and this constitutes the atrioventricular node (Fig.23 and 24). The conducting cells are identical to those described for the sinoatrial node except that some of the cells are slightly larger and loosely spread in the interatrial septum. The interatrial septum in the region of atrioventricular
The node is folded in such a manner that the surface area is considerably increased.

At the posterior end of the interatrial septum is situated a massive conducting tissue (Fig. 25 and 27) representing the atrioventricular bundle. These cells of the atrioventricular bundle (Fig. 26) also show characteristic nuclei and around the nuclei clear spaces. Some of the conducting cells of the atrioventricular bundle are remarkably bigger than the others. In between the cells are spread the purkinje fibres. At the caudal end, the atrioventricular bundle seems to give out branches, composed of conducting cells and fibres. These branches are extremely short and disappear in the right and left atrial muscles. The connecting muscles exhibit their continuity between the atrioventricular bundle and left atrium for some distance.

A part of the myocardium of the left atrium at its atrioventricular junction tends to merge with the peripheral part of the atrioventricular bundle.

The ventricle is traversed with muscles which form irregular bundles or groups. These muscles are oriented in varying patterns and no structural generalisation could be made about them.

Specialised muscles or cells could not be located in any part of the ventricle.

The conus arteriosus also lacks the characteristics specialised conducting and connecting structures.
APPENDIX - III

ILLUSTRATIONS AND ABBREVIATIONS ON RANA HEXADACTYLA

PLATE 9

Fig. 17 Figure showing the distribution of the extrinsic sympathetic and parasympathetic nerves to the heart and emerging vessels. Arterial vessels and vagal cardiac nerves of the right side, while the parasympathetic nerves and veins of the left side only have been shown.

Fig. 13 Cross section of the heart (obliquely sectioned) showing specialised conducting cells and muscles of the atrioventricular node (x225)

PLATE 10

Fig. 19 Cross section of the heart showing nerve fibres in the hinder part of the interatrial septum and specialised conducting structures of the atrioventricular node (x450)

Fig. 20 Photomicrograph of the heart showing ganglia and nerves in the wall of the left atrium (x1000)

PLATE 11

Fig. 21 A portion of the interatrial septum of the heart showing the disposition of atrioventricular node and ganglia (x350)

Fig. 22 Photomicrograph of the interatrial septum showing conducting tissue of the atrioventricular node and ganglia (x675)

PLATE 12

Fig. 23 Longitudinal horizontal section of the heart showing the atrioventricular node and associated ganglia in the interatrial septum (x450)

Fig. 24 Cross section of the heart showing the atrioventricular node and the nerves in the interatrial septum (x225)

PLATE 13

Fig. 25 Photomicrograph of the atrioventricular bundle, showing specialised cells and muscles (x1000)

Fig. 26 Caudal end of the interatrial septum showing specialised conducting tissue of the atrioventricular bundle and nerve fibres (x675)