# THE TOPOGRAPHY AND HISTOLOGY OF THE PARATHYROID GLANDULES IN *XENOPUS LAEVIS*

By B. G. SHAPIRO

*From the Department of Physiology, University of Capetown*

During the past few years the exceptional suitability of the South African clawed toad, *Xenopus laevis*, for physiological investigations has been increasingly appreciated. Especially useful is its ability to withstand the severest of operative procedures, and also the power of the living animal or of its isolated organs to resist great variations in the environment.

Of particular interest to the experimental physiologist is the endocrine system of *Xenopus* which has only been carefully investigated during the last two years. Rimer (1) published accounts of the pituitary and thyroid glands, while Zwarenstein and Schrire (2) and Epstein, Gunn, Epstein and Rimer (3) elucidated the distribution and structure of the adrenal glands. The parathyroids have not hitherto been located. The need to do so has recently become more pressing in view of the large amount of work done during the last few years on the part played by the pituitary and ovaries in the calcium metabolism of *Xenopus*. The fact that the situation of the parathyroids in this animal is unknown prevented the further elucidation of the problem of the factors controlling the blood calcium, and impressed the need for investigating the whereabout of the glandules.

Amphibia are the lowest animals in which parathyroids have been found. Toldt (4) referred to the parathyroid bodies in Amphibia as "Nebenschilddrusen," a term which led to their being confused with true accessory thyroids. Maurer (5), however, recognised that they were not accessory thyroids, but homologous with the parathyroid glandules of higher vertebrates.

The following is an account of the anatomical relations and histological structure of the parathyroid glandules in *Xenopus*. In order to locate them serial sections of the head and thorax as far down as the apex of the heart were cut.

## TOPOGRAPHY

The glandules lie very deeply, and in order to expose them the skin, pectoral muscles and sternum must be removed, and the heart with its large blood vessels revealed. The glandules are most easily located by reference to their relations to these blood vessels which should be clearly defined.

The sinus venosus is joined by a single inferior vena cava and right and left superior venae cavae. Each superior vena cava is seen to receive (1) the

external jugular vein passing down from the region of the ventral wall of the mouth; (2) the vena anonyma formed by the junction of the internal jugular vein and a smaller vein, the subscapularis, from the muscles of the scapula. The vena anonyma then runs downwards parallel with the musculus petro-hyoideus. In this connection the nomenclature of Grobbelaar (6) has been preferred to that of Gilchrist and von Bonde (7) on both phylogenetic and embryological grounds. The superior vena cava also receives (3) the subclavian vein formed by a branch from the abdominal muscles, a branch from the skin and by the brachial vein from the arm.

The conus arteriosus is seen to divide into two branches, each of which subdivides into three arches. (1) The carotid arch, which passes laterally and is characterised by a bulbous enlargement—the carotid body. From the region of this body two arteries pass forwards. The more medial is the muscular artery (referred to as the hyothyroid artery by Rimer) which supplies the mylohyoid muscle and the thyroid gland, the lateral is the lingual artery. They sometimes have a common stem of origin which may be considered to represent the external carotid of *Rana*. Beyond the carotid body the arch continues as the internal carotid artery. (2) The systemic arch, which passes laterally and backwards on each side, and unites with its fellow of the opposite side to form the dorsal aorta. It is important to note, in connection with the precise relations of the parathyroids to be described below, that the systemic arch curves round the lateral aspect of the distal end of the processus thyroideus of the hyoid apparatus, and that as it does so it is pronouncedly kinked. (3) The pulmocutaneous arch which curves just below the systemic arch and divides into a pulmonary and a cutaneous artery.

Once the blood vessels of the region have been clearly defined localisation of the parathyroids is easy and accurate despite the fact that they are so small as to be invisible to the naked eye.

They were found to lie remarkably far down and, as in other Amphibia, at a very considerable distance from the thyroid gland.

There are two glandules on either side situated in a triangular area bounded by the carotid arch anteriorly, the systemic arch posteriorly, and the hypoglossal nerve, as it passes upward to supply the muscles of the ventral wall of the mouth, laterally. They usually lie in the lateral part of this area in a line with the carotid body anteriorly and the systemic arch at the point where it is kinked as mentioned above, posteriorly (fig. 1). The glandules are often found attached by fibrous connective tissue to either of the two last-mentioned structures.

In *Rana*, on the other hand, the parathyroids occupy a somewhat different position. They lie on the lateral side of the external jugular vein in the sinus sternalis and medial to the external carotid artery near its origin (fig. 2). It must be explained that external carotid is here used in conformity with the nomenclature of Gaupp (8) and corresponds to what most English text-books less advisedly call the lingual artery.

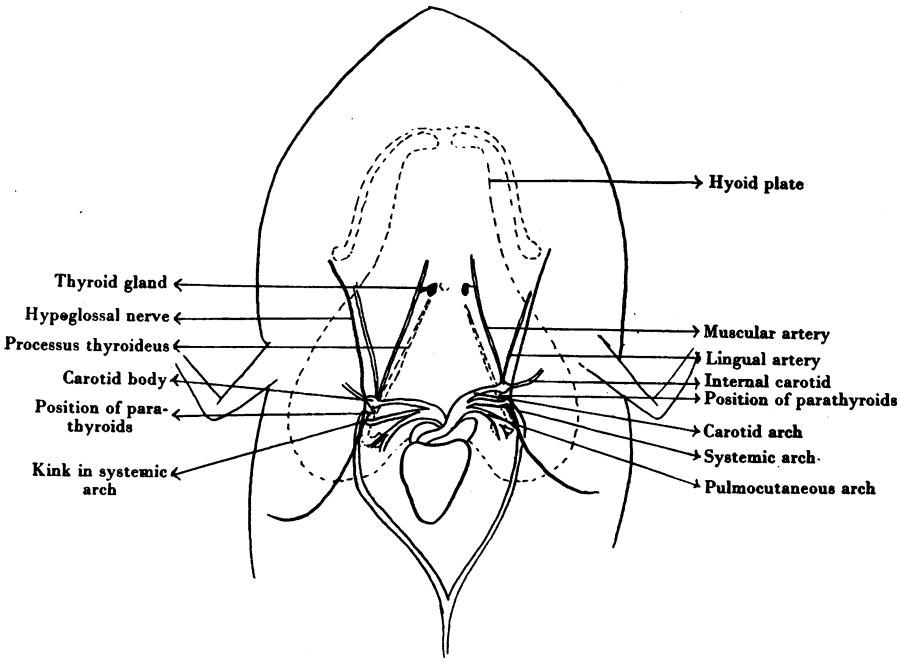


Fig. 1. Diagram showing relations of parathyroid glandules in *Xenopus laevis*.

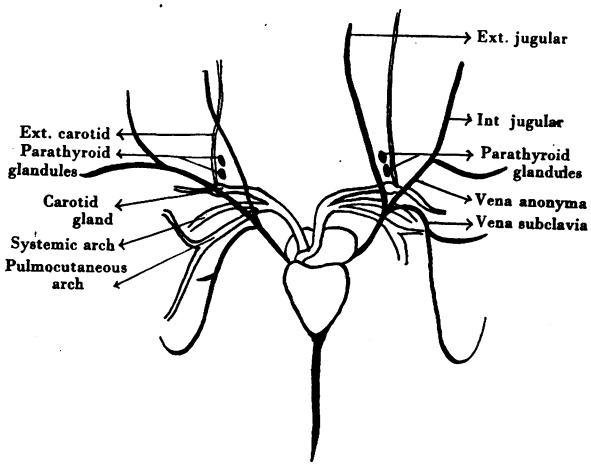


Fig. 2. Diagram of position of parathyroids in *Rana*.

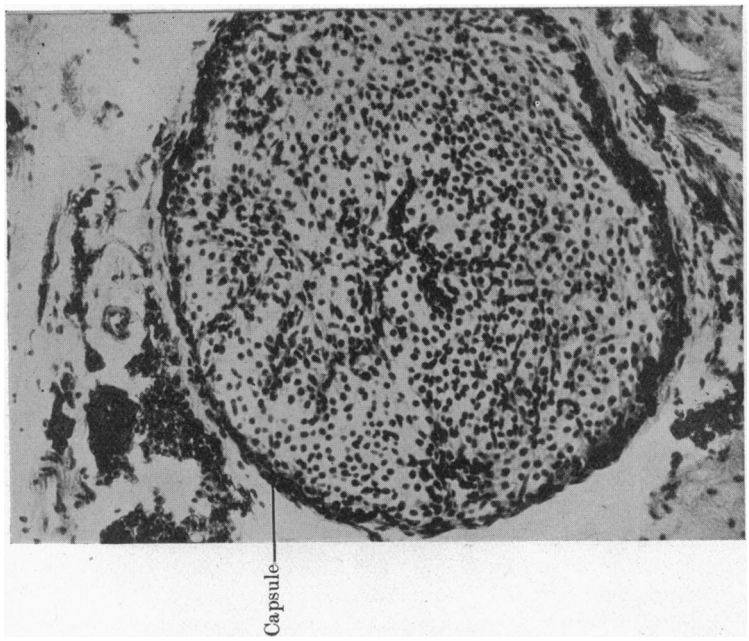


Fig. 4. High power view of a parathyroid glandule. × 200.

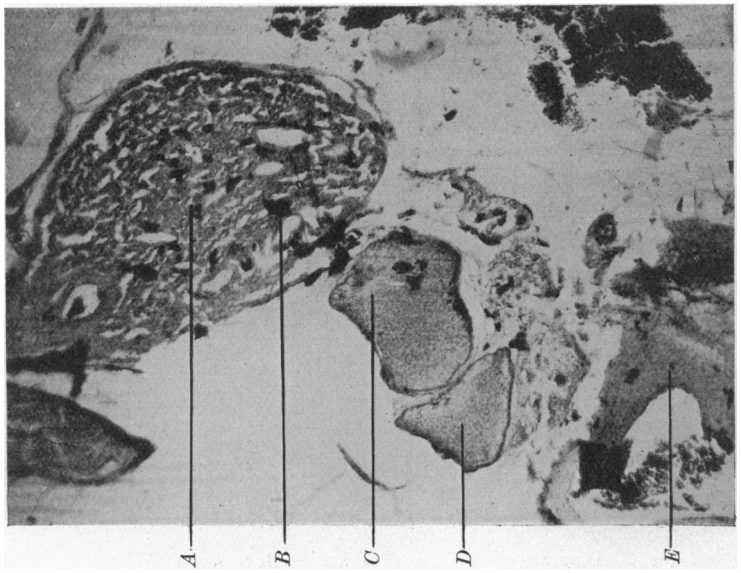


Fig. 3. Photomicrograph of sagittal section through parathyroid region in *Xenopus laevis*. × 50. *A*. Carotid body; *B*. Pigment in carotid body; *C*. Anterodorsal glandule; *D*. Postero-ventral glandule; *E*. Systemic artery.

In *Xenopus* it was found that one glandule is generally dorsal, anterior and somewhat medial to the other, the adjacent surfaces being separated by fibrous tissue. They are both irregular bodies, the antero-dorsal glandule tending to be spheroidal and the postero-ventral one pyramidal in shape (fig. 3). Each glandule is of the order of 0·3–0·4 mm. along its greatest axis as compared with 1 mm. in other Anura generally. Occasionally only three glandules could be found, two on one side and one on the other.

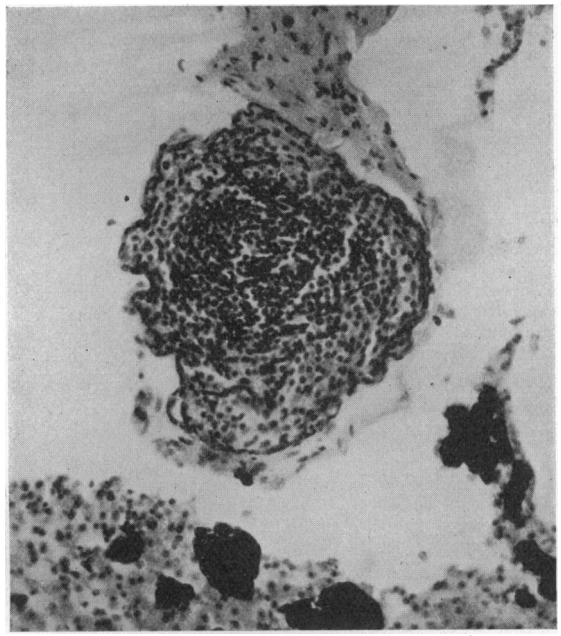

Fig. 5. Photomicrograph of a glandule which showed a whorl arrangement. × 200.

## HISTOLOGY

The tissues were fixed in formalin, and some were stained with haematoxylin and eosin and others with van Gieson's stain.

Each glandule is invested in a strong compact fibrous tissue capsule which is surrounded by looser fibrous tissue continuous with the adventitia of the neighbouring blood vessels.

The structure of the glandules (fig. 4) is identical with that described for other Anura in that the interior of the body is compact and consists of epithelial cells which are closely packed especially towards the centre. Some of the cells are round, others elongated, and they contain round, spindle-shaped or elongated nuclei which stain very deeply. Some of the round cells tend to be vacuolated.

On the other hand it must be remarked that, whereas the cells of the parathyroids of other Anura are characterised by a whorl arrangement of the cells as if the body had been subjected to a process of torsion, in only a very small percentage of the parathyroids of *Xenopus* was there any suggestion of such a disposition of the cells. Fig. 5 is a photomicrograph of one such case. In the fact that it generally lacks this characteristic and in the smallness of its dimensions the parathyroids of *Xenopus* resembles more that of the Urodeles than of the Anura. In this connection it is interesting to note that Rimer finds that the pituitary of *Xenopus* essentially conforms to the salamandrine type in the incomplete separation of the pars tuberalis from the pars anterior, and that Zwarenstein and Schrire noted that the adrenal gland of *Xenopus* is essentially similar in distribution and structure to the adrenal of Urodeles.

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