

Morphological and Ultrastructural Aspects of the Innervation of Rat Ureter *

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The fine innervation of rat ureter has been studied by means of histological and electron microscopic technique. Different thickness of the different layers of the ureter have been observed.

Nerve filaments with minor proportion of myelinic fibres are found in the adventitious layer. Amyelinic fibres, with very fine collaterals whose terminal portion could not be seen, exist in the muscular layer between the external longitudinal fibres and the internal circular ones. Nerve fibres are rarely observed in the centre of the internal circular layer, although it is possible to see terminal buttons, with neural tubules and vesicular formation.

These buttons have been observed in some cases beside the muscular membranes, given rise to the hypothetical existence of a synaptic relationship between both membranes.

The presence of fine amyelinic filaments, underneath the basal membranes, have also been shown. No ganglionic structure has been observed in the various layers of the ureter, or nerve elements in mucosa.

With regard to the motility of the ureter it still is not clear whether its automatism is due to the intrinsic properties of its musculature or to an autonomous nervous mechanism, mediated through nervous plexa. From the morphological point of view abundant nervous structures exist which allow one to suppose that the innervation may play some part in it.

Materials and Methods

This experiment has been carried out on preparation obtained from male Sprague-Dawley rats, weighing 200 ± 15 g.

The rats were killed by decapitation without anesthesia. The ureter was removed immediately after death. Segments of 1 mm from five normal rat ureters were immersed in freshly prepared cold buffered glutaraldehyde. The tissue was then washed in 0.2 M sucrose cacodylate buffer, pH 7.2, post-fixed in 2% osmium

* This paper has been carried out at the Service of Electronmicroscopy of the University of Barcelona (Prof. L. Vallmitjana).

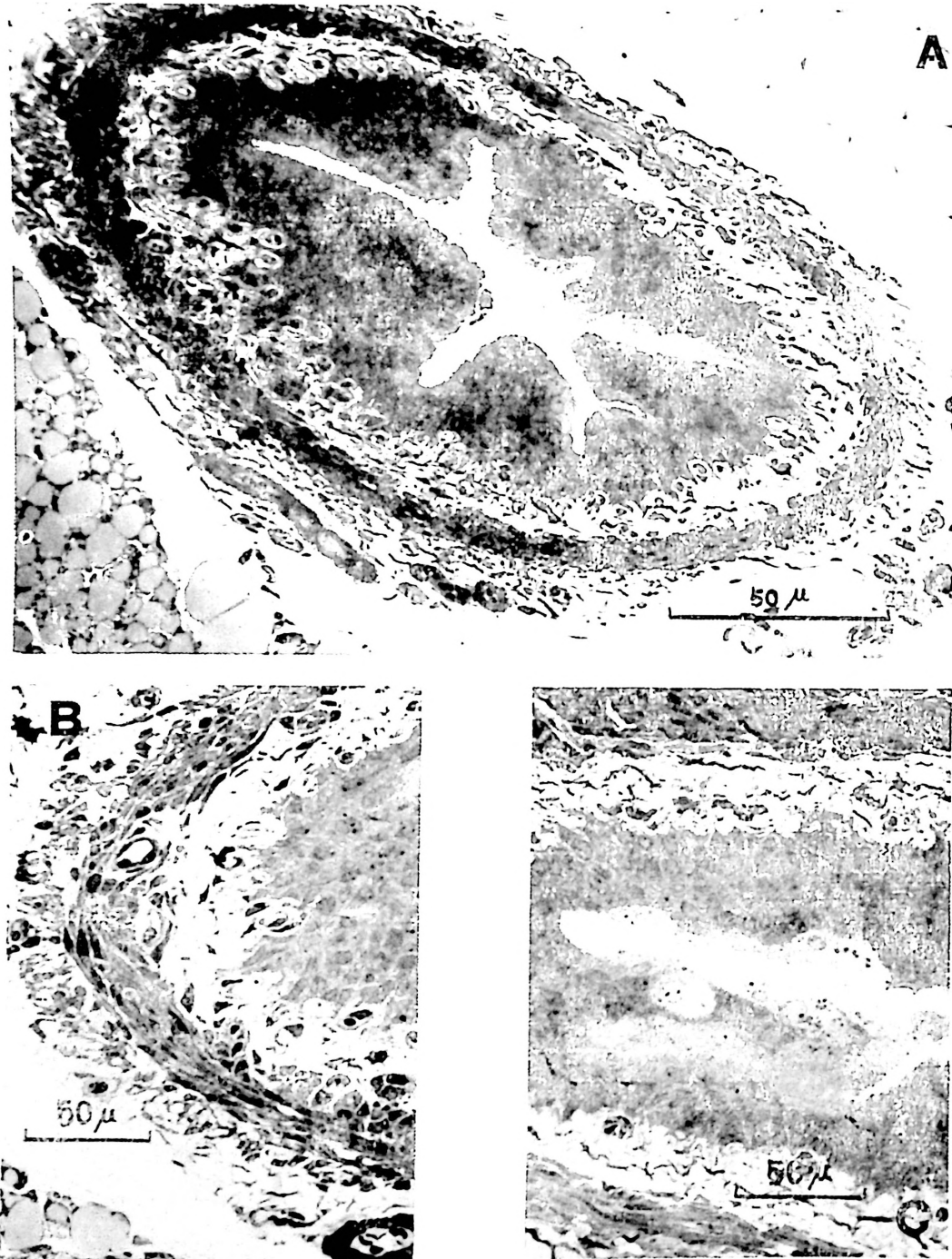


Fig. 1. *Morphology of rat ureter.*

A) A low-power photomicrograph of a transversal section of rat ureter, showing the different layers. B) Muscular layers. C) Mucosa layer.

tetroxide, desydrated in a graded series of alcohol water mixtures, placed in propylene oxide and embedded in Araldit resin. Thin sections were cut a glass knife on a Reichert OmU-2 microtome. Sections 0.5-1 micron mounted on glass slides were stained with 1 % toluidine and 1 % blue methylene-borax and examined with a Leitz light microscope.

The black and white photomicrographs were taken with the fine grain Kodak panatomic-X, FX-135.

The sections fines were stained with 2 % uranylacetate and lead citrate and examined with a Philips EM-200 electronmicroscope. The black and white electronmicrographs were taken with the fine grain release positive 5302 Kodak.

Results

Light microscopy. In the adventitious layer abundant nerve trunks are demonstrate with a discret proportion of myelinic

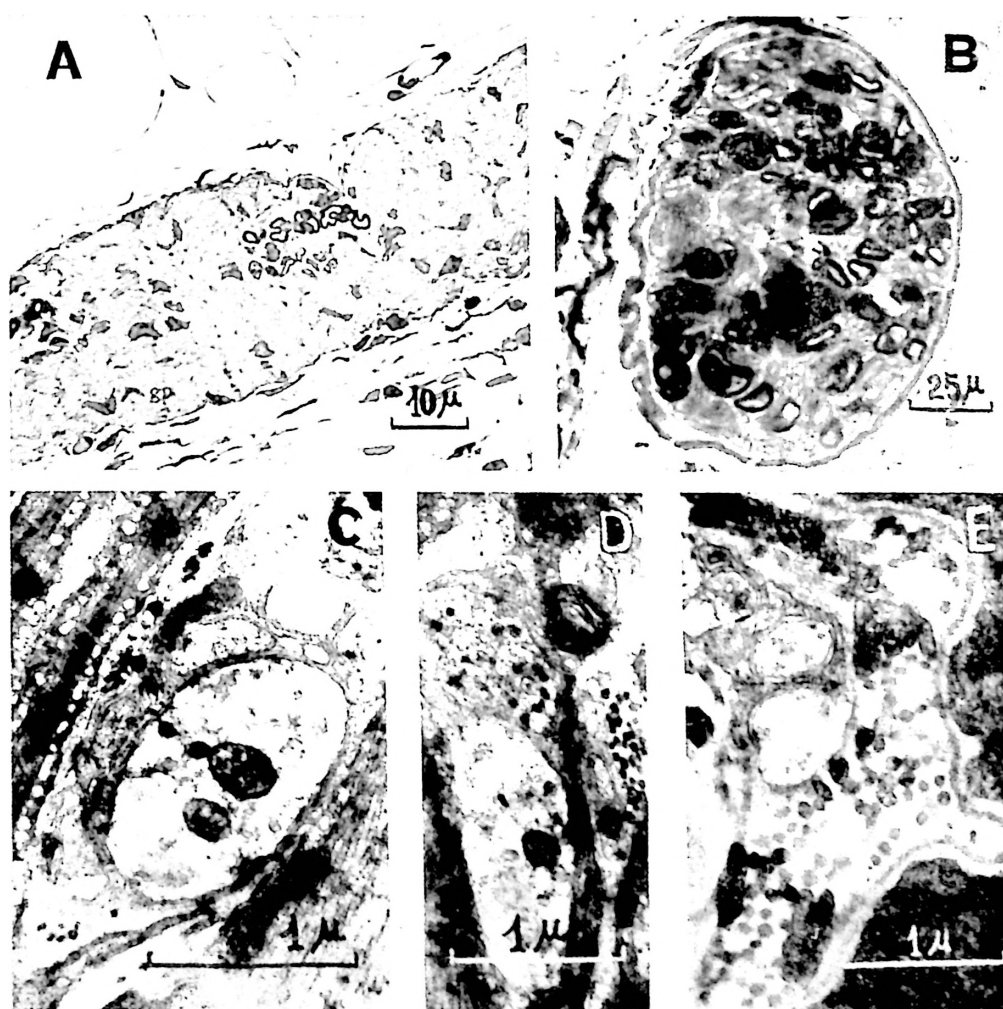


Fig. 2. *Innervation of rat ureter.*
Localization of the innervation: A and B, adventitia; C and D, muscular layer; E, fine amyelinic filaments underneath the basal membrane.

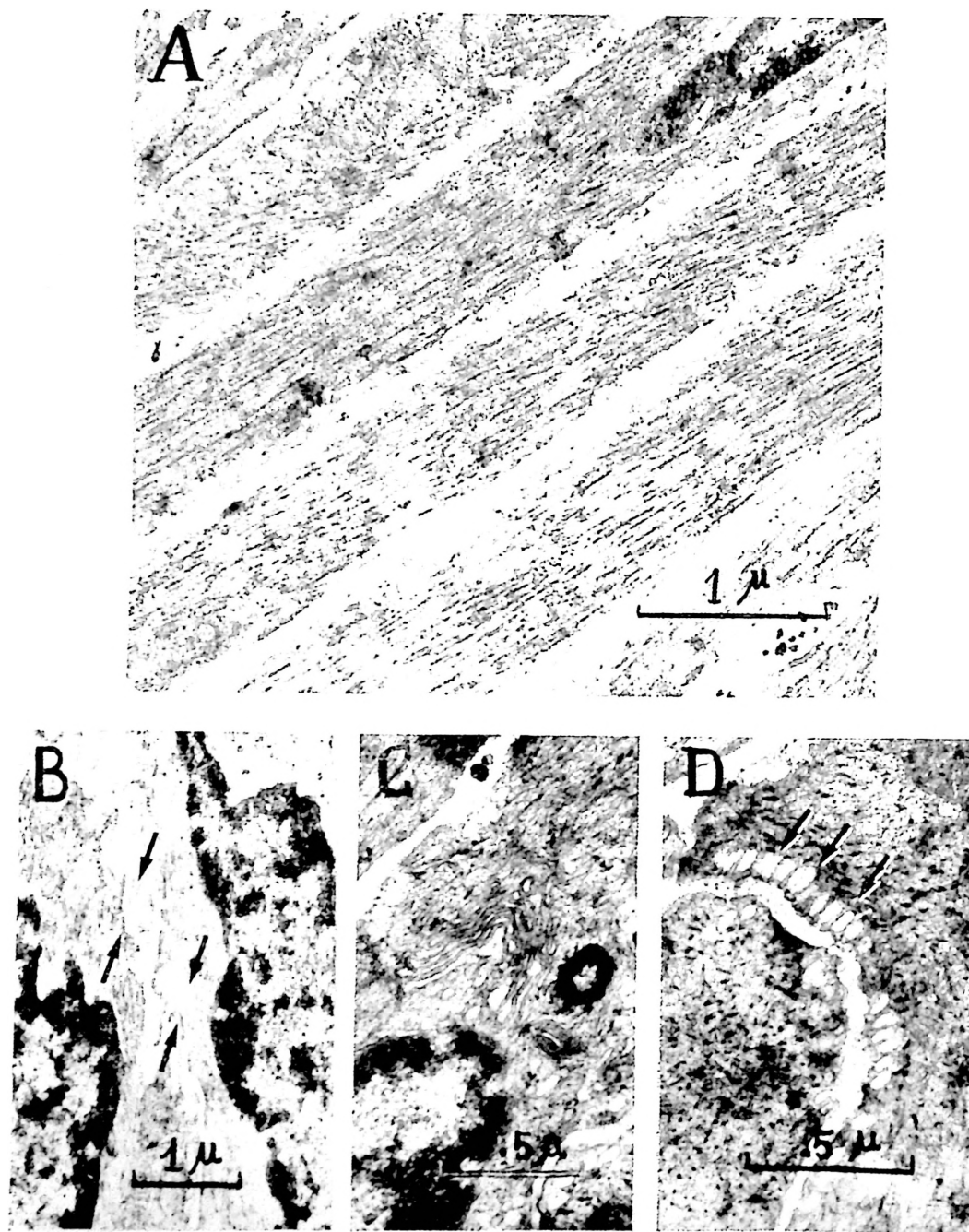


Fig. 3. *Morphology of smooth muscle of rat ureter.*
Ultrastructure of smooth muscle shows sarcoplasm and pinocytotic vesicles (A and D); interdigitating processes (B); Golgi apparatus (C).

fibres, whilst in the muscular layer all the fibres are myelinated and more abundant in the external muscular layer. Between the internal muscular layer and the basal membrane of the epithelium and undefined layer exists (*lámina propia*) of about 20 microns in thickness, and in which myelinated fibres are also found which reach the basal membrane near the epithelium. From the basal membranes and in the thickness of epithelium no nervous element or similar structures has been observed.

Electronmicroscopy. From the ultrastructural point of view, it wish to emphasize the following characteristics in the smooth muscle fibre and in the nerve endings: *Smooth muscle fibre:* Small intercellular space of about 1,000 Å; thickness of the smooth muscle fibre at level of its thicker central portion, of little more than one micron. Length of the fibres from 4-8 microns, nucleus and centriole with great electronic density Golgi apparatus with a well-developed saccular system. Abundant vesicles in the periphery of the cell membrane, well lined, mitochondria with a very dense matrix, near to areas rich in vesicles. Tonofilaments.

Nerve endings: «Nucleated» vesicles of a size from 600-1,000 Å and «empty» or anucleated vesicles of a more or less oval aspect differentiating them from the above ones, which are round. This size is from 300-400 Å.

Discussion

The muscular layer, which could play a motor function in the ureter, is fairly thin and true synaptic dispositions have been detected in this work. This possibility of synapses had already been pointed out (2).

If we consider the anucleated vesicles as cholinergic and the nucleated vesicles as adrenergic (1), it can be presumed that both adrenergic and cholinergic transmitters exist. In any case, the morphological observations seem insufficient to justify the pharmacological responses obtained.

Resumen

Se estudia la inervación del uréter de rata mediante técnicas de histología clásica y de microscopía electrónica. En la capa adventicia se observan filetes nerviosos con una discreta proporción de fibras mielínicas. En la capa muscular, entre las fibras longitudinales y las circulares se encuentran fibras amielínicas con finas colaterales, en las cuales no ha sido posible, sin embargo, descubrir su porción terminal.

En el espesor de la capa circular interna raramente se observan fibras nerviosas, aunque por microscopía electrónica se observan botones sinápticos, que representan neurotúbulos y formaciones vesiculares. En algunos casos se ha observado un estrecho contacto de estos botones con la membrana muscular.

Bajo la membrana basal se observa igualmente la presencia de finos filetes amielínicos.

References

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2. NOTLEY, R. G.: *Brit. J. Urol.*, **40**, 37-52, 1968.

