ÅSE JESPERSEN

ON THE MALE UROGENITAL ORGANS OF NEOCERATODUS FORSTERI

Det Kongelige Danske Videnskabernes Selskab Biologiske Skrifter 16, 5



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Synopsis

Three males and one female of the Australian lungfish, *Neoceratodus forsteri*, were studied with regard to the urogenital connections and histological structure of the kidney and the testis. Tusch gelatine injections and serial sections of tissuemat embedded material were applied.

Eleven and thirteen vasa efferentia were present, on one side, in two of the males examined. The vasa efferentia lead from the longitudinal testis duct to the Malpighian corpuscles in the sexual part of the kidney. The structure of the nephrons through which the sperm pass, and that of normal nephrons are identical, except for the dimensions. Peritoneal ducts with open funnels communicate with the neck segments of the nephrons.

The histological structure of the different sections of the nephron was studied and compared with those of the two other genera of lungfishes (see the scheme p. 8).

Finally, a short comparison was made between the male urogenital connections in *Neoceratodus* and that of other genera of lungfishes and primitive *Actinopterygii*.

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Introduction

The first general anatomical description of the testis and kidney of *Neoceratodus* forsteri was given by GÜNTHER in 1871. He found no connections between the testis and the kidney, but described two vasa deferentia running from the testis, attached to the ventral margin of the ureters and terminating at a common opening in the dorsal part of the cloaca.

SEMON (1901) observed that the sperm on its way out passes through some of the Malpighian corpuscles in the kidney.

KERR (1901) investigated the male urogenital organs of *Lepidosiren* and *Pro*topterus, and reconstructed the testicular network. At the time he was not able to give a similar description of *Neoceratodus* as he lacked adult material. Later, he was sent several adult males, and BALLANTYNE (1928) made an examination of this material. He found four vasa efferentia on each side, leading from the testis into the kidney tubules or the Malpighian corpuscles near the posterior end of the kidney. He described the testis as composed of a large formative part and a small posterior vesicular section from which the vasa efferentia originated.

As far as we are aware, the urogenital ducts of *Neoceratodus* have not been studied since 1928. As the Institute of Comparative Anatomy in Copenhagen received in 1967 ten adult specimens of this species, it was possible to make a new examination of the urogenital organs with special reference to the testicular network. That this material could be obtained was made possible by a grant from the Carlsberg Foundation.

I want to thank Professor K. G. Wingstrand for all help and assistance.

Material and Methods

Neoceratodus I: ♂ Tl: 90 cm.

Fixation: Bouin solution, perfused from the dorsal aorta.

Right kidney and testis: 10 and 15 μ tissuemat sections were stained with PAS-hematoxylin, hematoxylin-eosin or Heidenhains azan.

Left kidney and testis: India ink-gelatine were injected from the longitudinal testis duct through the vasa efferentia to the Malpighian corpuscles in the kidney. Cleared over 96 $^{0}/_{0}$ and absolute alcohol in benzyl benzoate.

1*

Neoceratodus II: \bigcirc Tl: 95 cm.

Fixation: Bouin solution, perfused from the dorsal aorta.

Left kidney: 10 and 15 μ tissuemat sections were stained with PAS-hematoxylin, AB, hematoxylin-eosin or PAS-hematoxylin after treatment with diastase.

Neoceratodus III: 3 Tl: 104 cm.

Fixation: Bouin solution perfused from the dorsal aorta.

India ink-gelatine injected through the ureters from the cloaca. The kidneys and testes were cleared over 96 $^{0}/_{0}$ and absolute alcohol in benzyl benzoate.

Neoceratodus IV: 3 Tl: 78 cm.

Fixation: Glutaraldehyde $(2 \ 0/_0)$ perfused from the dorsal aorta. Small pieces of kidney and testis tissue were post-fixed in OsO_4 and embedded in epon.

Right kidney and testis: Embedded in tissuemat and cut into 10 and 15μ sections. A complete series from the anterior to the posterior end of the kidney (12.2 cm) was made. The sections were stained with PAS-hematoxylin or hematoxylin-eosin.

Left testis: The anterior part of the testis was embedded in tissuemat, cut into 10μ serial sections and stained with hematoxylin-eosin.

The number of vasa efferentia was counted in *Neoceratodus I* and *IV*. On one side there were in the first case 11 and in the second 13 vasa efferentia. Two perspective graphic reconstructions (LISON, 1936) of nephrons were made, a normal nephron (text-fig. 1) and a nephron in connection with a vas efferens (text-fig. 2).

Results

The kidney of *Neoceratodus* is a paired organ, situated retroperitoneally in the posterior part of the abdominal cavity. The lengths of the kidneys of the specimens examined were 9–12 cm. The kidney consists of about ten lobes, and is attached ventro-medially to the testis along its anterior half (plate I, fig. 2). In the peritoneal connective tissue, which separates the kidney and the testis, two longitudinally ducts are seen (plate II). The dorsal Müllerian duct extends from the anterior end of the testis to the cloaca. Here the two Müllerian ducts fuse and come to a dead end. The ventrally-situated Wolffian duct, or the ureter, passes from the anterior end of the kidney to the cloaca. The ureters come together immediately in front of the cloaca, and this unpaired duct opens into the dorsal wall of the latter.

The testes are elongated organs of variable shape, about 30-35 cm in length. In the specimens examined they occupy most of the abdominal cavity (plate I, fig. 1). The medial margin is attached to the lung and, at the caudal extremity, to the kidney. The outer surface is covered by the peritoneum. 10μ transverse sections from the anterior, the intermediate and the posterior region show no division of the testis into an anterior formative and a posterior vesicular part contrary to BALLANTYNE's thesis. The seminiferous tubules, each with different developmental stages of spermatozoa,

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Fig. 1. Perspective graphic reconstruction of a nephron with no connection to a vas efferens. B: Bowman-nian capsule, N: Neck segment, P₁ and P₂: Proximal segment, I: Intermediate segment, D: Distal segment, In: Initial collecting segment, C: Collecting segment. Scale: 200 μ .

Fig. 2. Perspective graphic reconstruction of a nephron situated in the sexual part of the kidney. Ve: Vas efferens. Other abbreviations, see text-fig. 1. Scale: $400 \ \mu$.

open into a longitudinal marginal testis duct. The posterior part of this duct is connected by the vasa efferentia to some of the Malpighian corpuscles in the kidney. The number and situation of the vasa efferentia were revealed by examination of the serial sections of *Neoceratodus IV* and of the specimen, *Neoceratodus I* (text-fig. 3), in which india ink had been injected. In *Neoceratodus IV* the number was 13, whereas *Neoceratodus I* showed 11 vasa efferentia on one side.

The vasa efferentia start from the longitudinal testis duct with regular intervals (text-fig. 3). The duct continues behind the testis on the ventro-medial edge of the kidney, and is closed at the end. Some of the vasa efferentia start from this renal part of the duct.

The vasa efferentia lead into the part of the kidney lobe situated next to the testis, here called the sexual part (text-fig. 5). In the kidney they ramify and each of them opens into several Malpighian corpuscles (plate III, fig. 1). Widenings of the testis duct also open directly into the Bowmannian capsules (plate III, fig. 2). In the sexual part of the kidney all the scattered nephrons are in connection with vasa ef-

ferentia. The luminary dimensions of these nephrons are about twice the dimensions of a normal nephron (text-figs. 2 and 1).

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In the normal part of the kidney lobe, the Malpighian corpuscles are situated on the periphery. The neck segments and first portion of the proximal segments are seen more centrally, and in the centre of the lobe the second part of the proximal segments, the intermediate segments and the distal segments are found. The collecting segments and the peritoneal ducts often follow the surface of the lobe (plate II and text-fig. 5). Interrenal tissue is seen in the centre of the kidney in the form of small groups of cells embedded in connective tissue close to the veins (plate VII, fig. 2).



Fig. 3. Lateral view of the left testis (T) and kidney (K). India ink-gelatine $10^{0}/_{0}$ was injected from the testis duct (ltd). Transparency of the tissue was obtained in benzyl benzoate. The drawing shows the 11 vasa efferentia and their ramifications in the kidney lobes. Scale: $0.7 \times$.

The peritoneal ducts are seen as systems of narrow ciliated parallel ducts. They open into the peritoneal cavity with ciliated funnels between the testis and the kidney (plate II). They pass across the kidney and communicate with the initial neck segments (text-fig. 5 and plate IV, fig. 2). Different opinions exist about the persistence of the peritoneal funnels in the adult *Neoceratodus*. AYERS (1885) found no peritoneal funnels. SEMON (1901) reported peritoneal funnels from young (up to 17.8 mm) specimens, but not from the adult *Neoceratodus*. BALLANTYNE (1928) described a network of small tubules in the ventral part of the kidney running across from side to side. Some of these tubules open into the nephrons. In the examination of the embryology of the kidney of the dipnoan fishes, KINDAHL (1937) described the development of the peritoneal funnels in *Neoceratodus* up to the 55 mm stage. She had reasons to believe that adult specimens also have persistent funnels.

Histological examinations of the tubule cells in different parts of the nephron show no modifications of the cells of the sperm-transporting nephrons. Only the luminary dimensions vary; the sperm-transporting nephrons are more extended. The diameter of the Bowmannian capsules varies from 200–500 μ in the normal nephrons and from 400–700 μ in the sexual nephrons. In both types of nephrons the glomerulus is well-developed. The first segment of the nephron is a long (c. 700 μ) ciliated neck segment (plate VI, figs. 2 and 3); then follows a brush-bordered proximal segment Nr. 5

divided into two parts (plate V and plate VI, figs. 2 and 3), a ciliated intermediate segment (plate VI, fig. 1), a distal segment (plate VI, fig. 2), an initial collecting segment (plate VII, fig. 1), and a collecting segment (plate VI, fig. 3), which opens into the Wolffian duct.



Fig. 4. Diagram showing the urogenital organs of *Neoceratodus* and their connections. T: Testis, K: Kidney, ltd: Longitudinal testis duct, Ve: Vas efferens, W: Wolffian duct, M: Müllerian duct, c: Cloaca. Scale: 2 cm.

The nephron of lungfishes has been described by, among others, CORDIER, 1929 (Protopterus dolloi), BARGMANN, 1934 (Lepidosiren paradoxa), EDWARDS, 1935 (Protopterus aethiopicus), GUYTON, 1935 (Lepidosiren paradoxa) and GRAFFLIN, 1937 (Lepidosiren paradoxa). Comparisons between Protopterus, Lepidosiren and Neoceratodus are made in the following resumé:

Cordier (1929) P. dolloï	BARGMANN (1934) L. paradoxa	Edwards (1935) P. aethiopicus	GUYTON(1935) L. paradoxa	Present investigation N. forsteri
Malpighian corpuscle 3–4 together diameter: c. 140 μ	Malpighian corpuscle 3-5 together diameter: 100×140 μ	Malpighian corpuscle diameter: c. 153 µ	Malpighian corpuscle 2–12 together 180×200 μ	Malpighian corpuscle 2–15 together diameter: 200-700 μ
Collet cilié	Halsstück ciliated, c. 270 µ long	Neck segment ciliated, c. 100 μ long	Neck segment ciliated, c. 300 μ long	Neck segment ciliated, c. 680 µ long
Tube contourné brush border, in cytoplasm: hyaline acidophile drops, yellow granules.	Hauptstück brush border, tall cells, nucleus: basal.	Prox. tub. 1 brush border, tall, broad cells, eosinophi. cytoplasm, nucleus: unregular placed.	Prox. tub. 1 brush border, cytoplasm: large granules apically, blue (azan); basally: vacuoles; nucleus: central.	Prox. tub. 1 brush border, tall cells. Granules apically: eosiniphi. PAS-positive, alcianblue-nega- tive, blue in azan. Brown pigment- granules. nucleus: basal.
Segment rectiligne sexuel segment, brush border, vacuolated cytoplasm in males with active testes.	Überleitungs- stück brush border, ciliated cells more frequently in the posterior part.	Prox. tub. 11 brush border, tall cells, cytoplasm: Slightly basophilic.	Prox. tub. 11 3 cell types: Light cells, brush cells and ciliated cells.	Prox. tub. 11 brush border, cubical cells, centrally situated nucleus, brown pigment granules.
Segment grêle cilié ciliated	÷	Intermediate segment uniciliated, cuboidal cells.	Intermediate segment ciliated, low cells.	Intermediate segment low, -cuboidal cells, ciliated.
Segment intermédiaire	Mittelstück cuboidal cells, centrally placed nucleus, striated cytoplasm, secretion on the luminar side of the cell.	Distal segment low, columnar neutrophilic cells.	Distal segment cuboidal cells; nucleus centrally placed, striated cytoplasm, vacuolated cytoplasm.	Distal segment low-cubical cells, vacuolated cytoplasm, centrally placed nucleus, many mitochondria in basal infoldings of the cell membrane.
Segment d'union intracellular canals, vacuolated cytoplasm, many mitochondria.	Querkanal unregular cells be- tween cubical cells, inter or intra- cellular spaces.		Initial collecting segment	Initial coll. segment Vacuolated cyto- plasm, oval nucleus centrally placed. PAS positive secretion on the luminal side of the cell (in the posterior part of the segment).
	Sammelrohr cylindrical cells, unregular cells, to the Wolffian duct.			Collecting segment Cells as in the posterior part of the init. coll. segment. Open into the Wolffian duct.





Fig. 5. Diagram showing a transverse section of testis and kidney on one side. The subdivision of the kidney into a normal part (K_n) and a sexual part (K_s) is shown. In the sexual part three Bowmannian capsules in connection with a vas efferens are seen. In the normal part of the kidney the situation of the different segments of the nephon is shown. Mc: Malpighian corpuscle, N: Neck segment, P: Proximal segment, I: Intermediate segment, D: Distal segment, In: Initial collecting segment, C: Collecting segment, W: Wolffian duct, M: Müllerian duct, p: Peritoneal funnel, v: Vein, Ve: Vas efferens. — In the testis (T) four seminiferous tubules with developmental stages of spermatozoa and their openings into the longitudinal testis duct (ltd) are seen. The mature spermatozoa (sp) are situated in the lumen of the tubules. Scale: 3 mm.

The results of the investigations of the nephron of *Neoceratodus* are in accordance with the findings of GUYTON and EDWARDS in regard to the division of the nephron into segments. The nephrons of *Lepidosiren*, *Protopterus* and *Neoceratodus* show normal structures of fresh-water fish nephrons. No sexual segment was found in *Neoceratodus* as described by CORDIER in Protopterus dolloi.

As to the urogenital connections, the lungfishes are quite different. The two Neoceratodus males examined show 11 and 13 vasa efferentia on one side leading from the longitudinal testis duct to the Bowmannian capsules situated in the kidney along its whole length. The testis is not divided into a sperm-producing and a vesicular part.

In Lepidosiren the testis ampullae open into a longitudinal duct which continues behind the testis as a simple tube, broken up by trabecules. From this spongeous cavity, called the vesicular part of the testis, 5-6 vasa efferentia lead to the normally developed Malpighian corpuscles in the posterior part of the kidney (KERR, 1901).

In *Protopterus* the central testis duct communicates behind the testis with nephrons in the posterior part of the kidney. These nephrons have no excreting function judging from the absence of glomeruli (PARKER, 1892 and KERR, 1901). In principle, Protopterus has a single vas efferens which communicates with several kidney tubules.

Polypterus was investigated and described by JUNGERSEN (1900). In *Polypterus* the testis duct continues behind the testis and opens into the distal part of the ureter.

In *Lepidosteus* and *Acipenser* the great number of vasa efferentia start from the testis marginal duct along its whole length, and communicate with a longitudinal kidney canal. The kidney in these two genera is a long paired organ extending from the heart region to the cloaca, whereas the testes are short organs situated in the intermediate part of the abdominal cavity. From the longitudinal kidney canal short ducts lead the spermatozoa to the Malpighian corpuscles (SEMON, 1891).

In Amia (JUNGERSEN, 1900) the vasa efferentia each opens into a longitudinal kidney canal, and from there the sperm passes directly into the Wolffian duct.

According to the findings reported in this paper it may be concluded that the urogenital connections of *Neoceratodus* show the same primitive evulotionary features as those of *Lepidosteus* and *Acipenser*.

References

AYERS, H., 1885: Beiträge zur Anatomie und Physiologie der Dipnoër. Jena. Z. Naturw. 18.

BALLANTYNE, F. M., 1928: Note on the Male Genito-urinary Organs of Ceratodus forsteri. Proc. zool. Soc. Lond. 2, 697–698.

- BARGMANN, W., 1934: Untersuchungen über Histologie und Histophysiologie der Fischniere. I. Dipnoer: Lepidosiren paradoxa. Z. Zellforsch. mikrosk. Anat. 21, 388–411.
- CORDIER, R., 1929: Le tube urinaire du Protoptère (Dipneuste). C.r. Ass. Anat. 24, 157–165. Réunion. Bordeaux.
- 1937: Sur le rein du Protoptère, particulierement sur son dimorphisme sexuel. Z. Zellforsch. mikrosk. Anat. 26, 4, 756–765.

Edwards, J. G., 1935: The epithelium of the renal tubule in bony fish. Anat. Rec. 63, 263-279.

GRAFFLIN, A. L., 1937: The structure of the nephron in fishes. Anat. Rec. 68, 287-303.

GUYTON, J. S., 1935: The structure of the nephron in the South American lungfish, Lepidosiren paradoxa. Anat. Rec. 63, 213–229.

GÜNTHER, M. A., 1871: Description of Ceratodus. Phil. Trans. R. Soc. II, 511-571.

- JUNGERSEN, H. F. E., 1900: Über die Urogenitalorgane von Polypterus und Amia. Zool. Anz. 23, 328-334.
- KERR, J. G., 1901: On the Male Genito-urinary Organs of the Lepidosiren and Protopterus. Proc. zool. Soc. Lond. 19, 484–498.
- 1902: The Genito-urinary Organs of Dipnoan Fishes. Proc. Camb. phil. Soc. biol. Sci. 11, 329–333.
- KINDAHL, M., 1937: Zur Entwicklung der Exkretionsorgane von Dipnoërn und Amphibien. Acta zool., Stockh. 19, 1–190.
- LISON, L., 1936: Une méthode nouvelle de reconstruction graphique perspective. Bull. Histol. appl. Physiol. Path. 13, 357–380.
- PARKER, W. N., 1892: On the Anatomy and Physiology of Protopterus annectens. Trans. R. I. Acad. **30**, 111–230.
- SEMON, R., 1891: Notizen über den Zusammenhang der Harn- und Geschlechtsorgane bei den Ganoiden. Morph. Jb. 17, 623–636.
- 1901: Zur Entwicklungsgeschichte des Urogenitalsystems der Dipnoer. Zool. Anz. 24, 131-135.

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PLATES

PLATE I

- Fig. 1. Neoceratodus forsteri 1 ♂. Ventral view of the testes (T), the abdominal wall is removed. Scale: 7 cm.
 Fig. 2. Neoceratodus forsteri 1 ♂. Lateral view of the kidneys (K) and the posterior part of the testes (T). Scale: 2 cm.





PLATE II

Transverse section of testis (T) and kidney (K). The kidney tissue on the testicular side of the lobe contains scattered nephrons in connection with vasa efferentia. The Müllerian duct (M) and the Wolffian duct (W) are seen. An opening of some peritoneal ducts into the peritoneal cavity is seen (p). — 15μ sections. PAS. Scale: 2 mm.

PLATE II



PLATE III

- Fig. 1. Three Bowmannian capsules in connection with a vas efferens (Ve). N: Neck segment. 10 μ section. PAS. NA: 0.20. Scale: 250 μ.
 Fig. 2. An opening of the testis canal into a Bowmannian capsule. 10 μ section. PAS. NA: 0.16. Scale: 250 μ.

PLATE III



PLATE IV

Fig. 1. Chain of 11 Bowmannian capsules. N: Neck segment. — 10μ section. PAS. NA: 0.45. Scale: 200μ . Fig. 2. Opening of a peritoneal duct (P) into a neck segment (N). — 15μ section. HE. NA: 0.45. Scale: 50μ .

PLATE IV



PLATE V

Fig. 1. Proximal segment. Fixation: Glutaraldehyde. — 2μ epon section. Toluidin blue. NA: 1.0. Scale 25μ . Fig. 2. First part of the proximal segment. — 10μ section. PAS. NA: 0.65. Scale: 25μ .

PLATE V



PLATE VI

- Fig. 1. Intermediate segment (I) with cilia. In: Initial collecting segment. 10 μ section. PAS. NA: 0.45. Scale: 50 $\mu.$
- Fig. 2. First and second part of the proximal segment (P₁ and P₂) and distal segment (D) with pigment granules. N: Neck segment. 10 μ section. PAS. NA: 0.45. Scale: 50 μ.
 Fig. 3. Neck segment (N), first part of the proximal segment (P₁) and second part (P₂). Collecting segment
- (C). -10μ section. PAS. NA: 0.45. Scale: 50 μ . Fig. 4. Bowmanian capsule with spermatozoa. -10μ section. PAS. NA: 0.45. Scale: 50 μ .

PLATE VI



PLATE VII

- Fig. 1. Initial collecting segment (In). Fixation: Glutaraldehyde. 2 μ epon section. Toluidinblue. NA: 1.0. Scale: 25 μ.
 Fig. 2. Interrenal tissue (Ir.). 10 μ section. PAS. NA: 0.45. Scale: 50 μ.

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PLATE VII



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