

THE MALE UROGENITAL SYSTEM IN THE SIRENIDAE

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Within the several families of the amphibian order Urodela are various degrees of evolution of the urogenital system (Baker and Taylor, 1964). Comparative anatomy texts, however, use the drawings of Spengel (1876) emphasizing *Triton taeniatus*, or of Chase (1923) of *Necturus maculosus*. The consistent utilization of these two species in illustrations of the urogenital system often gives the impression that one or the other is the "typical" urodele urogenital system. Certainly, the urogenital system is basically similar in the modern Amphibia (Parson and Williams, 1963), but within the six families of the Urodela may be seen diverse stages of the development of the system. It is the purpose of this paper to describe this system of the male of the family Sirenidae in contrast and in relation to that of other families of the order Urodela.

Formerly the bases of evolutionary relationships were external characteristics, methods of fertilization, or miscellaneous details of the skeletal and nervous systems. Little reference is made to the urogenital system to illumine chordate evolution, and thus the scope of previous research on the urogenital system of the urodeles is limited largely to two families, the Salamandridae (*Triton taeniatus*, Spengel, 1876; *Triturus torosus*, McCurdy, 1931; *Triton vulgaris*, Gray, 1932; *Salamandra salamandra*, Francis, 1934; *Triton punctatus*, Kindahl, 1938; *Triturus viridescens*, Adams, 1940) and the Proteidae (*Necturus maculosus*, Chase, 1923; Hyman, 1942; Jollie, 1962). This study should provide clarification toward the establishment of firm phylogenetic relationships within the order Urodela.

Comparative anatomists agree that there are three primary kidney types: pronephros, mesonephros and metanephros. A functional pronephros is found in early larval or unhatched embryos of most kinds of fishes and amphibians, but in nearly all of these forms it degenerates as soon as the posterior nephrotomes have given rise to a second type of kidney, the mesonephros, which is often referred to as the adult kidney (Eaton, 1951). The third type, the metanephros, is the adult, functioning kidney of the amniotes. The terms pronephros and mesonephros are generally accepted as embryological and are not used in reference to the adult kidney. Recent theory is that the kidney of fishes and many amphibians is a mixed kidney, including in its development the posterior two-thirds of the embryonic nephrotomal plate. Since that area is the precursor of both mesonephric and metanephric tissues, Kerr (1919) coined the widely accepted term, opisthonephros, to refer to this mixed adult structure. In accordance with this terminology the major concerns of this report are the degree of development of the anterior end of the

opisthonephros, the epididymis, and the degree of development and emancipation of the opisthonephric (sperm, nephric, archinephric, pronephric, mesonephric, holonephric, epididymal or Leydig's) duct from its ancestral excretory function. This duct will be referred to as the Wolffian duct throughout this paper.

The opisthonephros of urodeles consists of two portions differing in both structure and function: the epididymis or sexual kidney and the definitive or urinary kidney (Goodrich, 1930). The objective here is to determine the nature of the epididymal units, whether they occur as a series of separate units as in *Necturus* (Chase, 1923) or degenerate and/or fused units as in the Ambystomidae or are embryonic as proposed by Baker and Taylor (1964).

A fundamental consideration in a study of the Wolffian duct is its uniqueness as a result of the intermingling of the excretory and reproductive systems. The close association of the systems appears to be a result of embryonic propinquity. The major organs of both arise in areas of the mesoderm, very near one another, in the walls of the trunk at the dorsal part of the coelomic cavity. The basic differences from group to group of the vertebrates concern the kidney, the kidney ducts, and the urinary bladder. There are two causes for the variations as indicated by Romer (1963): (1) The kidney must begin to function at an early stage to take care of embryonic wastes, and (2) genital organs lying adjacent to the kidneys—the testes in particular—tend to invade the urinary system, taking over part of its tubes and ducts for their products. In consequence, the abduction of these ducts and tubules has caused a marked modification of the urinary organs.

MATERIAL AND METHODS

Representatives of each of the three species of Sirenidae were considered, namely *Siren lacertina* Linne, the Greater Siren; *Siren intermedia nettingi* Goin, the Western Lesser Siren; and *Pseudobranchius striatus axanthus* (Netting and Goin), the Narrow-striped Dwarf Siren. The gills, the fusiform body, and lack of pelvic girdle make these sirenids distinctive among the urodeles. *S. lacertina* and *S. intermedia* have three pairs of gill slits; *P. striatus axanthus* has but one pair. All are larval salamanders, never undergoing a true metamorphosis even with the stimulation of powerful drugs, remaining neotenus throughout life (Cochran, 1961).

S. lacertina is the largest of the three and is relatively large in contrast to other urodeles, growing to a maximum length of 36 inches. It has 36-39 costal grooves. Its color in life is light grey, sides lighter than back; venter bluish with many dull, yellow flecks. (Preserved

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specimens are slate above, grey below). It inhabits shallow ditches and weed-choked, mud-bottom lakes. It is particularly abundant in Lake Miccosukee, Florida, from which our specimens were collected.

Likewise in mulchy, muddy ditches, sloughs and flatland ponds, *S. intermedia* abounds. It is generally smaller than *S. lacertina*, attaining a known length of 15½ inches. It is greyish blue along its sides and venter, often with light spots. It is commonly available in the southeastern regions of the United States under the name of "mud eel." These specimens were obtained from shallow ponds near Lonoke, Arkansas.

The smallest member of the family is *Pseudobranchius* whose maximum measured length is less than 8 inches. It is striped with brown and yellow on the body and is not uniform slate as is the half-grown siren. Its favorite habitat is the undergrowth of water hyacinths. The several species of *Pseudobranchius* are often sold as fish bait, and are particularly abundant in the region around Brooksville, Florida.

Permanent preparations of the entire urogenital systems were made by killing and fixing in Bouin's solution. They were processed and cleared—some for external observations as whole mounts (*S. lacertina*, 4; *S. intermedia*, 3; *Pseudobranchius*, 3), and others for sections (*S. lacertina*, 4; *S. intermedia*, 1; *Pseudobranchius*, 3). The systems serially sectioned were cut at 25 micra, stained with standard hematoxylin, and counter-stained with erythrosin. Micro-reconstructions were made from the serial sections and correlated with studies of the whole mounts.

OBSERVATIONS

The testes in the sirenids are paired, non-lobed, elongate (length 7-13 times greater than width) organs, each supported dorsally by a narrow, longitudinal mesentery, the mesorchium. The opisthonephroi are dorsal to the testes and in the epididymal portion of each specimen there are three degenerate nephric units. The units of the epididymis are distinct and separate with no degeneracy of the glomeruli. The number of nephric units in this anterior portion of the opisthonephros appears dependent upon species and length of the entire system. The anterior portion (epididymis) is less specialized than the posterior (excretory), retaining clear evidence of its segmental nature. The urogenital system in the sirenids is relatively long, occupying approximately 70% of the total body length. The general structure of the system for the three species can be represented schematically (Plate 1, Fig. a.) to indicate the relative proportions and locations of the various structures. The differences are readily visible as the detailed reproductions are studied (Plates 2, 3, 4).

The opisthonephroi in the sirenids are elongate and fused posteriorly. The caudal portion resembles a bulbous protuberance of the dual anterior portion. The split portion is asymmetrical and ribbon-like, becoming wider and thicker posteriorly. The sexual portion, so called because of its association with the testes, is a true mesonephros (Francis, 1934). Ciliated nephrostomes

are evident in the excretory portion but none are present in the epididymis. In the animals available there are 15-23 nephrostomes opening on the lateral surfaces of each half of the excretory kidney; they are located in a double row, ventro-medial to the enclosed Wolffian duct and renal portal vein.

There is one glomerulus to each unit in the epididymis. These glomeruli, in their Bowman's capsules, occur at regular intervals on the lateral edge of the epididymal tissue. Within the excretory or definitive kidney while not arranged in linear rows, there are as many as 23 glomeruli visible in a cross-section. This excretory portion forms the bulk of the adult organ, the caudal part of which may be developed from segments below the cloaca (caudal kidney of elasmobranchs and teleosts). There is a general tendency for the openings of the renal tubules to shift backward and acquire a special blood supply from the aorta, not belonging to the renal portal system (Goodrich, 1930). The caudal kidney contains glomeruli arranged in a circular fashion and emptied by accessory urinary tubules which empty in turn into the Wolffian duct, not directly into the cloaca.

The testes are paired, asymmetrically placed in the abdominal cavity, the right one being slightly anterior to the left. Each is supported from the ventro-medial portion of the sexual kidney (epididymis) by an extremely short mesorchium. These testes are not lobed and show no appreciable differences in color or texture along their lengths. There is no single, continual central or longitudinal canal within the testes; instead, many primary cords produce a series of tubes in which the sperm mature (small, spherical ampullae). These ampullae are expendable, in that when sperm are discharged at breeding the series of ampullae concerned are resorbed to be replaced by others which have developed meanwhile. A network of small canals, the rete testis, connects the ripe ampullae and from these a number of parallel tubules (vasa efferentia) extend to the ventro-medial surface of the kidney (Romer, 1963). The vasa efferentia course through the mesorchium in a slightly caudal direction before entering the Bowman's capsules of the epididymis. The number of vasa efferentia may vary considerably, the average number being 16 in each mesorchium. *S. lacertina* tends to have the longest urogenital system and the greatest number of vasa efferentia, 10.17 cm. and 18 respectively. *S. intermedia* averages 7.9 cm. in length

ABBREVIATIONS USED IN PLATES

cloacal aperture
dorsal aorta
definitive kidney
epididymis
glomerulus
mesorchium
neck
proximal convolution
renal portal vein
renal tubule
testis
urinary tubule
vas efferens
Wolffian duct

c. a.
d. a.
d. k.
epi.
glo.
mes.
n. s.
p. c.
r. p. v.
r. t.
t.
u. t.
v. e.
W. d.

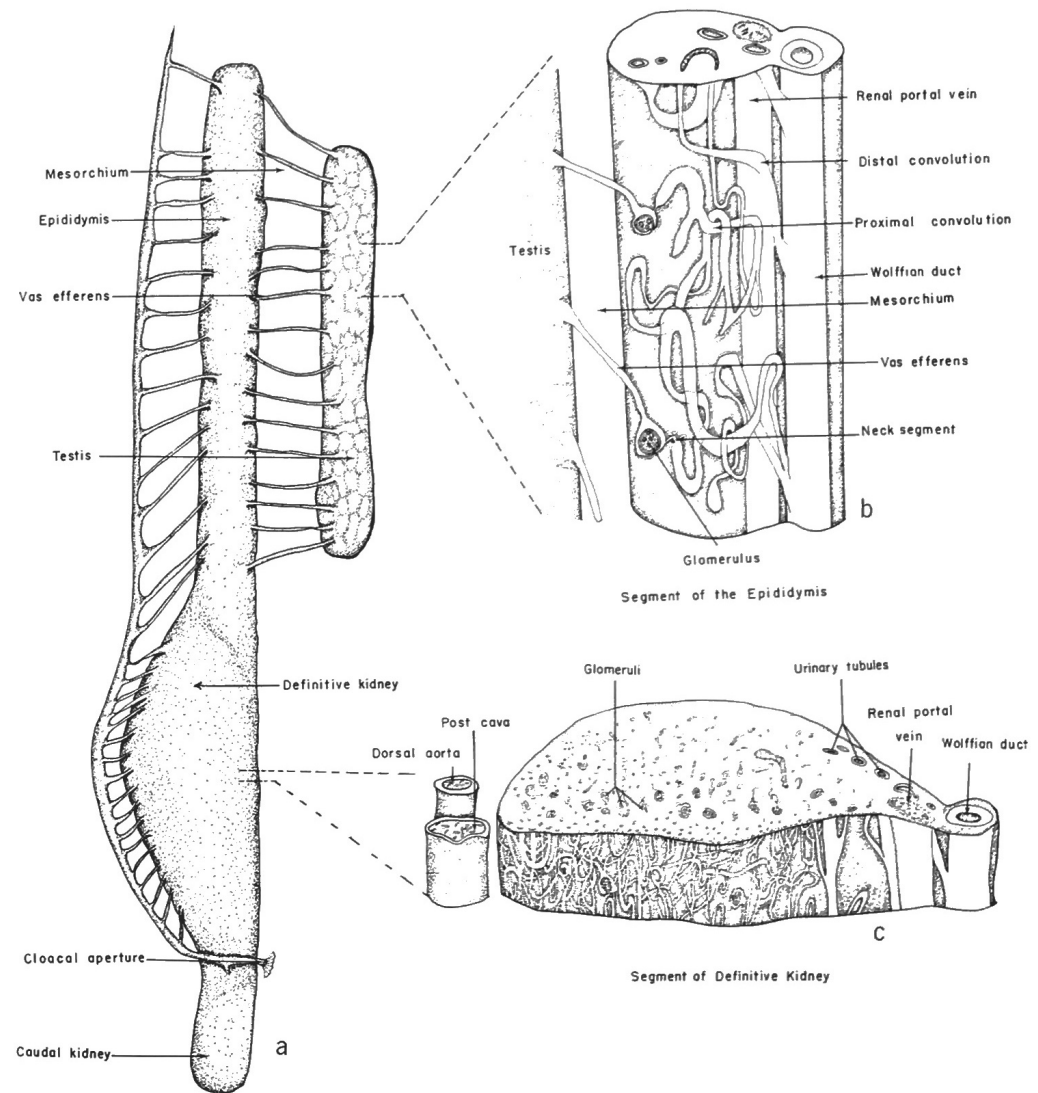


Plate 1. Diagrammatic representation of the male urogenital system in the Sirenidae.

a. Schematic representation of the urogenital system to show relative proportions and gross anatomy of the system. Note the lack of Bidder's (longitudinal) duct and rudimentary Mullerian duct. The Wolffian duct is drawn apart from the main mass for illustrative purposes; its true position in relation to the opisthonephros is shown in b and c.

b. A partial reconstruction of a portion of the epididymis. The testis is deflected to the left to reveal the underlying epididymis. Note the singularity of the nephric units, the enclosure of the Wolffian duct.

The testis is, in the living animal, ventral to the epididymis; Wolffian duct is at the dorsal limit of the opisthonephric mass.

c. A partial reconstruction of the opisthonephros in the area of the definitive kidney. The curve of the tissue of the living animal brings the enclosed Wolffian duct to a ventro-lateral position. Four distinct layers of tubes are seen as follows from ventral to dorsal sides: (1) the very small and indistinct group; (2) the semi-circle of glomeruli; (3) the main mass of large tubules; (4) the collecting urinary tubules which parallel the Wolffian duct for a short distance before entering it.

and 25 vasa efferentia. *Pseudobranchius* 7 cm in length and 22 vasa efferentia.

Evidently sperm leave an ampulla, enter the intratesticular network, and leave a testis through a vas efferens. Once within the epididymal mass they immediately enter a Bowman's capsule surrounding a renal corpuscle of the sexual kidney, travel through the convolutions of the epididymal tubule to the Wolffian duct

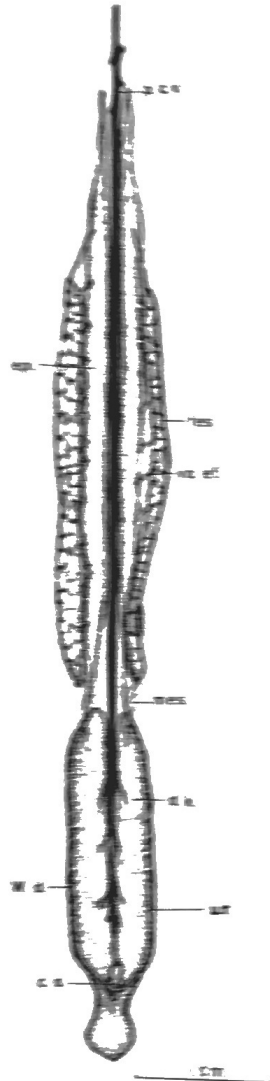


Plate 2. Urogenital system of the male *Salamandra atra*.

and thence to the cloaca (Plate 1, Fig. b.). Curiously, as Festschmel (1962) found in *Salamandra*, 12 eggs were identified in a testis of *S. atra*. No eggs were observed in *S. lacertina* or *Pseudobranchius* although it is likely that this condition is not unusual in these species. No developmental stages of spermatogenesis in the sirenids have been observed and recorded.

The Wolffian duct begins slightly anterior to the

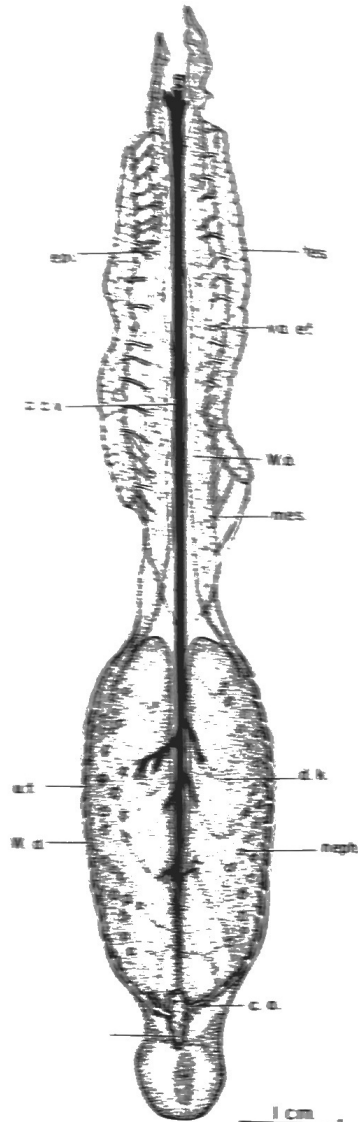


Plate 3. Urogenital system of the male *Salamandra atra*.

sexual kidney, is bound in a mesentery with the episthophros, and is not visible except in a cross section where it appears dorso-lateral to the main mass in the epididymis and ventro-lateral in the definitive kidney. This condition is comparable to that found in the Salientia and female elasmobranchs. The number of openings into the anterior Wolffian duct equals the number of vasa efferentia (i. e., one from each epididymal unit) and the average number of openings into

this duct from the definitive kidney varies as to species: *S. lacertina*, 19; *S. atra*, 20; *Pseudobranchius*, 15. The urinary tubules, draining the definitive or excretory kidney, parallel the Wolffian duct for a short distance before entering it. The diameter of the lumen of the Wolffian duct varies little with no distinguishable seminal vesicle.

The cloaca of the male is very similar to that of the female, offering no ready means of identification of the sexes externally. There are no cloacal glands evident in the male. Since the function of these glands is to secrete mucoid spermatozoa which envelop the sperm as they are shed, it follows that fertilization is external in members of the family Sirenidae. This is most, since little is known of the mating habits in this group and copulation never has been observed (Goim, 1962).

The urinary bladder is a short, singular, sac-like projection of the cloaca. It has very thin walls when extended, but when emptied appears as a thick, empty balloon. It has no direct connection with the Wolffian duct so that urine can reach it only through the cloacal chamber. It is ventral to the definitive kidney and just anterior to the cloaca.

Omitted from this discussion and the accompanying figures are accessory structures such as the adrenal glands and fat bodies. Two structures usually found in urodeles but absent in these sirenids are the longitudinal canal, which when present lies alongside the epididymis immediately adjacent to it, and the rudimentary Mullerian duct normally present but functionless in the male.

DISCUSSION

The purpose of this report is to illustrate the uniqueness of the family Sirenidae through a detailed description of the urogenital system and to clarify the phylogeny of the urodeles through a comparative discussion. Evidence must be considered in justification of using the urogenital system as a basis of comparative phylogeny.

Romer (1963) has long maintained that vertebrates first evolved in a fresh water environment and Smith (1959) has held a similar view even longer on the basis of changes in the kidney that occurred coincidentally with the evolution of the vertebrates (Smith, 1960.) The complicating factor in these discussions of phylogeny is often the neotenic individual encountered in urodeles. For example, *Necturus*, *Ampelisca*, *Cryptobranchius*, and *Siren* are incompletely metamorphosed as evidenced by their incompletely developed aortic arches (Baker, 1949). Baker and Taylor (1964) surmise that the retention of an embryonic or larval urogenital system also should be expected. But, since this system of the neotenic individual performs adult functions, reproduction and excretion, it, of all the organ systems, should be considered no less than fully developed. There is in vertebrate embryos a great difference in the rapidity with which organ systems develop. The nervous system for example grows very rapidly in early stages; the genital organs on the other

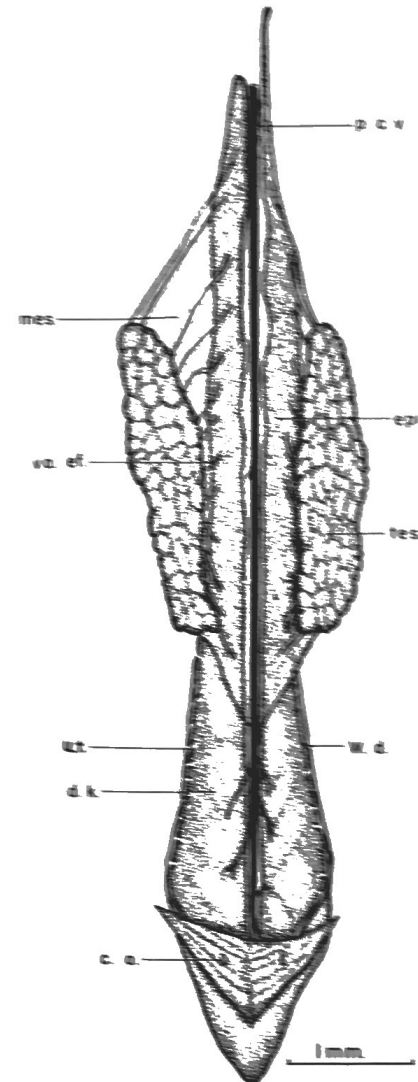


Plate 4. Urogenital system of the male *Pseudobranchius striatus*.

hand are slowest of any to develop. This retarded development is correlated with the fact that sex organs do not function until maturity of the individual has been attained (Romer, 1963). Thus the urogenital system is fully developed at sexual maturity. As an adult structure, even in an otherwise larval body, this system should be considered a trustworthy basis for the establishment of phylogenetic relationships.

On the basis of the urogenital system, Sirenidae is either the most primitive family yet studied of the Urodela, or it belongs to a separate order, the Trachystomata, as postulated by Goin (1962). He bases the removal of Sirenidae from Urodela on the detailed structure of the tail vertebrae which show a marked resemblance to the arthropod-nectridian stock rather than the microsaurian. Further, he suggests that Sirenidae illustrates not neoteny but paedo-genesis, "a genetically fixed condition in which tissues fail to respond to secretions of the thyroid gland that bring about metamorphosis." The reasons for setting Sirenidae apart from the Urodela on the basis of the urogenital system will be discussed in detail.

Perhaps the most significant feature of the urogenital system of the Sirenidae from a phylogenetic standpoint is the enclosure of the Wolffian duct in the opisthonephric mass (Plate 1, Fig. b, c.). The only urodele having a comparable condition is the proteid *Necturus* in which the Wolffian duct lies just outside the nephros, immediately adjacent to it but distinctly separate from it (Chase, 1923). In addition to its enclosure, the Wolffian duct in Sirenidae is relatively straight while that of *Necturus* is highly convoluted in the area of the sexual kidney. Weichert (1958) states that this enclosure is contrary to the caudate condition, typifying the salientian system. Montagna (1959) in turn, gives a description of the salientian archinephric duct which exactly defines the position observed in the Sirenidae. This raises two possibilities: (1) Sirenidae is not a family of Urodela but a remnant of an ancient separately derived stock (Goin, 1962); (2) if a urodele, Sirenidae must be the most primitive family of the order as it is logical that the most primitive family would have structures similar to those of other orders in the same phylum—a like, though not identical, ancestral origin assumed.

The dual function of the Wolffian duct is likewise notable. In the epididymis of *Siren* and *Pseudobranchius* are glomeruli closely resembling those of the definitive kidney. Francis (1934), observing a like state in *Salamandra*, assumes that the epididymal glomeruli are functional and thus the Wolffian duct conveys both reproductive and excretory products along its full length. This is, however, doubtful. There is a strong trend in sharklike fishes and amphibians for the development of separate ducts for urine and sperm transport, foreshadowing the amniote development of a ureter and a vas deferens (Smith, 1960; Romer, 1963). Various stages of the evolution of two functionally distinct ducts, one serving the kidneys (ureter) and the other serving the testes (vas deferens), are to be distinguished within the families of the order Urodela. The primary level of development is the Wolffian duct which serves both

excretory and genital systems, i. e., a true urogenital duct, a characteristic of *Siren*, *Pseudobranchius* and *Necturus*. The intermediate stage in the progression is the development of numerous urinary tubules which converge to enter the Wolffian duct just anterior to its entrance to the cloaca (*Salamandra*, Francis, 1934; *Gyrinophilus*, Strickland, 1963), or which enter the cloaca independent of the Wolffian duct (*Hynobias*, Yamagiva, 1924; *Cryptobranchius*, Ratcliff, 1965). The final step is the development of a ureter, freeing the Wolffian duct of urine transport. The latter condition is reported for *Ambystoma* and believed to be true also for the Salamandridae (Baker and Taylor, 1964). These stages are merely theoretical—only further comparative study of representatives of urodele families can reveal a detailed, structural outline of the evolution of the urogenital system.

Conspicuously absent in Sirenidae is the longitudinal collecting duct first described by Bidder (1846) and given his name, Bidder's duct. This canal lies in the mesorchium on the ventro-medial side of the kidney (McCurdy, 1931). It is this duct which serves as a sperm duct in the Teleostei (Kingsley, 1917; Goodrich, 1930), but which, conversely, serves as a ureter in the frog, *Alytes* (Jollie, 1962). Though a Bidder's duct is described in a majority of urodeles, *Gyrinophilus* (Strickland, 1963) and the Sirenidae have the vasa efferentia connecting directly to the renal corpuscles without the intercalation of a collecting duct and its transverse ducts. This Bidder's duct, or longitudinal canal, is believed to be the result of the anastomosing of the rete testis (Goodrich, 1930), solving some of the riddle of how sperm pass from the testis to the Wolffian duct. The relative importance of this canal in some species to their phylogenetic relationships is not as yet known and further investigations are encouraged.

Also absent in members of the Sirenidae is the rudimentary Mullerian duct, observed in all other urodele groups (Baker and Taylor, 1964). This Mullerian duct develops in both sexes of most amphibians but grows to a functional condition only under the influence of the ovary (Noble, 1931). Spengel (1876) identified this rudimentary duct in the male, although Von Wittich had described it previously as the homologue of the Mullerian duct of the female (Chase, 1923). Spengel noted a rudimentary Mullerian duct in *Proteus* and *Necturus*, running along the ventral wall

EXPLANATION OF FIGURES IN PLATE 5

- A. *Siren lacertina*. A section of the epididymis dorsal to the testis. Note the asymmetrical arrangement of the renal portal vein in relation to the Wolffian duct.
 B. *Siren intermedia*. A vas efferens opening into a glomerulus within the epididymis in the region of the testis.
 C. A renal tubule leaving the same glomerulus shown in "B."
 D. *Pseudobranchius striatus axanthus*. A typical section through the region just posterior to the testis. Note a renal tubule about to enter the Wolffian duct.
 E. Section just posterior to "D." The renal tubule entering the Wolffian duct.
 F. *Siren intermedia*. A typical cross section through the definitive kidney. Note the semi-circular arrangement of glomeruli toward the ventral surface of the definitive kidney; urinary tubules which will parallel the Wolffian duct for a short distance before entering it.
 G, H. *Pseudobranchius*. The left Wolffian duct is opening into the cloaca. Note the fusion of the two kidneys.
 I. *Siren intermedia*. A typical cross section of the definitive kidney posterior to the cloaca. Note the circular arrangement of the glomeruli.

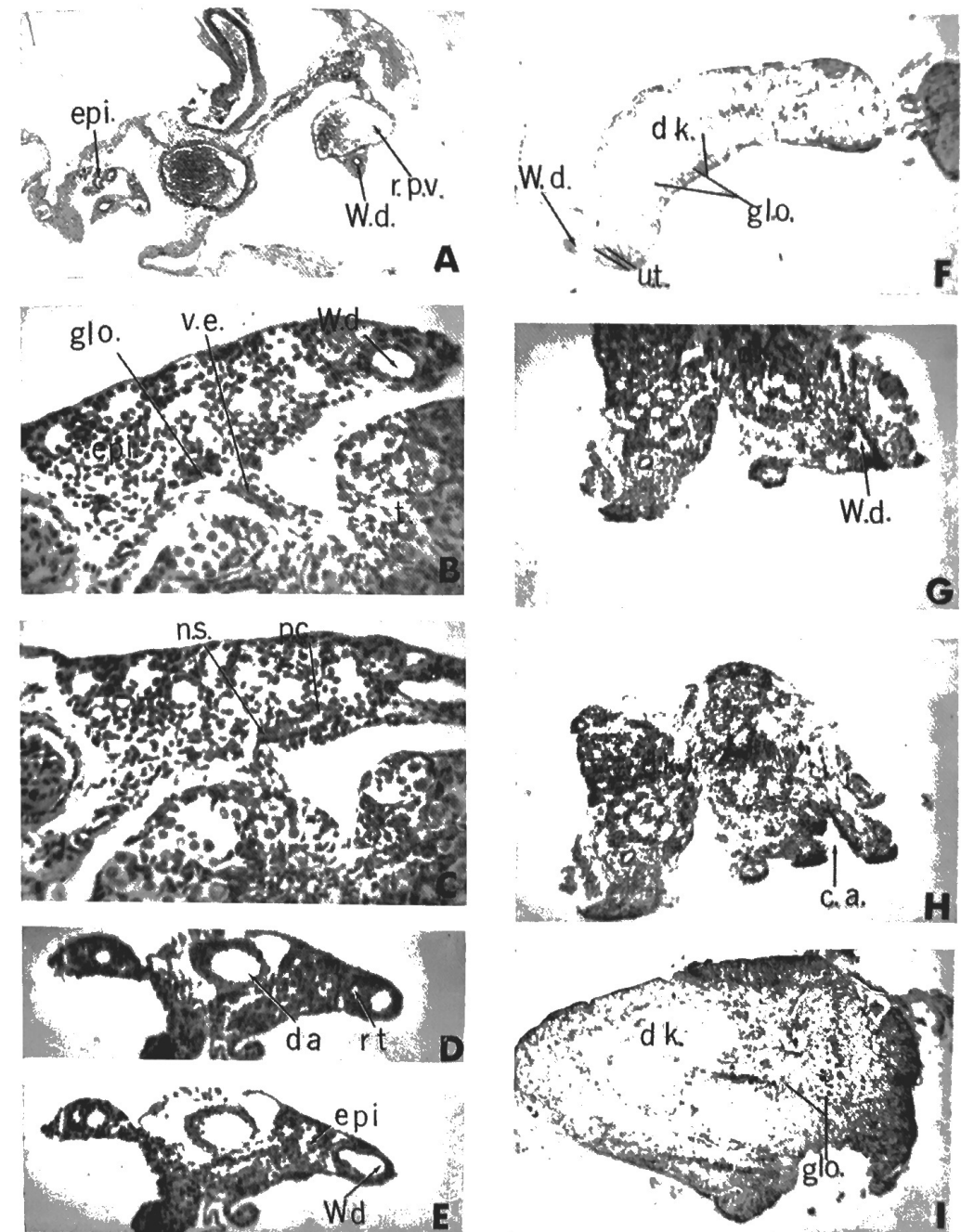


Plate 5. Representative cross sections of the male urogenital system in the family Sirenidae.

of the Wolffian duct and enclosed in the same connective sheath. No such structure was observed in the study of the genera of Sirenidae in serial cross-sections. The absence may be explained in the following ways: (1) the duct has no lumen in the Sirenidae, nor is it conspicuously pigmented and thus it may have been overlooked; (2) as a second longitudinal canal produced by the Wolffian duct it disappears after a short time in the male (Moog, 1949); (3) it is never present in the male urogenital system of the family Sirenidae. Perhaps a conclusion could be reached if experiments were made with a sirenid following the procedure of Adams (1930) with *Triturus* utilizing ovarian grafts.

Incongruously, though no rudimentary Mullerian duct seems to be present in the Sirenidae, eggs were observed in the testis, 12 in the right testis of a *S. intermedia*. This is not regarded as unusual in the amphibians (Witschi, 1956; Romer, 1963). The mechanisms of sex determination are so delicately balanced in the vertebrates "the gonads may hesitate (so to speak) between the two possibilities" and both egg and sperm may tend to develop (Romer, 1963). These eggs of *S. intermedia* were probably primary oocytes (personal communication, R. L. Amy, Southwestern College). Ovulate testes have been described in *Salamandra* (Feistmantel from Francis, 1934).

Maschkowzeff (1936) theorizes that the more primitive of the amphibian urogenital systems have a large number of vasa efferentia, evenly distributed along the mesial edge of the testis. His suggestion is a developmental sequence involving progressive degeneracy of the posterior vasa efferentia such that only the most anterior tubules remain to connect the testis to the epididymis and Wolffian duct. Evidence of this pattern of degeneration is the urogenital system of the male *Necturus* which has four vasa efferentia only two of which, the more anterior pair, are utilized for sperm transport (Chase, 1923).

In the Sirenidae the organization of the epididymal units in the opisthonephroi seconds the primitive individualism of the family. Each unit is distinct and separate with little or no overlapping of tubules. This arrangement approaches the metamorphism of embryogeny and, though not unique to the Sirenidae, is quite obvious in this family. Indeed, the epididymides in Sirenidae bear a striking resemblance to the ideal kidney of the anamniotes, the holonephros, with a single nephric tubule in each trunk segment on either side of the body, the nephric tubules draining through a pair of holonephric ducts. The entire opisthonephros in Sirenidae differs from the ideal of the theoretical holonephros (found only in larval hagfishes and apodous amphibians) in two main particulars: (1) There are three degenerate units anteriorly (remnants of the old pronephros perhaps); (2) a great number of secondary and tertiary tubules develop in the posterior portion of the opisthonephros. It remains similar in its retention of the Wolffian duct for both urine and sperm transport.

The final anomaly in the Sirenidae is the fusion of the caudal portion of the opisthonephros anterior to the cloaca. A similar condition has been noted in

Necturus which has not been illustrated in published figures. Strangely enough, there seems to be no hesitancy on the part of comparative anatomists to illustrate a fused caudal kidney in the female (Goodrich, 1930; Weichert, 1958; Smith, 1960; Jollie, 1962; Romer, 1963), but the male is not so illustrated. In the Sirenidae this fusion may be the result of the compact slimmness of the body and absence of the pelvic limbs, or, if the order Urodela is more closely related to the Dipnoi than to the Anura (Kindahl, 1938), the caudal fusion may be simply a primitive condition similar to an ancestor having a kidney closely resembling that of the female *Protopterus* (Kerr, 1919; Parker and Haswell, 1928). Again we have evidence that the Sirenidae seem out of step with the Urodela and is an order in itself.

Research on the embryological development in the Sirenidae should prove to be revealing and is encouraged to substantiate and clarify theoretical phylogeny.

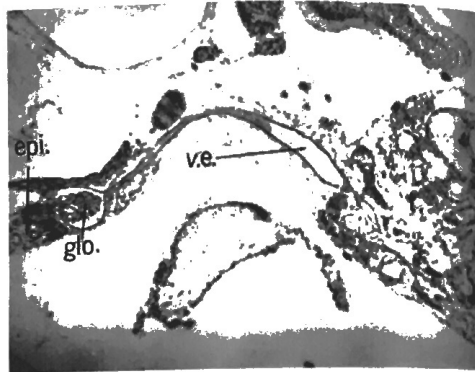


Plate 6. A vas efferens leaving the testis, traversing the mesorchium to enter a glomerulus in the epididymis. This is a typical section and illustrates the absence of a longitudinal canal.

SUMMARY

The Wolffian duct in the Sirenidae is enclosed in the epididymal mass and serves the dual function of sperm and urine transport.

There are no accessory urinary ducts opening into the cloaca.

There is neither Bidder's canal nor rudimentary Mullerian duct present.

The epididymal units are segmentally arranged with little overlapping of tubules and no fusion of nephric units.

The posterior portions of the opisthonephroi are fused and extend behind the cloacal aperture.

The structure of the male urogenital system in the Sirenidae leads one to believe that this system is either the most primitive of the urodeles or that this system gives evidence to substantiate Goin's classification of the family Sirenidae as a member of the order Trachystomata.

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Participation Office. Dr. Pollard said that establishment of the new offices is designed to provide additional emphasis to ORINS programs for colleges and universities. "The University Relations Division functions have been transferred to separate offices reporting to the Executive Director since these activities are of direct concern to our sponsoring institutions," Dr. Pollard stated. ORINS' three other divisions—Information and Exhibits, Medical and Special Training—will continue to operate as in the past.

research laboratory for scientific investigators and students. Research expeditions are organized by Dr. Robert J. Menzies, acting director of the Cooperative Research and Training Program in Biological Oceanography at the Duke University Marine Laboratory. The U.T. research classes aboard the vessel will be taught by Dr. Walter Herndon, associate dean of the College of Liberal Arts, and Dr. D. L. Bunting and Dr. Robert A. Rinaldi, assistant professors of zoology and entomology.

The University of Tennessee Physics Department has received a \$10,900 grant from the National Science Foundation to help finance an undergraduate instructional scientific equipment laboratory. The program will be directed by Dr. William M. Bugg, assistant professor of physics.

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