

## **First section.**

### **Observations on the development of the genitalia in amphibians.**

#### **Tab. I.**

#### **I. Batrachians.**

##### **a. Development of the Wolffian Bodies.**

##### **§. 1.**

Oddly enough, the Wolffian bodies are at the uppermost part of the trunk in embryos of frogs, toads, and salamanders, while in the other animals they occupy almost the whole trunk cavity at first, and later withdraw more into the lower and middle parts of the abdomen. This difference in the location is probably the reason why Rathke did not already find these organs in Batrachians. At the time when the embryos of frogs and toads leave the egg, the Wolffian bodies or false kidneys are very obvious; I have even recognized their internal formation in embryos which were stored in ethanol. If fresh embryos are left for only the shortest time in a vessel containing water or in low concentrations of ethanol, then the black skin falls off by itself as a slimy mass, and the embryo and its internal parts are clearly visible. Even more suitable for this investigation, as for the observation of the whole history of development, are the embryos of a particular toad species, *Bufo obstetricans*, whose eggs are incubated in the ground, and their tender embryos are, like those of the aquatic salamanders, almost completely colorless. As it is generally known, the intestinal canal is at the beginning in all these animals a simple sac-shaped tube, identical to the yolk sac, which developed

from the growth of the germ cell or the blastoderm. The backbone arched over this first bag-shaped bowel. The constriction and elongation of the bowel develop later when the constriction begins above and below, and the middle part gradually changes from a sac to an elongated tube.

Before these changes occur, and before any trace of the liver appears, Wolffian bodies are already very well developed. On both sides of the spine and the intestinal tube, at the uppermost part of it, under the gills, one always sees an oval bulge, from which one can follow a thread down the sides of the spine with naked eyes. Through microscopical examination, this bulge appears to be composed of a small number of short, tubular, blind-ending ducts, which spread out in all directions, but connect at the caudal end to a barely thicker efferent duct, which descends very clearly in a somewhat undulating course along each side of the spine and continues to the area of the anus. These organs are most clearly seen when the whole intestinal sac is carefully detached from the backbone, whereupon the parts mentioned above remain connected to the spine without any injury.

**Fig. 1. Tab. I.** represents a frog fetus from the front, **Fig. 2.** from the side.

**a.** The false kidneys or Wolffian bodies.

**b.** The excretory ducts of the same.

**Fig. 3.** is a rear view of the fetus after the intestinal bag has been removed.

The description is the same.

**Fig. 4.** The same fetus from the front.

It was important to me initially that Dr. Rathke himself replicated this observation. Therefore, I sent one of those embryos to my highly esteemed friend, who

replied to me on February 18, 1829, that he recognized the Wolffian bodies quite distinctly and completely in my preparation, as I had described them.

**§. 3.**

During the course of further development, these bodies and their blind-ending ducts retain their shape and position, while the intestinal sac develops into the first loops of the intestine. At this time, the excretory duct is still very distinct. In recent investigations, I also always saw these bodies and their excretory ducts even in older larvae of frogs, toads, and salamanders, which I had not seen previously in frogs and toads. I saw the traces of these bodies and their excretory ducts even in frog larvae with already developed extremities, which started to lose the tail, and in salamander larvae of 15 Lin. [15 line = approximately 30 mm] length. By the way, the Wolffian bodies behave with respect to their shape and location completely in the same way in frogs, toads, and salamanders. It will become clear later that in all the other amphibians, which do not, in contrast to frogs, toads, salamanders, and fishes, lack an amnion and allantois, they [Wolffian bodies] behave quite differently, and that in this aspect, as in everything relating to internal organs, the salamanders are exceptionally different from lizards.

**§. 4.**

For the interpretation of these parts, it is of great importance that the actual kidneys of the Batrachians develop in the larvae only very late, when the animals have lived for some time outside of the egg. The first traces of the kidneys are seen in the larvae of frogs and toads as a fine seam of a substance that consists of stalked bodies or vesicles, at a time when the intestinal canal has already reached its final coils, a time when they breath through lateral gill openings and the first trace of the lungs on each

side is recognizable as a very small, elongated air bubble. In salamander larvae, in which the organs remain much longer in an embryonic state, the kidneys are still so elementary in animals that already have reached a length of 15 - 20 Lin. [approx. 30 to 40 mm]. It is well known that the genitalia of Batrachians develops much later. It follows from the very different development of the Wolffian bodies and the kidneys in different places, that the latter does not develop from the former. The Wolffian bodies are located in the uppermost part of the abdominal cavity under the gills; they are always separated from the kidneys by a gap.

At the time when the kidneys have already developed, the parts have the relation to the location, as I have shown in **fig. 5. Table I.** of a frog's larva.

**a. a.** The kidneys, whose ureter develop on the outer side.

**b. b.** The Wolffian bodies.

**c. c.** The excretory ducts of the same, which, by turning from the top downwards to the inside, reach the upper end of the kidneys and descend below them. These are the threads which always stick to the end of the kidneys, if one detaches the kidneys in larvae of frogs and salamanders, which are also often found even in adult animals, as a thread-like continuation of the upper tip of the kidneys.

#### §. 5.

In frog larvae, which have not yet developed any extremities, I have always seen on the inner side of Wolffian bodies a very small cluster of greyish whitish granular substance, which in the beginning may be mistaken for the first rudiment of the testes or ovaries, if one has seen the origin of the testes and ovaries on the inner side of the Wolffian bodies in birds and mammals. See that substance depicted in **figure 5. A. Tab. I.** and especially in **Fig. 5. B.** In the latter figure, **a**, shows the blind-ending ducts of the Wolffian bodies, **b**, the mentioned cluster of greyish whitish substance, **c**, the excretory duct of the Wolffian body.

b. Development of the testes and ovaries until the disappearance of Wolffian bodies.

#### §. 6.

I could not decide from observation described in my previous publications whether in the Batrachians or as Rathke observed in birds, the germ cell-producing genitalia develop on the Wolffian bodies. Perhaps, as I hypothesized at that time, these are the well-known, lobed fat bodies, which are connected to the testes and ovaries in adult Batrachians, these enigmatic small fat bodies, only the last rudiments of the equally enigmatic Wolffian bodies of the embryos and larvae.



This is certainly not the case; my recent observations completely refute this, and I have convinced myself that the fat bodies develop completely differently. However, in this respect, was Rathke's earlier remark correct when he said that fat deposition does not form until the beginning of summer when the larvae have already developed both hind legs \*). As Rathke rightly pointed out, a delicate white line first appears on the inner margin of the kidney, which is usually slightly swollen at the front, and soon separates into individual crumbled pieces of fat.

I found the first trace of the germ cell-producing genitalia, in agreement with Rathke, at the time when the larva had already developed its four extremities and the tail began to shorten. This was in the middle of June. The germ cell-producing genital, testis or ovary, forms next to the fat itself, hence also on the inner margin and on the anterior surface of the kidney, as a white granular lump, which soon can be distinguished from the fatty particles above and below it. See **fig. 7. Tab. I. a.** Testes, fat bodies. Compare **fig. 8.** at a later time point, with **fig. 9,** where the fat-body had already begun to separate into 5 lobes, but the testes seemed to consist of strong granules or short, small cylinders, and had moved outwards to some extent. **a.** Kidney, **b.** Testes, **c.** Fat bodies.

### §. 7.

The most important question now is, where do the ovary or testis originate from? They do not develop from the Wolffian body; it is different compared to birds and mammals, in which the testes first appears on the inner margin of the Wolffian body. Here, both are located away from each other. Only the excretory duct of the Wolffian body goes from

the top downwards and slightly inwards towards the tip of the kidney. See **fig. 6. Tab. I.**  
from a frog larva, which had already 4 extremities and had not yet lost the tail, from the  
middle of June.

\*) a. a. O. p. 19.

\*\*) Ebend. p. 24.

- a. Kidneys.
- b. Germ cell-producing genitalia, testes or ovaries.
- c. Wolffian body, located under the gills.
- d. Excretory ducts of the same [Wolffian bodies], easily distinguishable from the two arches of the aorta, which unite over the kidneys into the simple abdominal aorta.

**§ 8.**

It would be possible that the testicles and the ovaries had a close relationship to the excretory duct of Wolff's body when they were released, and that the latter would become the seed, as is certainly the case with birds. In the adult frogs, toads and salamanders, the vas deferens goes high above the testicles, as a thread, to the uppermost part of the abdominal cavity, where it is lost to the outside.

This thread is in complete agreement with the earlier excretory duct of Wolff's body, except that in the adult Batrachians it goes along the outer margin of the kidneys. This thread is hollow in the Frogs and Urodelen, as Rathke \*) has shown, only in its lower part, as far as the region which corresponds to the upper end of the testicle. The upper thread-like part immediately becomes very thin and Rathke could not represent a cavity in it. According to Rathke, with the newts, there is also a difference in color between the upper and lower parts of the vas deferens, in which the former is white in all kinds of pigs, but the latter is black-brown in salamanders.

\*) a. a. 0. p. 40, and in the book on the Urodelen p. 72.

§. 9.

As far as the passages between the vas deferens and the testes are concerned, it is exceedingly difficult to represent the direct passage of strange vessels into the vas deferens. Swammerdam already saw such passages, or vasa efferentia, coming out of the testicle against the inner side, and soon proceeding again to the outer edge of the kidney, in order to pass into the ductus deferens; but Swammerdam falsely believed that the urine was evacuated into the ductus deferens, and he did not know the ureter, which also runs along the outer margin of the kidney \*).

In bird embryos, the vasa efferentia of the testicle passes through the Wolffian body into the excretory duct of the latter, which, running on the outer side of the Wolffian body, also goes further upward than the testicle reaches, and even in young birds is still to be followed as a blind from the so-called epididymis upwards against the adrenal gland running upwards blind vessel. This connection of the testicle and the excretory duct of the Wolffian body through vasa efferentia then remains; out of this connection, an appearance of epididymides develops in the birds, while the substance of Wolff's body gradually withers away and disappears in young birds.

So much for the problematic connection of the testicle and the excretory duct of Wolff's body with the Batrachians. Consider that I have not seen this connection and have not proven that it is reasonable for some simple reason;

*\*) Ex interno testiculorum latere nonnulla pullulant vascula seminalia majuscula, alia simplicia, alia in ramos partita, quae semen per totidem quasi rivulos e testiculis*

*evehunt, prout facile conspici potest, modo testiculos quis tantillum comprimat, tum enim pallido illa atque albescente spermate replentur. Seminalia haecce vascula, sive parastatae naturaliter divisae, paulatim adversus renes, quibus testiculi incumbunt, progrediuntur et tunicam renum investientem perforantes, tandem in deferens vas sese inserunt. Vasa autem isthaec deferentia externam renum oram occupant, ibique cum vasculis seminalibus modo memoratis junguntur. Hic vero probe animadvertendum est, quod renes suum quoque lotium per istud idem deferens vas, per quod testiculi in coitu semen suum excernant, etiam semen atque urina evacuantur. Bibl. nat. T. II. p. 795.*

because of the delicacy of the testicle at this time it is impossible to ascertain anything certain. It may well be that the upper filiform part of the ductus deferens is, however, the remainder of the excretory duct of the Wolffian body, but the ductus deferens, as far as it is hollow, is a new formation independent of that thread.

Likewise, I do not know the relation between the excretory duct of the Wolff's body and the conductor of the egg, or whether the conduction of the egg occurs in addition to this execution, as is the case with the birds. I have tried in vain to solve this difficult question; I even have to doubt that someone else will be happier. For what makes things even more difficult is the distinction of sex in very young frogs. In the birds, this is soon very easy and safe, because in the female usually the one ovary and oviduct very soon atrophy, so that it alone can recognize and distinguish already future males and females with complete certainty, a relief that completely eliminated in the mammals \*).

#### §. 10.

That the Wolffian bodies are not in the necessary relationship to the Amnion and the Allantois, which Rathke once supposed, has now been proved, after these organs have become known to frogs, toads, and salamanders, in general to the Batrachians, which in regard to the egg-hulls distinguish it from all other amphibians in such a strange way and agree with the fishes, possessing neither an amnion nor an allantois, while the lizards, turtles, snakes, with the birds and mammals agree by the presence of the amnion and the allantois.

## §. 11.

The fact that Wolff's bodies are also present in fish is very likely because of the Batrachians. Maybe they are here too

\*) On the temporal relations and the gradual changes of the vas deferens and ovules, as well as the egg and testicles, one finds many interesting observations in Rathke in his treatise on the development of the genitals in the amphibians and in the writing on the Urodelen.

just as high in the trunk cavity. I am very sorry that I have not been able to study fish embryos in this regard. Dr. Rathke has given me hope for this by promising me embryos of *Blennius viviparus* for this purpose. Maybe he will tell us about it, which is just as welcome. To date, I have only been able to examine one ray fetus and several fully developed embryos of sharks, the latter of which I possess; but without success. In that very young ray embryo, which had 3 inches of mass from the head to the tail end and still outer filiform fetal gills, lay in the 7 1/2 Lin. long abdominal cavity, 2 white on the sides of the spine, thinner on the upper side, broader, lower bodies on the sides, consisting of small blind cusps. On the lower part of the anterior surface of these bodies lay another smaller and narrower body of a similar form, which was also made up of nothing but very thin and small blind continuance. Which is the kidney, maybe a Wolffian body? In my work on the internal structure of the glands, I have given a picture of these organs. **Tab. XII. fig. 1.**