

On the Reno-pericardial Canals in Patella.

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With Plate 24.

STRANGE indeed, and happily unique in the annals of comparative anatomy, has been the history of our knowledge of the reno-pericardial canals of Patella. Although discovered more than thirty years ago, and investigated by many observers since, not only is their structure insufficiently known, but their very existence has been called in question, and even positively denied!

Wishing to find out definitely whether these ducts really existed or not, I undertook this work, which was carried out in Oxford, on material obtained from Plymouth and Naples. In this short paper I hope to establish clearly, and beyond the possibility of doubt, the fact that there are reno-pericardial canals leading from the pericardium to the right kidney and to the left kidney in Patella.

A communication between the pericardial and the renal cœlom of *Patella vulgata* was originally described by Professor Lankester in 1867. "By most careful dissection," he tells us, "Dr. Rolleston and myself detected what appears to be a minute opening from the pericardium into the supra-anal reticulated sac lying in the curve of the rectum [left kidney]. The orifice I found first by opening the pericardium, when it was seen between the bifurcation of the auricle at the right side of the cavity, and was then traced from both the pericardium and supraanal sac in other specimens." Dr. von

Jhering ten years later, in an important paper on the kidneys of molluscs, states that he was unable to find a reno-pericardial communication: "Die Pericardialöffnung sah ich nicht" (1877, Jhering). In 1881 Lankester and Bourne together reinvestigated the question, and described the canal thus:—"Its presence can be demonstrated both by injections which pass from the pericardium sometimes into the right, sometimes into the left renal sac, and by dissection. The orifice leads directly into a narrow subanal tract of the further or right renal sac, and not directly into the left or small renal sac" (1881, Lankester). It will be seen that, curiously enough, although the presence of the canal previously described as leading into the left kidney is not actually denied, yet the author seems not to be convinced of its existence. Shortly after, Mr. J. T. Cunningham undertook the study of these canals by means of series of sections (1883, Cunningham). In this paper, to the details of which we shall refer later on, two pericardial canals are described leading into the small left and large right kidneys respectively in *Patella cœrulea*. The fact that only a diagram of the canals is given, and that Cunningham made use chiefly of injected material, perhaps contributed to weaken the evidence brought forward. The main facts were, however, confirmed by Mr. Harvey Gibson in his studies on the anatomy of *Patella vulgata* (1887, Gibson). An important memoir on the kidneys of the Prosobranchs was brought out by M. Rémy Perrier in 1889; in this work the author states that although he made use of sections, and found the right reno-pericardial canal, yet he was unable to find a canal opening into the left kidney: "Je n'ai pu retrouver la communication du péricarde avec le rein gauche." Perrier concludes that the right kidney alone communicates with the pericardium (1889, Perrier).

We now come to the most sensational chapter in our story. In 1892 Dr. R. von Erlanger published an elaborate work on the 'Paired Nephridia of Prosobranchs' (1892, Erlanger), in which he positively denied the existence of any reno-pericardial duct in *Patella*. The author, criticising the injection method, maintained that previous observers had been misled by the

injection being forced through weak spots where the kidneys reached the wall of the pericardium. In conclusion, von Erlanger stated that in *Patella* there is "no reno-pericardiac duct whatever."

The absence of the communicating canals seemed now to be as firmly established as their presence had appeared to be but a short time before. The matter was not long allowed to rest in this condition. Hardly had naturalists become reconciled to v. Erlanger's view, when Dr. Béla Haller published some elaborate studies on Prosobranchs (1894, Haller), in which he describes in considerable detail a right reno-pericardial canal in *Patella magellanica*. A dissection is figured showing the apertures of this canal. As for the left canal, Haller denies its existence: "Wie wir wissen, hat Cunningham auch für die linke Niere eine pericardiale Mündung behauptet, darum war ich, obgleich dieses mir nach dem Verhalten bei der Monobranchen höchst unwahrscheinlich vorkam, doch bemüht dieses unbedungen zu verfolgen. Auf Totalpräparaten war dieses in Folge der subtilen Verhältnisse nicht recht möglich und darum benützte ich hierfür meine Querschnittserien, doch konnte ich bei keiner der untersuchten Formen eine Mündung der linken Niere in das Pericard auffinden. Eine solche fehlt ganz entschieden."

Having thus briefly reviewed the history of the subject, I must now give a short account of my own observations, which are founded on the examination of complete series of transverse sections. The structure and relations of the small left and large right kidney are now so well known that they need not again be mentioned. I shall, therefore, merely describe the selected sections figured on Pl. 24.

In fig. 1 is represented a section through the two kidneys, rectum, and pericardium, some little way behind the posterior limit of the mantle chamber. It will be seen that from the right ventral corner of the pericardium proceeds a diverticulum, which, in fact, is the beginning of the right reno-pericardial canal. A section taken farther forward (fig. 2), so as just to cut through the hinder region of the mantle cavity, shows the

right reno-pericardial canal separated off from the pericardium, and lying close to the wall of the subrectal portion of the right kidney. From the pericardium a second diverticulum is seen coming off at a higher level than the first,—it is the beginning of the left reno-pericardial canal. If we compare this figure (fig. 2) with fig. 25 *b*, pl. xxxvii of Erlanger's memoir, we can hardly doubt but that he actually figured the origin of the left canal without understanding its true nature; for nowhere else does the right wall of the pericardium become folded or pushed out at this level as v. Erlanger represented. Neither of the canals opens straight into the renal cœlom,—on the contrary, they bend forwards and extend along the walls of the kidneys for some considerable distance. The right reno-pericardial canal is especially long. If we follow the left canal to about one third of the way between its place of origin and the external aperture of the left kidney, we find that it opens into this kidney (fig. 3) through its left wall. Tracing out the right or lower canal farther forwards, we find it opening into the subrectal region of the right kidney, about two thirds of the way from its origin to the right renal pore (fig. 4). In both cases the reno-pericardial opening is situated at the end of a papilla projecting into the renal cœlom, and forming a ciliated funnel-like spout.

The excretory epithelium of the kidneys (fig. 9) is formed of a layer of very tall cells, the free ends of which are much swollen, and often broken off. They sometimes bear cilia. A round nucleus is situated towards the base, and outside it are numerous excretory granules; the swollen distal end appears almost empty—an effect due, no doubt, to the reagents. At the rim of the funnel (figs. 6 and 7, and the reconstruction in fig. 5) this epithelium changes suddenly into ordinary high columnar epithelium, provided with numerous long and powerful cilia directed towards the renal cavity. Near the base of the funnel the ciliated epithelium passes into the flat cœlomic epithelium lining the canal (fig. 8). The pericardial epithelium itself is identical and perfectly continuous with that of the canal.

Comparing this description with that given by previous observers, it may be remarked that in the main my results agree with and confirm those of Cunningham; yet neither he nor Gibson appears to have seen the well-marked funnels. On the other hand, like Gibson, I am unable to find the "triangular piece of tissue" described by Cunningham as forming "a sort of valve" over the opening. It is difficult, indeed, to see how such a flap would act in connection with the papilla. Haller describes a ciliated funnel at the right reno-pericardial aperture without figuring a section through it; but he further states that the canal itself is lined with high columnar cells. This is certainly not the case in the species I have investigated, and I cannot help thinking that he may have mistaken in this instance a branch of the ramifying kidney for the reno-pericardial canal. Both the kidneys give off numerous branches lined with epithelium similar to that of the main renal chambers.

In the four series of sections of *Patella vulgata* examined I have always found the two reno-pericardial canals present, and well developed. In *Patella cœrulea* I have observed two canals of essentially similar structure,—in fact, the description given above applies equally well to either species.

Summary.

In the foregoing pages it has been shown that in *Patella vulgata* and *cœrulea* there are two reno-pericardial canals, opening by means of projecting ciliated funnels¹ from the pericardium into the right and left kidneys respectively.

LIST OF REFERENCES.

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Similar but better developed structures are found at the mouth of the reno-pericardial canals of *Chiton* and other molluscs.

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EXPLANATION OF PLATE 24,

Illustrating Mr. Edwin S. Goodrich’s paper on “The Renopericardial Canals in *Patella*.”

All the figures refer to *Patella vulgata*.

FIGS. 1, 2, 3, and 4.—Four transverse sections through the region of the rectum and pericardium, showing the course of the two reno-pericardial canals. Drawn with the camera. $\times 9$.

FIG. 5.—Reconstruction of the opening of the right canal into the right kidney.

FIG. 6.—Section through the opening of the right canal into the right kidney. Cam. $\times 130$.

FIG. 7.—Section through the opening of the left canal into the left kidney. Cam. $\times 130$.

FIG. 8.—Section through the wall of a reno-pericardial canal, showing the flat cœlomic epithelium on the inside and blood space outside.

FIG. 9.—Section through the wall of a kidney, showing the large excretory cells.

