ON THREE POINTS IN THE NERVOUS ANATOMY OF AMPHIBIANS.

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With three figures.

In my studies of the head of *Amphiuma*, which I hope to have completed at an early date, I have found it necessary to make comparisons with the results of other observers, and in some cases to repeat their observations, especially in those cases where *Amphiuma* presented features not easily reconciled with the conditions existing in other forms.

For this purpose I have had to go over the results obtained by von Plessen and Rabinowicz in their classic "Die Kopfnerven von *Salamandra maculata*." Studying larvae of this species, varying between two and a half and three centimetres in length, these authors figure and describe a commissure as existing between the ramus palatinus of the facial and their supra-maxillaris superior of the trigeminal, a condition which is not easily reconcilable with what I find in *Amphiuma* nor with what other authors find to exist in the Urodeles. To test the question as to whether *Salamandra maculata* was unique in this respect I sectioned a larva of twenty six millimeters and plotted the sections in the same manner as these authors did. As a whole I can confirm their results, but there are a few features which need correction. In their figures they give a small nerve, designated by the letter *z*, forming a ramus communicans between the mandibularis and the maxillary (their supra-maxillaris superior) nerves. In my studies this ramus communicans also occurs, but, instead of its being very small it is fully as large as the branch from the "nebanganglien" with which it connects. Detailed study of many Urodeles shows that the maxillaris must be regarded as a compound nerve, with both facial and trigeminal components. See fig. 1.

Still further in front von Plessen and Rabinowicz describe a nerve uniting the maxillaris with the palatine. As such a ramus communicans occurs in no other Urodele which I have

Figure 1. Lateral reconstruction of the proximal portions of the fifth and seventh nerves of a *Salamandra maculata* embryo, body length 26 mm. *ag*, accessory ganglion of VII; *gf*, ganglion of facialis; *gg*, Gasserian ganglion; *md*, ramus mandibularis; *mx*, ramus maxillaris; *op*, ophthalmicus profundus; *os*, ophthalmicus superficialis; *ros*, root of the ophthalmicus profundus; *rv*, root of the trigeminal; *r VII*, root of the facialis; *, ramus communicans between the mandibularis and maxillaris nerves. x 30.

studied, this condition was also investigated. In all other Urodeles the connection occurs between the ophthalmicus profundus (the nasalis of von Plessen and Rabinowicz) and the palatine, a condition which is not found in their figures or description. In this I think they have made a mistake and that a part of their error has arisen in this manner. In *Salamandra*, near the anterior limit of the eye the maxillaris nerve comes to lie close against the inferior oblique muscle at its insertion on the ball while the middle branch (their *b*) of the ophthalmicus profundus lies against the same muscle near its origin. It therefore appears possible that they have mistaken the muscle for a part of the ramus communicans, a mistake the more readily made since in many forms there is such connection between the maxillaris and the palatine. The true relationship may be seen from fig. 2, which shows the middle division of the ophthalmicus profundus connected with the palatine by a short transverse commissure, just as is the case in *Amblystoma*, (my studies confirming the results of Herrick in this respect) and in *Amphiuma* and other forms. In *Salamandra maculata*, in front of this ramus communicans, the middle branch of the ophthalmicus profundus suddenly bends downwards and goes to

the alveolar region of the upper jaw, while the palatine is continued forward as described by these authors, passing just inside the internal nares, and forward and beneath the premaxillary bone.

Figure 2. Projection of fifth and seventh nerves of *Salamandra maculata*, viewed from above; letters as before excepting *op*², *op*³, middle and outer divisions of the ophthalmic profundus; †, ramus communicans between palatine and profundus nerves. x 30.

In the *Journal of Morphology* Vol. XI, No. 2, Mr. Alvin Davison gives an account of some features in the anatomy of the young and of the adult *Amphiuma*. It is unnecessary to notice here the whole article but there is a point of nervous anatomy mentioned which may fittingly be commented upon in a *Journal* devoted to neurological matters. Mr.† Davison says (p. 401): "The most important and interesting structure is found below and external to the eye in my smallest specimen, seventy eight millimeters in length. There appears in this re-

gion a canal, one-tenth of a millimeter long, which is walled by columnar epithelial cells extremely regular in outline. External to the epithelial wall there is seen a thick layer inferiorly of degenerated tissue, which is bounded by a thin layer of fibrous connective tissue. In three other specimens, eighty eight, ninety and ninety two millimeters respectively, no trace of this degenerate canal could be discovered, and in the smallest specimen I was able to detect it on the right side only."

In all probability it is this structure to which he refers later in his paper (p. 405). After briefly summarising Wiedersheim's observations on the tentacular apparatus of the *Gymnophiona* he says: "As I have already shown, there exists in my youngest specimen of *Amphiuma* the atrophied remnants of the tentacular apparatus. The columnar epithelial lining of the canal is very distinct in about one dozen transverse sections through the orbits. In some of the sections I have discovered what I believe to be the degenerated retractor muscle. This apparatus in *Amphiuma* has precisely the same relative location as in the *Coecilians*. For some unexplainable reason neither Hay nor Kingsley found this organ in the young embryo. . . . The occurrence of this degenerated structure in the young *Amphiuma* and its complete disappearance in the adult gives unmistakable evidence of the relationship of the *Coeciliidae* and *Amphiumidae*." A single figure illustrates the point made.

Were it true that *Amphiuma* possesses, either in the young or the adult, rudiments of a tentacular apparatus, the fact would prove of great value to those who would recognize in the *Gymnophiona* only degenerate *Amphiumæ*. It is not, however, "unexplainable" why neither Hay nor myself found such a structure *for no tentacular apparatus exists in Amphiuma*. I have considerable material in the way of young *Amphiumæ*—possibly forty specimens—embracing both younger and older material than that in the possession of Mr. Davison and including some from the same lot as the four specimens at his command. In the first place the structures described and figured by him are not in the proper position for the tentacular apparatus, as a little careful reading of the Sarasin's monograph would

have shown him. Secondly had he carefully examined the eye muscles of his *Amphiuma* he would have found that all are present, while the Sarasins say that the retractor muscle of the tentacle is probably produced from the retractor bulbi.

Figure 3. Portion of section through the head of a larval *Amphiuma*; letters as before excepting *f*, frontal bone; *p*, parietal bone; *ni*, ramus nasalis internus of ophth. profundus; *osp*, orbitosphenoid; *tr*, trabecula; *ps*, parasphenoid; *o*, optic nerve; *m*, maxillary bone; *b*, blood vessel; *b** and *mx**, blood vessel and branch of maxillary nerve constituting the tentacular apparatus of Davison.

On the other hand I find a canal and a solid structure lying immediately beneath it, in the very place where Mr. Davison's tentacular apparatus appears, but I interpret the features differently. The supposed degenerate muscle is a peripheral branch of the maxillary nerve, the tentacular canal is one of the branches of the sub-orbital blood vessels. The only objection to this is that our author describes the canal as lined by columnar epithelium, a condition possibly the result of contraction of the vessel and a consequent throwing of its intima into folds, or possibly he has mistaken the contained blood corpuscles for epithelial cells. The short course which he allows the canal is explained by the fact that distally it breaks up while more proximally it is compressed as it passes between two nerve twigs