An Experimental Investigation on the Function of Reissner's Fibre.

By

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Some fifty years ago a German investigator, Reissner, discovered *lying freely in the central canal of the spinal cord* of the lamprey a very fine cylindrical rod, which he supposed, notwithstanding its unusual situation, to be a delicate nerve fibre. He failed, however, to learn anything concerning its connection with the central nervous system, and his discovery, although confirmed, seems to have attracted but little attention. The few observers who have since that time recorded observations upon Reissner's fibre were almost all agreed that it was to be looked upon merely as an artifact produced by the coagulation of the cerebro-spinal fluid by the action of the fixing reagents employed.

In the early years of the present century, however, Sargent (1900–1904) took up the study of this fibre of Reissner and announced that he found it to be a *nerve tract* which formed a direct connection between the optic centre in the mid-brain and the musculature, and permitted, he believed, of a quicker response to optic stimuli than was possible through the ordinary spinal tracts. He claimed to have obtained experimental confirmation for this theory, by observations made upon elasmobranchs, in which he had broken the continuity of the fibre, declaring that he could detect an appreciable slowing in the passage of optical stimuli in the subjects of his experiments as exhibited by their failure to quickly avoid obstacles placed unexpectedly in their path.

My own observations upon Reissner's fibre and related structures in the central nervous system, which were begun in 1907 and have continued until the present time, while establishing beyond question the fact that the fibre is really a preformed structure,* have at the same time shown conclusively that it is not a nerve fibre or a nerve tract.

I have been able to demonstrate that the fibre takes its origin from an extraordinary epithelial organ which lies beneath the posterior

* Edinger, as recently as 1908, had affirmed that it was merely an artifact.

commissure. This structure, for which the name sub-commissural organ has been proposed (and which, as I shall hope to show in a paper now nearly ready for publication, develops from an anlage in the brain, which is serially homologous with the anlage of the lateral and pineal eyes), *must be looked upon as an intra-cerebral sense organ.* In early development a paired structure, it takes up, in many forms, a median dorsal position, and in almost all vertebrates becomes in the adult a most conspicuous structure in the mid-brain.

It is from the internal (ventricular) aspect of the cells of this organ that Reissner's fibre arises as a large number of cilia-like fibrillae, which converge beneath and behind the posterior commissure into a rod-like structure which may, at its anterior end, be either paired at first or single and median. In either case it shortly becomes a single median thread and stretches backward as such to the extreme hind end of the central nervous system. Beneath the rhombo-mesencephalic fold it frequently comes to lie in a well-marked dorsal median groove (the "isthmic canal"), which deepens with age, and which may be paired if the paired character of the fibre is maintained so far caudally.

Through the central canal of the spinal cord Reissner's fibre may be traced backwards lying centrally and apparently supported at frequent intervals by cilia from the ependymal cells.

At the actual extremity of the spinal cord (filum terminale) the central canal widens out into a sub-spherical space which was named by Retzius* the sinus (ventriculus) terminalis. This chamber is not, however, wholly enclosed within the nervous system, for, posteriorly, the ependymal epithelium—which alone constitutes this part of the filum terminale—fails entirely, and there is left a wide opening which I have called the "terminal neural pore." The wall of the sinus terminalis is thus completed posteriorly only by the connective tissue sheath of the spinal cord. Into this meningeal wall Reissner's fibre, flaring out into a trumpet-like end, passes and is inserted.

If in freshly killed material Reissner's fibre be cut, it recoils spirally in both directions from the point of section, forming dense tangled knots such as would be formed in a thin elastic thread which, held firmly at one end, *was twisted from the free end continually in one direction.* In this reaction, as also in its straining reactions, in its origin in the brain, and in its ending in the meninges, Reissner's fibre is altogether unlike any known nerve.

Since then it is not a nerve, Sargent's "Optic Reflex Theory" can no

* Retzius knew of its occurrence only in Amphioxus and Cyclostomes. It is to be found even better developed in Elasmobranchs and Teleosts.

longer be maintained, and the question of its function (and that of the related sub-commissural organ) is reopened.

The supposed inaccessibility of the fibre had led Sargent to operate upon it in the region of the hind-brain, and his experiments were therefore open to the serious objection that they involved great risk of grave damage to the brain itself. My discovery, however, that the fibre is, in the lower vertebrates at any rate, comparatively readily accessible in the region of the tail (where it actually passes out of the central canal of the sheltering spinal cord through the terminal pore), suggested the practicability of experimental work upon Reissner's fibre without danger of damage to the central nervous system.

The experiments, which consisted simply in breaking the fibre by a slight incision at the end of the filum terminale, were carried out in the Laboratory of the Marine Biological Station at Plymouth, in the summers of 1910 and 1911, and I desire here to acknowledge my obligations to the British Association for the Advancement of Science, and the Senate of London University for the use of their Tables, and also to the Royal Society for a Grant which enabled me to carry out the more extensive series of experiments in 1911. My thanks are also due to Dr. Allen and the other members of the staff for the courteous way in which they met my wishes and facilitated the carrying out of the work.

In all, the experiment was carried out upon some seventy specimens (dogfish and rays), and a short account of the earlier experiments has already been published (*Anat. Anz.*, Bd. XL, pp. 409–432). In compliance with the conditions under which the licence to conduct the experiments was granted the specimens were anæsthetized—a most unnecessary precaution (in view of the trivial character of the operation, which rarely drew a drop of blood), and one which, in the case of some of the subjects of experiment, proved a much more serious matter than the operation itself.

Upon these anæsthetized specimens the necessary prick was quickly inflicted and the specimens returned to the tank. Subsequent observation (extending in different cases over a period of less than an hour to as much as three weeks or more) showed that apart from a slightly different action in swimming, which I found almost impossible to analyse and describe, the only discoverable effect of the operation was that many of the specimens when at rest adopted a pose which was markedly unlike that of the normal animal. In the normal specimen at rest the under surface of the head and the lower lobe of the caudal fin touch lightly upon the supporting surface, and the entire long axis of the body extends in a straight line. In these subjects of the experiments (in which subsequent microscopic examination of the

material showed that the fibre had been broken) the animal was found to retire to the darkest part of the tank and there to remain sluggishly with head and tail sharply uplifted, and often with the body sharply bent or in a sinuous curve. In the rays, the whole body was often strongly arched transversely as well. The reaction lasted for a longer or shorter period, and was usually very pronounced.

Subsequently, in the aquarium, specimens were found showing this reaction, and the examination by sections of their central nervous system showed that in each case Reissner's fibre had been broken in life, presumably by some recent accident.

Thus the principal result of the breaking of Reissner's fibre in the living animal appears to be that the animal adopts, while at rest, an unnatural pose, and probably also swims with a slightly different action. This lends support to the suggestion put forward by Dendy (*Nature*, December, 1909), that the apparatus forms part of a mechanism for automatically regulating flexure of the body.