Histology. — *"On the Regeneration of Sensitive End-corpuscles after section of the nerve"*. By Prof. J. BOEKE.

(Communicated at the meeting of September 30, 1922).

During the process of regeneration of the motor endplates of striated muscles we are in a position to observe not only that the nerve-fibers put forth new shoots again and unite with the muscle-fibers to form new end-plates, but also that all the surrounding tissue elements: the connective tissue as well as the muscle-fibers, the nerve-sheaths and the axis-cylinders of the nerves themselves, play a part in the regeneration process and are instrumental in ensuring its success.

In the case of sensitive nerve-endings it is more difficult to observe this procedure: 1° because there is a greater variety in the shape of these endings than in that of the motor end-plates, 2° because many more varieties occur side by side in the same environment, and 3° because sensory endings generally offer greater difficulty in establishing the relation between the nerve-fibers and the surrounding cells than motor end-plates do.

Now in the cere of the duck's bill there are two sorts of sensory end-bodies, viz. those of GRANDRY and HERBST, which are very well adapted to such an investigation by their simple, well-defined structure.

We examined the regeneration after cutting the nerve. The operation was well sustained by the animals and in a short time the wound was healed in primam (among 24 cases one inconsiderable suppuration) without any injury to the animals.

After 4—5 days the severed nerves were completely degenerated; nothing was left of the axis-cylinder except a few granules staining brownish black by BIELSCHOWKY's method. After some days these also disappeared.

An alteration of GRANDRY's tactile cells or of HERBST's core-cells, described by GASIOROWSKI years ago after cutting the nerve, consisting in shrivelling of the cells and bulging and wrinkling of the nuclei, I have not been able to detect. In agreement with the aspect of the soles of the motor endings the protoplasm became more coarse-grained, swollen, while the impression was given that in the core of HERBST's corpuscles there were more nuclei than the normal corpuscle presents. There also seemed to exist a slight increase in the number of the capsule-cells of GRANDRY's corpuscles.

While regenerating the nerve-fibers follow the old nerve-courses (which have changed into strands of BÜNGNER), and pass again into the primary corpuscles. It seems, however, that all along also new corpuscles, especially GRANDRY's corpuscles, are formed, in which process sheath-cells (lemnoblasts) grow larger and become tactile cells, as HERINGA has established as to embryological development. As soon as the nerve-fibers have reached the tactile cells of GRANDRY, they branch out, grow sinuously round them, always embedded in the protoplasm of the capsule-cells and at length force their way between the tactile cells. Directly after this the neurofibrils begin to branch, broadening reticulations appear, which gradually spread between the tactile cells, first as a delicate retiform structure, afterwards as a close-mesh network. In this way the whole interspace between the two tactile cells is occupied again by a net-shaped neurofibrillar nerve-plate.

Two things strike us here as being remarkable:

First of all that in the beginning of the process of regeneration the nerve-fibers bend round the tactile cells in various convolutions and ramifications, but that in the following stages (after 2 or 3 months) this process is less pronounced, so that gradually the normal condition asserts itself in the same way as with the motor endplates; secondly that neither the nerve-fibers themselves nor their terminal branches and terminal broadening ever run freely, but always remain enclosed in the protoplasm of the conducting cells and the capsule-cells, and that directly when they are within reach of the tactile cells, a peculiar network is formed around them, inside the protoplasm of the tactile cells, which could also be demonstrated, in complete distribution, in the normal corpuscles of GRANDRY; lastly that here the process of regeneration of the intraprotoplasmic network shows itself first round the end-branches (end-reticulations and end-knots) of the nerve-fibers and then appears to extend gradually over the whole extent of the flat tactile cells. The whole regeneration-process takes two or three months.

In the case of HERBST's corpuscles the in-growing nerve-fibers also follow the old nerve-tracks. At their point of entrance into the core of the corpuscle we see also here that the nerve-fiber not only proceeds linearly into the protoplasm of the syncytially connected celss of the core, but also that it throws out its branches and passes with many convolutions through the protoplasm, so that the aspect

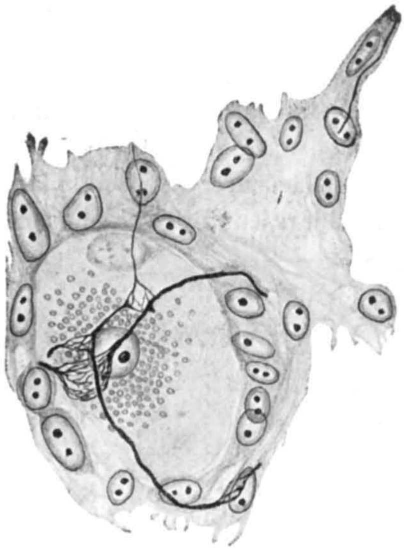

Fig. 1. GRANDRY's corpuscle. 36 days after cutting the nerve. Initial stage of the surface-enlargement in the neurofibrillar apparatus of the nerve-threads that grow round the tactile cells. Transverse section.

Fig. 2. GRANDRY's corpuscle, 46 days after cutting the nerve. Complete regeneration, double growth round the tactile cells. Longitudinal section.

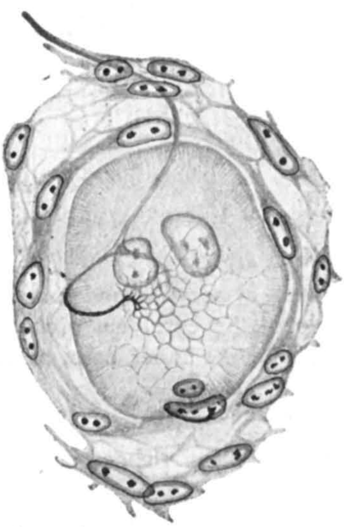

Fig. 3.

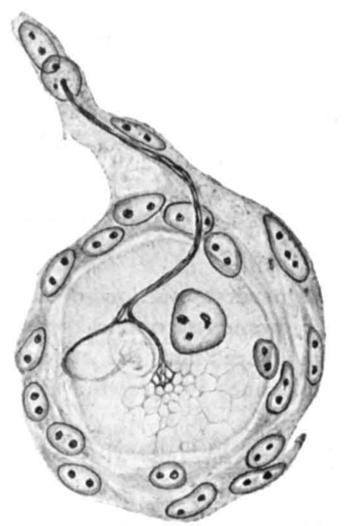

Fig. 4.

GRANDRY's corpuscle. 42 days after the cutting of the nerve. Transverse section of the same end-body at different planes. Splitting of the in-growing nerve-thread. Intrusion between the tactile cells, formation of a protoplasmic network (receptive substance, periterminal network) round the end-buds of the neurofibrillar nerve-apparatus.

of the whole structure becomes much more complicated than that of the primary nerve-fiber of the normal HERBST-corpuscles. However, here also the normal relations gradually assert themselves. I have not been able to ascertain whether new HERBST-corpuscles are forming in the course of the regeneration process.

Round the inner core in HERBST's corpuscles are disposed a large number of connective-tissue lamellae, separated by lymphspaces.

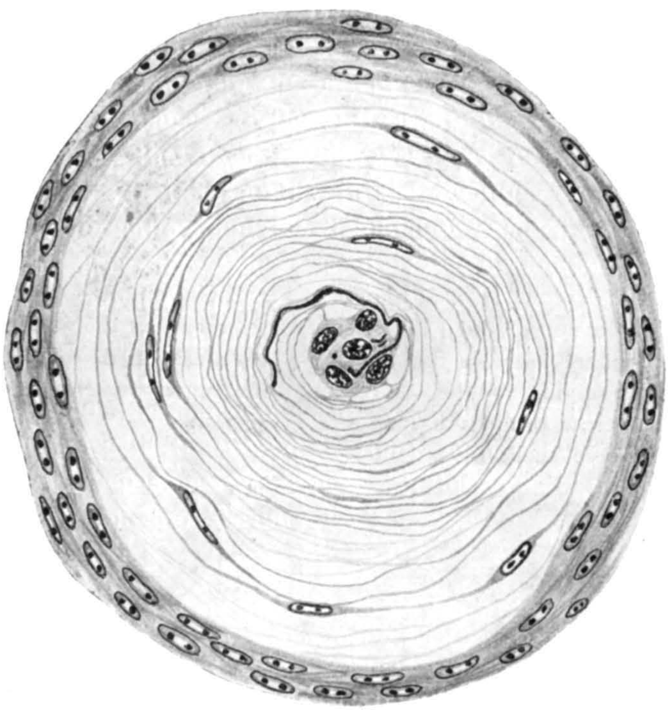

Fig. 5.

Transverse section of a HERBST-corpuscle, with a nerve-thread that not only branches out in the protoplasm of the cells of the core, but proceeds from there into the connective-tissue lamellae round the inner core, where it continues its growth. 42 days after the cutting of the nerve.

These lamellae are connected by means of cellular processes, thus forming a whole.

Now in watching the regeneration it may be repeatedly observed that the nerve-thread, which has passed into the inner core of a HERBST-corpuscle and ramifies in the protoplasm of the core, does not remain enclosed here in its entirety, but that some of the end-branches leave the core and intrude into the tissue of the connective-tissue lamellae. This then is the very place to see quite clearly, that these nerve-fibers do not force their way into the lacunae between the connective-tissue lamellae, but that they lie in the lamellae, enveloped by protoplasm, and remain there. This envelop must decidedly partake of the nature of connective tissue. This observation, therefore, is in perfect harmony with what could previously be established for the neuromuscular spindle of striated muscles. In them also the in-growing regenerating nerve-threads could be seen moving through the protoplasm of the connective-tissue cells of the capsular space, which cells have developed into a conductive-tissue.

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