ent. In the preparations of the muscles of mastication in which the fibers of the mandibular nerve have undergone degeneration, remnants of some of the end-plates of the myelinated fibers are still visible. In all these preparations slender unmyelinated nerve fibers, some of which are intimately associated with the blood vessels while others occur either singly or in small bundles entirely apart from the blood vessels, are present. None of these fibers, many of which terminate on muscle-fibers, show any evidence of degeneration. The terminal structures of these fibers, like the ordinary motor end-plates, are always hypolemmal in position and rest on a layer of granular sarcoplasm which lies superficial to the myofibrillae. Some of these fibers terminate in a single end-net or end-loop, others give rise to two or more terminal branches which terminate in smaller end-nets or end-loops of similar character. These observations conform in all essential details to those recorded by the authors named above regarding the unmyelinated nerve-fibers and their terminal structures in preparations of voluntary muscles in which the somatic nerve-fibers have undergone degeneration. Inasmuch as, in our experimental animals, all the somatic nerve-fibers supplying the muscles in question had been cut and ample time was allowed for the degeneration of these fibers we must conclude that the unmyelinated nerve-fibers which remain are sympathetic in origin.

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Experimental observations on the functional significance of the sympathetic innervation of voluntary muscles.

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In this study we adopted the plan of extirpating the sympathetic trunk in the lumbar region on one side only, using dogs as the experimental animals, and comparing the tonus, the power of contraction and the resistance to fatigue of the muscles of both hind limbs both immediately after the operation (6 dogs) and after ample time (10 to 36 days) had been allowed for the degeneration of the sympathetic nerve-fibers supplying the mus-

cles of the hind limb on the side of the operation (4 dogs).[1] Only the more important results obtained can be reported in this paper.

In the animals which were allowed to live following the operation a degree of hypotonus of the muscles of the hind limb on the side of the operation could be demonstrated by palpation for some time, but gradually subsided. This is in accord with the observations of Negrin, Lopez and von Brücke (1917)[2] and Dusser de Barenne (1917)[3] on cats. We are not prepared to state how long such hypotonus persists. In one animal it was still demonstrable two weeks after operation, in another it could not be demonstrated by palpation ten days after operation. However, when these dogs were placed under surgical anesthesia, even after the hypotonus referred to had apparently subsided, a marked difference in the flaccidity of the muscles of the two hind limbs became apparent. As the animals lay on their backs with the limbs free the hind limb on the side of the operation dropped to a lower position than the other. When equal weights of 100 or 200 grams were attached to both hind feet and suspended over pulleys at the end of the table the limb on the side of the operation was more fully extended than the other. Weights of 600 grams drew both limbs out equally, both being fully extended.

In order to secure graphic records of the contractions of individual muscles the hind limbs were fixed in moderate extension, as the animal lay on its back under surgical anesthesia. The tendons of the gastrocnemius muscles were isolated and cut at their insertions. A strong cord was attached to each isolated tendon and led over a pully at the end of the table to an ergograph or to a muscle lever with a weight attached. The stimulating current was supplied by two or three dry cells and an inductorium. The stimulus was applied to the exposed sciatic nerves.

The most significant graphic records obtained are the curves of fatigue of the gastrocnemius muscles when the sciatic nerves were stimulated by means of a uniform tetanizing current. The muscle on the side on which the lumbar sympathetic trunk was extirpated invariably underwent fatigue in less time than the one on the opposite side. The initial contractions of both muscles, whether isometric or isotonic, were usually approximately equal.

[1] We are indebted to Dr. F. J. Tainter for these operations.

[2] *Pflüger's Archiv.*, Bd. 166, S. 55.

[3] *Pflüger's Archiv.*, Bd. 166, S. 145.

When the ergograph was used the curve obtained on the side of the intact sympathetic trunk was maintained at a fairly constant level for some time, then dropped gradually to the base line. The curve obtained on the opposite side either began to drop at once or was maintained at a constant level but for a short time, then dropped to the base line rapidly. In those cases in which the experiments were made immediately after the extirpation of the lumbar sympathetic trunk the curve obtained on the side of the operation not infrequently reached the base line in less than half the time required on the opposite side. In those cases in which the experiments were made after the sympathetic fibers supplying the muscles of the hind limb had undergone degeneration the decrease in the resistance to fatigue of the gastrocnemius muscle in this limb was still more marked. Cutting of the sciatic nerve on the side of the operation had no further effect on the resistance to fatigue of the gastrocnemius muscle, under the conditions of these experiments. The curves obtained when the muscle lever with a constant weight attached was used indicate the same difference in the resistance to fatigue of the gastrocnemius muscles of the two limbs.

In order to obviate the possible effect of changes in circulation through the muscle due to the interference with the innervation of the blood vessels in the limb on the side of the operation, experiments were made under otherwise similar conditions but with the common iliac arteries ligated. It is probably safe to assume that while no blood is flowing through the common iliac arteries no considerable changes in the volume of blood flowing through the gastrocnemius muscles could be brought about by reason of their activity or the stimulation of the sciatic nerves. Yet the curves of fatigue obtained immediately after ligation of the common iliac arteries as well as those obtained after these arteries had been ligated 15 to 20 minutes show differences in the resistance to fatigue of the gastrocnemius muscles comparable with the differences apparent in the curves obtained before the arteries were ligated.

The positive results obtained in this experimental study following unilateral extirpation of the lumbar sympathetic trunk are: (1) a degree of hypotonus of the muscles of the hind limb on the side of the operation which gradually subsides, (2) marked flaccidity of the muscles of this limb as compared with the muscles of the other hind limb while the animal is under surgical

anesthesia, even after the initial hypotonus of these muscles has apparently subsided, (3) decreased resistance to fatigue of the muscles of this limb, as illustrated by the curves of fatigue of the gastrocnemius muscles when the sciatic nerves are stimulated by means of a tetanizing current.

These results seem to justify the conclusion that the sympathetic innervation is a factor in the maintenance of the tonus of voluntary muscles, although this need not be apparent in the normal activities of the animal. The fact that voluntary muscles in which the sympathetic nerve-fibers have undergone degeneration are more flaccid than the corresponding muscles on the opposite side while the animal is under surgical anesthesia seems to indicate that the tonus of voluntary muscle which is maintained through its sympathetic innervation, like the tonus of involuntary muscle, is less completely eliminated by anesthesia than the tonus which is maintained through its somatic innervation. The decreased resistance to fatigue of the muscles of the hind limb following extirpation of the corresponding lumbar sympathetic trunk, which is more marked after the sympathetic fibers have undergone degeneration than immediately following the operation, as illustrated by the curves of fatigue of the gastrocnemius muscles obtained in the above experiments, seems to indicate that the sympathetic innervation is an important factor in sustaining the activity of voluntary muscles under conditions of stress and that this involves an outflow of nerve impulses directly from the sympathetic ganglion cells. Doubtless, the sympathetic ganglion cells constitute a source of nerve impulses which are also an important factor in maintaining the normal efficiency of voluntary muscles.

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Sex-reversal following ovariotomy in the fowl.

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It has been known for a considerable period of time that the female in many breeds of birds takes on certain male characters following the removal of the ovary, either by ovariotomy or