Physiology. — *"On muscle-tone", (abstract).* By Dr. J. W. LANGELAAN (Communicated by Prof. T. PLACE).

The researches of late years have revealed a great system of afferent nerve fibres, partly originating in the muscle itself, partly in its adjacent tissues. Now it is highly probable, that the afferent nerve fibres belonging to the muscle, come into relation with the motor nerve cells in the anterior horn of the same muscle and form in this manner a muscle-reflex are on which muscle tone depends.

To ascertain the extent of this tonicity, I chose the wellknown fact, that a normal muscle, the tendon of which is cut, undergoes abruptly a permanent shortening. This fact shows, that an elastic force resides in the tonic muscle. In order to determine this force, the distention of the muscle in rest was registered by means of a weight increasing with constant velocity. The muscle experimented on was the gastrocnemius of Rana esculenta, completely left in connection with its nerves and bloodvessels.

For the purpose of calculating the distensibility of the muscle from these tracings, the increase of length (Δ l) corresponding with a little augmentation of the charge (Δ p) was measured. The mean of two sets of measurements was taken as the amount of the distensibility at a certain moment, of which the differential coefficient $\left(\frac{dl}{dp}\right)$ is the symbol. This quotient, taken as measure of the muscle-tone, was therefore called the tonicity-quotient, and the tracings from which it was calculated named tonicity-curves.

From the experiments resulted, that, within the limits of the proof, succeeding increases of the charge forming terms of a geometrical progression, accorded with tonicity-quotients forming terms of an arithmetical progression; or formulated otherwise, that there existed a logarithmical relation between the value of the succeeding tonicity-quotients and the correspondent augmentations of the charge.

If the supposition made by FICK, HEIDENHAIN and afterwards by MOMMSEN, BENEDICENTI, GOWERS and SHERRINGTON is correct, that the terminations of the afferent nerve fibres in the muscle are stimulated by tension, it is evident that in my experiments the value of the distending weight must be a measure of this stimulus. Therefore if p be the amount of this weight $C_1 p$ must be the rate of stimulation, and the result consequent upon this excitement is the according value of the tonicity, symbolized by $C_2 \frac{dl}{dp}$. Applying, in this case,

the law of FECHNER we are lead to the following connection:

$$C_1 p = e^{C_2 \frac{dl}{dp}} \qquad e \text{ base of the Nep. log.}$$

By integration this equation leads to the connection:

$$l = A.\,p + B.\,p.\,\text{lgn. } p.,$$

$$A = \frac{\text{lgn. } C_1 - 1}{C_2}$$

$$B = \frac{1}{C_2}$$

where l denotes the increase of the length of the resting muscle and p the augmentation of the charge.

The three tables added show how far this formula agrees with the facts.

A = 0 00724 B = — 0.00080		
p.	l. meas.	l. calc
3.0c_1	0.013	0 017
6.2	0.030	(0.030)
12 6	0.060	0.057
25 4	0.102	(0.102)
33.5	0.121	0.129

A = 0.00925 B = — 0.00144		
p.	l. meas.	l calc.
3 0c_1	0.017	0.020
6.2	0.036	(0.036)
12.6	0 064	0.062
25.4	0 104	(0.104)
30.9	0.116	0.119

A = 0.00777 B = — 0.00103		
p.	l. meas.	l. calc.
3 0c_1	0.016	0.019
6.2	0 035	(0.035)
12.6	0.065	0.063
25.4	0.110	(0.110)
27.1	0.113	0.111

Division of the spinal cord at the level of the second vertebra, did not change these results in any way.

Severing the tibial nerve above the knee-joint, the muscle is divided from its reflex-centre, the afferent and efferent paths being interrupted. The section is succeeded, within thirty seconds, by an allongation of the muscle, varying in different experiments from 0.3 to 1 pCt.; the distention-curves show quite a different form and the distensibility is diminished.

The beginning of these distention-curves is a straight line corresponding with an increase of the weight not beyond 5.5—9 gram;

after a short part of transition, the distention-curve is represented by:

$$l = Ap + Bp^2$$

The tables added give an idea of the agreement.

A = 0.00441 B = — 0.00005		
p.	l. meas.	l. calc.
$5.45c_1$	0.0226	0.0229
6.45	0.0269	(0.0269)
7.45	0.0318	0.0306
12.1	0.0484	0.0468
13.1	0.0516	0 0500
14.1	0.0548	0.0531
25.4	0.0817	0.0807
26.4	0.0828	0.0825
27.1	0.0839	(0.0839)

A = 0.00633 B = — 0.000097		
p.	l. meas.	l. calc.
$6.0c_1$	0.0312	0 0313
7.0	0.0366	0.0368
11.0	0.0527	0.0531
12.0	0.0570	(0.0570)
13.0	0.0613	0.0608
17.0	0.0763	0.0735
18.0	0.0796	0.0771
19.0	0.0827	0.0798
23.0	0.0893	0.0894
24.0	0 0914	(0.0914)
25.0	0.0935	0.0933
30.0	0.105	0.100
31.8	0.107	0.102

A = 0.00499 B = — 0.00006		
p.	l. meas.	l. calc.
$7.9c_1$	0 0301	0.0323
8.9	0.0344	0.0359
9.9	0.0376	0.0363
15.0	0.0559	0.0561
16.0	0.0591	(0.0591)
17.0	0.0623	0.0621
23.0	0.0764	0.0773
24.0	0.0785	0.0795
25.0	0.0807	0.0816
32.1	0.0935	(0.0935)

From this it is clear, that the atonic muscle obeys the same empirical approximative formula of other elastic bodies.

In order to disturb only the afferent path, cocaine was injected into the spinal canal. The tracings obtained, all showed a rectilineal commencement, but this part of the curve never reached above a charge increase of 5.5 gram; for the further part it was found, that the variation of the distensibility grew slower than the increase of the charge, but faster than agreeable with a logarithmical relation.

To study the influence of the contraction of antagonistic muscles upon the tonicity of the agonists, I registered curves of the m. gastrocnemius, while during a certain interval of time the mm. tibialis anticus longus and peroneus were stimulated to a continuous contraction, by the current of a secondary coil. It was found, that the contraction of these praetibial muscles was succeeded by an

increase of tonicity of the m. gastrocnemius of about 25 pCt. According to the definition of muscle-tone here adopted, the m. gastrocnemius became more distensible and this fact was already seen by BELL and afterwards found again by SHERRINGTON.

The variation of the tonicity becomes discontinuous, when the muscle contracting under a little charge, retains a residual shortening. In this case the tonicity-curve is built up of straight lines, at the end of each of those a part of the shortening is given back, while at the same moment the tonicity varies. The number of rectilineal part of which the curve is constituted, is almost constant for the same muscle, varying for different individuals. The length of each of these parts is mostly variable, but under favourable circumstances it is possible to obtain tracings in which they are nearly equal. In other cases doubtless compensations are found.

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Physiology. — "*On the determination of sensory spinal skin-fields in healthy individuals*". By Dr. J. W. LANGELAAN (Communicated by Prof. C. WINKLER).

What we know about this subject in man, was mainly due to pathological cases, and the schemas of HEAD were the most complete we had. But the physiological experiments by SHERRINGTON on Macacus rhesus, carrying on the investigations of TÜRCK and many others, and the minute dissections of BOLK on man, have given, independently of each other, results so accordant, that we can believe this problem to be solved in great features. Therefore not to add new facts, but only to show how it is possible to determine these fields in normal persons, this paper is communicated.

It was found in a case of locomotor ataxy by my colleague BEYERMAN, that in pricking the skin with a pin, there were narrow hyperalgetic bands, which closely seemed to follow the skin-field borders. I saw the same fact in another case of tabes and we interpreted them as the fields of overlap.

In order to research if these fields could be determined in a healthy person, I chose intelligent individuals, who could fix their attention for some time. I began to prick over the skin of the limb first crossing the mid-ventral line, great care being taken to prick in equal distances, with the same force and with equal intervals of time. Approaching the mid-line they all accuse a quickly increasing sensation of pain. Now I claimed them to note the just perceptible