The real values can then be about 6% *smaller* than those calculated in table IV. The calculated values are of the expected order of magnitude, and change little with the temperature.

TABLE IV.

T	D	$\zeta \cdot 10^5$	$a \cdot 10^8$
0	0.22^6	1797	4.2
23.2	0.52^4	935	3.8
32.9	0.64^9	755	3 9
43.4	0.84^1	618	3 8
52.3	0.98^7	531	3.9
62.0	1.16^8	459	3.9
70.2	1.35^2	406	3.9

In the calculation of the radius use has been made of the determinations of the internal friction of BINGHAM and WHITE [1]) and of the N-value of MILLIKAN [2]).

In a following paper we shall communicate the results of a series of experiments, which enable us to determine the value of the radius by another way.

The diffusion experiments will be continued with other substances.

Physiology. — *"The movements of the heart and the pulmonary respiration with spiders"* [3]). By Dr. V. WILLEM (Ghent). (Communicated by Prof. VAN RIJNBERK).

(Communicated in the meeting of May 27, 1916).

We do not know anything about the respiratory movements with spiders. The only modern investigator who has tried to find them experimentally, was F. PLATEAU, he applied in vain to Arachnida the artificial methods that had succeeded with insects; not a single method of investigation made him find the slightest change of the shape of the body that could be attributed to inhalation or exha-

1) BINGHAM and WHITE. Zeitschr. f. physik. Chemie **80** 684 (1912).

2) l. c.

3) According to investigations made in the Physiological Laboratory of the University of Amsterdam.

lation [1]). It seems that this failure of so dexterous and careful an investigator, as F. PLATEAU was, has detained naturalists from making any new experiment, to my knowledge there does not exist in literature a communication about the respiratory movements with spiders. Anatomists have of course pronounced various hypotheses, but there is no necessity of discussing these here.

PLATEAU had discovered with certain spiders, the enlarged images of which he projected on a screen, very slight oscillatorical movements of the palps and the abdomen, but he did not deem them of any interest. I intend to explain in the first place the signification of these rythmical movements.

If we examine an *Epeira* that has previously been fastened at the thorax, under the microscope, we observe the following phenomena, the posterior point of the abdomen moves upward and downward with a rhythm of 130 movements a minute: they are slight oscillations which, though showing some diversity, are never smaller than $^1/_{50}$ millimeter. The entire abdomen takes part in this movement which forms in reality an oscillation round the peduncle of the abdomen.

The palps oscillate likewise in the same rhythm, and even every foot, in so far as its point stands free. the angles formed by two successive segments become alternately larger and smaller, and so the point moves, as if it beat the time of the rhythm.

One tries immediately to find the explanation of such phenomena in quick variations of the pressure of the blood, which would correspond with the systoles of the heart. The heart lies under opaque tissues; but we find on the feet some spots, the teguments of which are sufficiently transparent to enable us to observe through them the circulation of the blood; we perceive in the superficial parts of the organ, between the muscles, ramifications of the centripetal current, in which the blood-corpuscles push onward by saccades that are isochronal with the examined rhythm.

The contemplation of the structure of the blood-system (fig. 1) explains the cause of the phenomena we observed, and chiefly of the downward movement of the abdomen, when the heart contracts. I find two factors for it: 1. the tension of the curved aorta under the influence of the increased interior pressure; 2. another depending upon the pericardial cavity. during the systole of the heart the pressure of the blood in this cavity decreases, and consequently this curved tube assumes a greater curve.

1) F PLATEAU. De l'absence de mouvements respiratoires perceptibles chez les Arachnides. Archives de biologie T. VII, 1887.

These two factors operate together on the parietes of the abdomen by means of the ligaments, and compel the abdomen to go downward; in my opinion the directions of the ligaments even indicate the lines along which the different partitions of the central blood-organ operate upon the teguments.

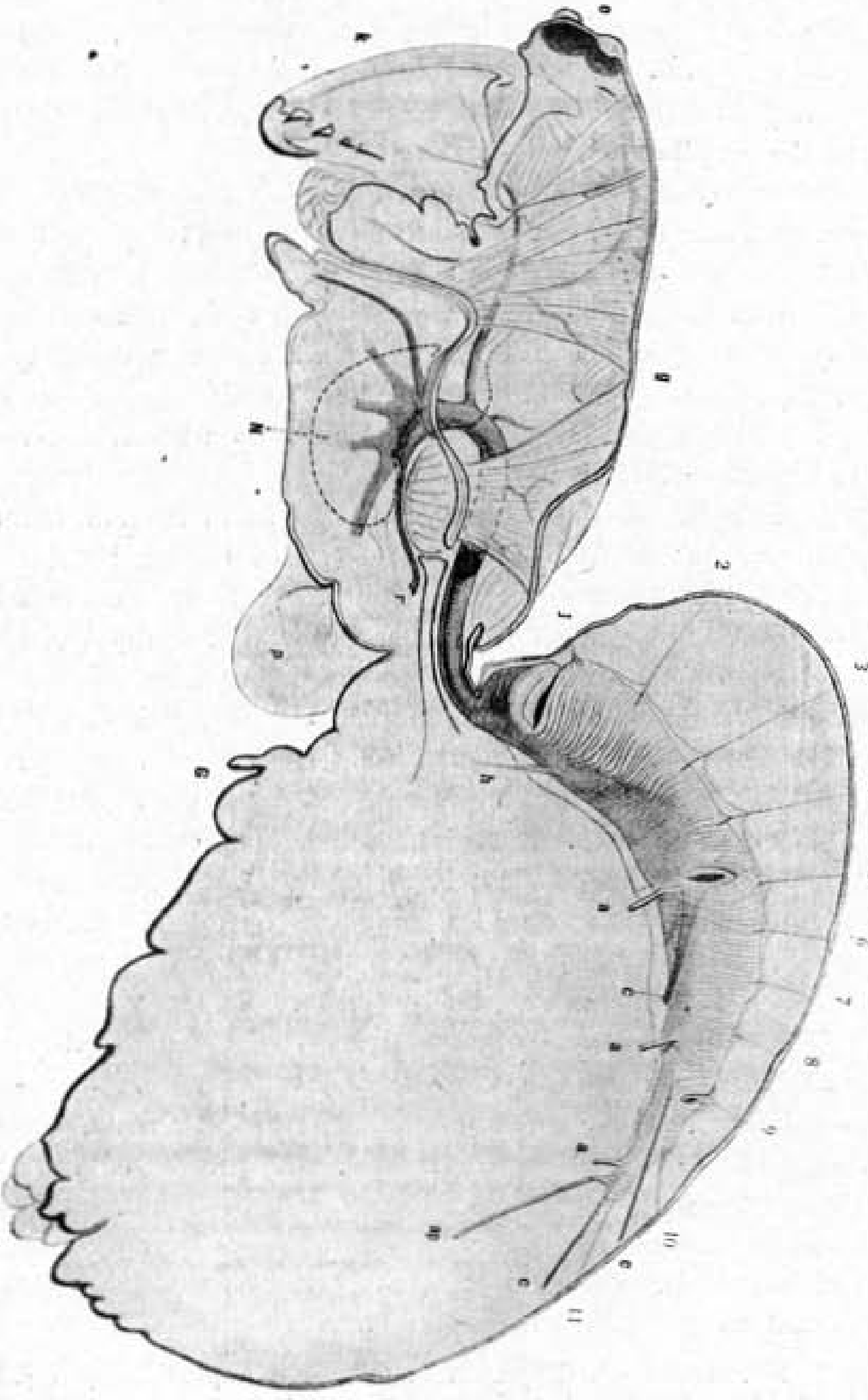

Fig. 1. *Epeira diadema.* On a sagittal section are represented inter alia: the heart and the pericardial space, the ramifications of the aorta into the cephalothorax, the three pair of abdominal arteries (*a*) and the posterior artery (*ap*), the "ligaments épicardiques" (1—11), some "ligaments commissuraux" (*c*) and "ligaments hypocardiques" (*h*).

But the movements of the abdomen that accompany the systole of the heart, are more complicated.

1. A group of hairs on the central part of the back do not change place parallelly, as would be the case, if they simply took part in the general rotation of the abdomen; they make a rhythmical oscillating movement, which can only be the result of a special deformation of the field, on which they have been infixed. This deformation consists in a rhythmical descent of the part we had in view, corresponding with the descent of the entire abdomen. It is caused by a tension in the ligaments épicardiques (especially 3 to 9) which accompanies the systole of the most active part of the heart.

2. The region of the median dorsal line, lying quite frontal, just over the peduncle, is pushed forward about $\frac{1}{120}$ millimeter in a frontal direction at the beginning of every pulsation (when the abdomen descends): at the beginning of the general contraction of the heart-tube the motion of the blood causes there a tumefaction of the vessel of short duration.

3. The exterior wall of the lungs shows likewise very slight oscillations and descends to the interior at every systole : a phenomenon indicating a decrease of the pressure of the blood under this region.

This leads us to the study of the influence of the systoles of the heart on the contents of the lungs. I have been able to make a special study of this subject with another species of spider possessing transparent teguments, allowing us distinctly to observe some movements of the interior organs.

With *Pholcus phalangioïdes* one observes similar movements and variations of the shape of the abdomen as with *Epeira*, but these are still more complicated, because the teguments are more flexible, and correspond more to the local variations of the interior pressure; yet, I shall for the present moment not describe them more accurately.

A direct observation convinces us that the contraction of the heart causes a diminution of the pressure of the blood in the pericardial cavity and in the pulmonary vein: the laps of the "liver" surrounding these blood-cavities are seen to move inwardly at every systole, and the more violently as the examined point lies nearer to the most active part of the heart.

The same phenomenon shows likewise a similar diminution of the pressure in the large blood-lacune in which the heart lies; consequently there exists a suction of the blood from the peripulmonary lacuna to the pulmonary vein, and likewise, which is of importance for the respiration, from the lacunes of the lamellas of the lung; a sufficient illumination allows us even to see, that, when a systole takes place, the blood-corpuscles suddenly remove themselves from these lamellas. In consequence of this suction the thickness of the lamellas decreases, and the complex of the lamellas is seen to be

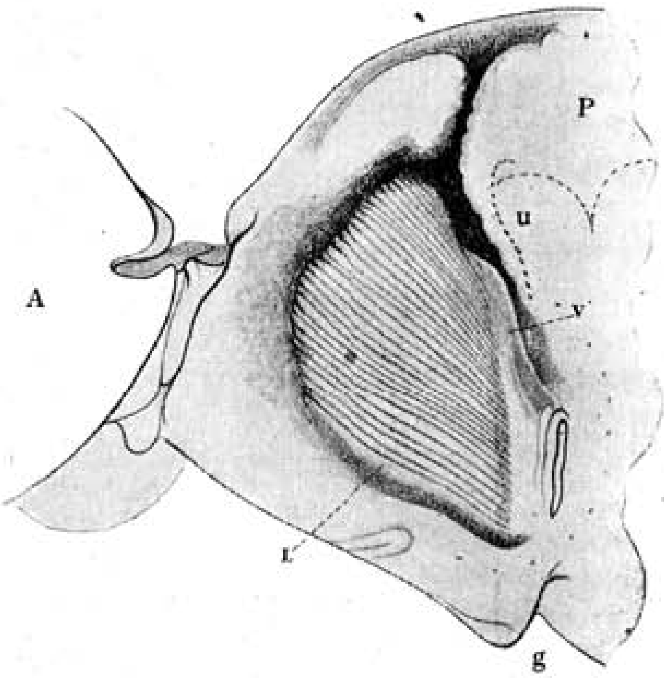

Fig. 2. *Pholcus phalangioïdes.* The left lung and the surrounding region seen from aside; one sees through the teguments the lung, the peripulminary blood-lacune, the pulmonary vein (*u*). *P*, pericardial space; *c.*, superior wall of the vestibulum of the lung; *L*, inferior lamella of the lung; *g*, genital opening ♂; *A*, posterior part of the cephalothorax.

compressed (over about $^1/_{25}$ of its thickness) at every systole; as by their elasticity the lamellas resume their former volume at the end of the systole, the white mass seems to move like an accordion one side-wall of which would be fastened.

So we understand the circulation of the blood in the lungs; it is not a consequence of a general contraction of the pillar-cells, to which, with Mac Leod, one was inclined to attribute a contractility of their own, but it is a passive consequence of the systole of the heart and the elasticity of the components.

Inhalation and exhalation can be explained in the same way from these phenomena. The blood-pressure of the peripulmonary lacuna which always surpasses the atmospheric pressure, keeps the air-cavities of the lungs and the cuticular products of the lamellas and of the vestibulum compressed. Through the variations of this pressure, caused by the palpitations of the heart, the air-cavities become alternately smaller and larger; consequently the elasticity of the cutilar products of the lamellas is the intermediate factor of the movements of the air in the lungs.

I must however still add that in special circumstances some more important movements of inhalation and exhalation can be observed, which are brought about by the operations of muscles of the body and of a special muscle of the vestibulum. I intend to discuss these in a subsequent communication.

Physiology. — *"On the nature and progress of visual fatigue".* By Dr. A. A. GRÜNBAUM (Odessa). (Communicated by Prof. G. VAN RIJNBERK) [1]).

(Communicated in the meeting of May 27, 1916).

The problem of visual fatigue has, in contrast with cognate problems as those of light- and darkness-adaptation hardly been broached from an experimental side.

The widely spread, purely theoretical views have from one side contributed to this fact, according to which the self-regulation of optically sensitive substances leads to a practical indefatigability. (HERING). On the other hand the traditional postulate, according to which the application of very strong optical stimuli in itself lies already beyond the physiologic limits of the pathological domain, plays an important part in the neglect of our problem.

Notwithstanding this I have only been conducted by purely experimental requirements and consequently selected strong stimuli, causing a positive fatigue. A 400 N. K.-lamp e.g., tempered by a milk-glass and placed at a distance of 1.25 m. from the experimental person, forms such a stimulus.

I have studied the progress of the fatigue caused by this light-stimulus by availing myself of the already often investigated phenomena of "flickering".

When we cause a light-stimulus to influence, intermittingly with a dark pause, on the eye, we can at a definite frequency of the succeeding stimuli no longer distinguish them; the impressions fuse, and from the flickering light the impression of a relatively quiet light is experienced.

The number of light stimuli (and consequently likewise that of

1) The results recorded here form part of a series of experiments made in the years 1914—16 in the Physiological Laboratory of the University of Amsterdam, serving to obtain the venia legendi in experimental psychology at the Medical Faculty there.