

*Citation:*

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$F$ ). When we put in (8) and (9)  $y = 3$ , then it follows:

$$\frac{1}{RT} \cdot \left( \frac{dP}{dx} \right)_{x=0} = \frac{1}{V-v} \text{ and } \frac{1}{RT^2} \cdot \left( \frac{dP}{dx} \right)_{x=0} = - \frac{1}{\Delta W}. \quad (17)$$

Herein  $V-v$  is the increase of volume on melting,  $\Delta W$  the heat of melting of the substance  $F$ .  $V-v$  can be as well positive as negative,  $\Delta W$  is always positive. From (17) it now follows that:

when the equilibrium  $F + L + G$  is situated in the minimum-meltingpoint of the substance  $F$ , addition of a third substance will increase the pressure ( $T$  constant), when the substance melts with increase of volume ( $V > v$ ) and decrease when the substance melts with decrease of volume ( $V < v$ ). The temperature ( $P$  constant) is lowered.

We may express the above-stated also in the following way:

from  $F$  the pressure increases along the vapoursaturationcurve under its own vapour-pressure going through  $F$  and the temperature decreases along the boilingpointcurve going through  $F$ .

From  $F$  the pressure increases along the saturationcurve under its own vapourpressure going through  $F$ , when  $F$  melts with increase of volume and the pressure decreases when  $F$  melts with decrease of volume. Along the boilingpointcurve going through  $F$  the pressure decreases from  $F$ .

Also we should be able to examine what influence has a third substance on the binary equilibrium  $F + L + G$ , when this is situated in the point of maximum temperature (point  $H$  in figs. 5 and 6) or in the point of maximum pressure of its  $P, T$ -curve. We refer to this later.

*(To be continued).*

**Physiology.** — “*The effect of subcutaneous turpentine-injections on the chemotaxis of remote places.*” By Prof. H. J. HAMBURGER.  
After experiments by Dr. J. BUITENHUIS.

(Communicated in the meeting of November 29, 1913).

On a former occasion the attention was drawn to the favourable effect of slight amounts of turpentine on the rapidity of phagocytosis.<sup>1)</sup> In a dilution of 1 : 100.000 an increase was found of 24.7 % and even in a dilution of 1 : 500.000 an increase of 16 %.

<sup>1)</sup> HAMBURGER, DE HAAN and BUBANOVIC: On the effect of Chloroform, Iodoform and other substances dissoluble in fat, on Phagocytosis. Proceedings of the Meeting of Jan. 28, 1911, p. 913.

Elsewhere<sup>1)</sup> we have pointed out that the result agrees with a great number of clinical experiences. The gynaecologist FOCHIER at Lyons for example has successfully applied turpentine in the treatment of puerperal fever. For this purpose he injects turpentine under the skin which gives rise to an abscess in this place and the fever soon disappears.

FOCHIER thinks that the abscess attracts the noxious substances which cause the fever, thus rendering them inactive. He speaks of an "Abscès de fixation".

In veterinary circles this treatment has caused much enthusiasm. The pneumonia (crupposa) of horses is at present chiefly and successfully treated with turpentine-injections. In the veterinary School at Utrecht for instance J. J. WESTER adopted this method with excellent results.

He justly doubts, however, whether we are right in assuming "abscès de fixation". No plausible reasons can be adduced for this hypothesis. Therefore he is more inclined to attribute this favourable result to an improved action of the heart.

It seems not impossible to me that this factor has to be reckoned with. But it is certainly not the only one; for in Denmark the same treatment is successfully applied to chronic mastitis of the cow. A better action of the heart, such as is often necessary in pneumonia, would be of no avail here.

*Therefore we have asked ourselves if this favourable effect of turpentine may not be explained by assuming that this substance enters the circulation from the place of injection as a weak solution, stimulating the phagocytosis also in the hearths of the disease, and would assist the curative process.*

From a technical point of view, however, it is very difficult to investigate the degree of phagocytosis in an inflamed centre and to determine thus whether the activity of the phagocytes has increased.

*This seemed possible, however, by chemotactical experiments.*

For this purpose, just as in the case of Calcium, two methods were adopted<sup>2)</sup>.

The first method consisted in capillary tubes, filled with an extract of coli bacteria, being placed under the skin of one of the hind

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<sup>1)</sup> HAMBURGER: Physikalisch-chemische Untersuchungen über Phagozyten. Bedeutung vom allgemein biologischen und pathologischen Gesichtspunkt. Leipzig, J. F. BERGMANN, 1912, p. 159.

<sup>2)</sup> Cf. HAMBURGER. The effect of slight quantities of Calcium on the motility of the phagocytes. Proceedings of the Meeting of May 28, 1910.

of a rabbit at the inside of the thigh. These extracts also contained traces of turpentine.

Similar tubes were placed at the other hind leg with the same contents, but without turpentine.

After 20 hours the leucocyte columns, which owing to chemotaxis had entered the tubes, were measured. This rendered it possible to establish if, and if so, to what extent, turpentine had promoted chemotaxis and stimulated the phagocytes.

The second method consisted in 0.3 cc. of turpentine being injected under the breast skin of some rabbits; it was then determined if a greater amount of leucocytes had entered the capillary tubes with coli-extract, than if the same rabbits had been injected with 0.3 cc. of NaCl-solution instead of 0.3 cc. of turpentine.

Before stating the results obtained on the effect of turpentine we shall communicate a series of experiments which were made to ascertain the degree of accuracy of the method. In four rabbits capillary tubes are placed right and left under the skin of the leg. These tubes are filled with the same extract of coli-bacteria in NaCl 0.9 %.

The following table will require no further explanation.

T A B L E I.  
Effect of extract of Coli-bacteria on chemotaxis.

		Left leg: Extract of Colibac- teria in 0.9% NaCl	Right leg. Extract of Colibac- teria in 0.9% NaCl	
Rabbit 1	Total of 4 leucocyte- columns after 2 hours	4.1 mm	4.5 mm	+ 0.4
" 2	"	6.3 "	5.5 "	- 0.8
" 3	"	5.6 "	5.5 "	- 0.1
" 4	"	5.6 "	5.2 "	- 0.4

This table shows that the greatest deviation amounts to 0.8, whilst the deviation in all 4 rabbits together only comes to 0.9 mm.

*First method.*

Under these circumstances it could be established now, to what extent an addition of turpentine to an extract of B. Coli in NaCl-solution would affect the degree of chemotaxis. <sup>1)</sup>

<sup>1)</sup> The technical details were about the same as those we described in VIRCHOW'S Archiv B. CLVI p. 329, 1899 and in "Physik. Chemische Untersuchungen über Phagozyten". BERGMANN 1912. p. 94 foll. Only instead of cork paraffin was used to keep the capillary tubes in their places.

For this purpose we used capillary tubes with extract of bacteria-coli in NaCl 0,9 %, in which 1 : 100.000 turpentine had been dissolved.

In each rabbit 4 capillary tubes with and 4 without turpentine were placed on one side under the skin of the leg. After 20 hours they were taken away, and the lengths of the leucocyte-columns were measured.

Table II gives the results of this experiment.

T A B L E II.  
Effect of extract of Coli-bacteria on chemotaxis.

		Left leg. Coli-bacteria extract in 0.9% NaCl	Right leg. Coli-bacteria extract in 0.9% NaCl + 1:100.000 turpentine	
Rabbit 5	Total of 4 leucocyte-columns after 20 hours	4.8 mm	4.6 mm	- 0.2
" 6	"	3.2 "	4.8 "	+ 1.6
" 7	"	4.— "	5.1 "	+ 1.1
" 8	"	4.8 "	6.4 "	+ 1.6
" 9	"	4.1 "	5.2 "	+ 1.1
" 10	"	6.9 "	7.1 "	+ 0.2
" 11	"	2.2 "	3.1 "	+ 0.9

In 6 of the 7 cases, therefore, the turpentine in a concentration of 1 : 100.000 has stimulated the chemotaxis.

In order to investigate if rabbit 5 made an exception to the rule, or if a mistake had been made in the experiment, the experiment was repeated with the same rabbit in the same places. It was found then that the values became 5,1 and 6.8 respectively. In this case too an increased chemotaxis has, therefore, been established.

We subjoin an experiment with a weaker turpentine-solution viz. with turpentine 1 : 500.000. Cf. table III.

*These results show that an addition of turpentine 1 : 500.000 has had a much more favourable effect still on the chemotaxis than turpentine 1 : 100.000.*

Elsewhere<sup>1)</sup> a more detailed account of the experiments will be published.

<sup>1)</sup> In the dissertation (Bern) of Mr. J. BUITENHUIS.

T A B L E III.

Effect of coli-bacteria-extract on chemotaxis.

		Left leg. Extract of coli-bacteria in 0.9% NaCl	Right leg. Extract of coli-bacteria in 0.9% NaCl +1:500.000 turpentine	
Rabbit 12	Total of leucocyte- columns after 20 hrs	4.9 mm	6.4 mm	+ 1.5
" 13	"	4.5 "	7 "	+ 2.5
" 14	"	4.2 "	5.8 "	+ 1.6
" 15	"	3.6 "	5.4 "	+ 1.8
" 16	"	4.4 "	4.8 "	+ 0.4
" 17	"	6.1 "	8.1 "	+ 2
" 18	"	6.2 "	7.4 "	+ 1.2

*Second method.*

As we observed before, the second method of investigation consisted in turpentine being injected subcutaneously in the lower chest to enable it to spread through the body with the blood, thus entering also into the lymph of the hind leg, where tubes with extracts of bacteria in NaCl 0.9% had been placed. The experiment showed that turpentine entered the system but slowly. For when after 7 days the injectionplace was opened, the mucous mass which came out still strongly smelled of turpentine. Turpentine, indeed, does not dissolve readily in watery fluids.

Since in different rabbits the chemotactical action is not the same, the columns of each rabbit were measured without anything being injected. When this had been determined half the rabbits were injected under the breast with 0.3 ccm. of turpentine and the other half, as a test, with 0.3 ccm. of NaCl-solution 0.9%.

Five or six hours after injection the capillary tubes were placed under the skin and they were removed after 20 hours. The following table gives a survey of the results obtained.

Now if we compare the total of the differences of 2, 4, 6, 8 and 10 which comes to + 6.1 mm. with the total of the differences of 1, 3, 5, 7 and 9, which amounts to — 0.1, then it appears that the subcutaneous injection of turpentine has evidently stimulated the chemotaxis.

It must therefore be concluded that, in accordance with our hypo-

T A B L E IV.

Effect of the subcutaneous injection of turpentine on chemotaxis.

	Length of 4 leucocytecolumns		
	Left leg. Before the injection of NaCl or of turpentine	Right leg. After the injection of 0.3 cc. of turpentine or NaCl 0.9%	Difference
Rabbit 1	6.6 mm	Turpentine 7.4 "	+ 1.8 (Turpent.)
" 2	6.6 "	NaCl 5.7 "	- 0.9 (NaCl)
" 3	6.3 "	NaCl 5.9 "	- 0.4 (NaCl)
" 4	5.8 "	Turpentine 5.8 "	0 (Turpent.)
" 5	4.8 "	NaCl 5.5 "	+ 0.7 (NaCl)
" 6	6 "	Turpentine 7.2 "	+ 1.2 (Turpent.)
" 7	5.1 "	NaCl 6.4 "	+ 1.3 (NaCl)
" 8	4.4 "	Turpentine 7.1 "	+ 2.7 (Turpent.)
" 9	4.9 "	NaCl 4.3 "	- 0.6 (NaCl)
" 10	5.8 "	Turpentine 6.2 mm	+ 0.4 (Turpent.)

thesis, turpentine has gradually been removed from the place of injection to different parts of the body, also to the blood-vessels of the leg where turpentine was imparted to the lymph, which had a favourable effect on the chemotaxis.

*Repeated injection of turpentine in diluted solution.*

If this view was correct then it might be expected that an injection of turpentine in a diluted solution, if repeated a few times, would likewise effect an increased chemotaxis.

This would, moreover, prove that the salutary therapeutic effect of the turpentine would be entirely independent of the notion "abcès de fixation". At the same time this might lead to the application of turpentine in human pathology being resorted to more frequently, for in spite of the success obtained by FOCHIER and others after him, it is a wellknown fact that the subcutaneous injection is, if possible, avoided because the sterile abscess, caused by it, is so extremely painful. Indeed when we see how, after the abscess has existed for some days, the mass taken out, which still smells of turpentine, is

a mucous one, it becomes evident what destruction the turpentine has caused there.

We investigated therefore whether the chemotaxis could not likewise be stimulated by injecting subcutaneously a solution of turpentine in NaCl 0.9 % in a concentration of 1 : 10.000, instead of pure turpentine.

Provisional experiments have indeed shown that this has a favourable effect on chemotaxis. It was not considerable however.

Probably this must be attributed to the ineffective manner in which the experiments were carried out. In the first place too little was injected viz. only 5 times 5 cc. of a turpentine solution of 1 : 10.000, which means only a total amount of 0.0025 cc. of turpentine. But especially too much time elapsed between the injections so that the turpentine injected, had ample opportunity to be secreted in large quantities by the kidneys, whilst the method of injection adopted by FOCHIER creates a reserve of turpentine, from whence turpentine is continually yielded to the circulation.

In subsequent experiments, which, owing to lack of time, could not be carried out as yet, the above-mentioned consideration will be taken into account.

As the technical difficulties attending turpentine-injections are being removed, it will be possible to make use of these injections much more frequently in human pathology ; meanwhile it may now be concluded already from the foregoing experiments that turpentine also stimulates chemotaxis in remote places. Further we may infer from the greater mobility of the phagocytes, which is indeed also the foundation of an increased chemotaxis, that in those places the phagocytosis will be stimulated likewise.

Groningen, November 1913.

*Physiological Laboratory.*

**Botany.** — “*Adjustment to light in oats*” By W. H. ARISZ. (Communicated by Prof. WENT).

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#### § 1. *Introduction.*

In this preliminary communication there will be considered a number of phenomena which are generally grouped as adjustment phenomena (German: “*Stimmung*”). By functional adjustment is usually meant the state of an organ which determines the effect with which the latter reacts to a stimulus of a certain strength.