Physiology. — *"On the relation between the electrical phenomenon in cloudlike condensed odorous water vapours and smell-intensity"*. Bij H. ZWAARDEMAKER and H. ZEEHUISEN.

(Communicated in the meeting of May 31, 1919).

In earlier publications [1]) we set forth that all true odorous substances, a large number of saponins and antipyretica possess the property of imparting an electrical charge. This phenomenon manifests itself most distinctly with the first group, less distinctly with the second, and again less with antipyretica. However, the result is largely dependent on the solubility in water of the individual substances, as it can be of some significance only when, at the spraying, an adequate number of dissolved molecules are present in the water. Suspended particles are of themselves of no value for the phenomenon. Before proceeding we wish to call attention to a fourth group to be discussed later on, viz. the alkaloids. The phenomenon appears with many of them, but their solubility being very slight, it cannot reach a high degree of intensity. To give an idea of the great differences among the four groups, we observe that on comparison, e.g. of the charge of a saturated camphor-solution with that of a saturated quinine-solution, the former appears to be at least twice as strong as the latter. It follows then that among the organic substances of physiological activity the electrifying power is always highest in the odorous substances, so that they are most appropriate for the study of the phenomenon.

It has been established before, that in homologous series the intensities of electrifying power and olfactory capacity rise and fall concomitantly. In order to ascertain the relations of these intensities for odorous substances we selected at random 26 of them, distributed over various groups and series and we diluted their aqueous solution to such a degree that on spraying they yielded only inappreciable electrical phenomena (with an electroscope of moderate sensitiveness [2]) a deflection of from 0.1 to 0.2 scale-marks). When

[1]) K. Akad. v. Wetensch. Amst. 25 Maart 1916, 27 Mei 1916, 30 Sept. 1916, 23 Febr. 1918, 29 Juni 1918. Arch. neérl. de physiol. T. 1, p. 347; Nederl. Tijdschr. v. Geneesk. 1918 II 980—982.

[2]) A tension of 220 vlts made the instrument deflect 10 scalemarks. (It had a capacity of ± 50 Electrostat.-units).

examined in a simple olfactometer these solutions yielded a very weak sensation of smell, which could readily be determined by the length to which the olfactometrical cylinder had to be moved out, in order to procure a minimum perceptibile.

Table I*a* shows the olfaction-values of the solutions when we try to find the "Reizschwelle". Table I*b* gives of the same substances the lengths to which the cylinder has to be moved out when we search for the "Erkenntnisschwelle".

TABLE 1*a*.

The odorous substances arranged in the order of the smell-intensity of solutions yielding an approximately equal, extremely weak electrical charge (0,1—0,2 scale-marks).

Substances (arranged in ascending order of smell-intensity).	"Reizschwelle" in centims to which the cylinder is moved out.
Caproic acid	5
Artificial moschus	1
Valerianic acid	1
Amylalcohol	1
Cumidin	1
Allylalcohol	1
Iso-amylacetate	0.5
Terpineol	0.5
Skatol	0.5
Indol	0.5
Pseudocumol	0.3
Xylol	0.3
o. Toluidin	0.2
Anilin	0.2
p. Xylenol	0.1
m. Xylidin	0.1
m. Toluidin	0.1
Thymol	0.1
Benzol	0.1
Toluol	0.1
Naphthalin	0.1
m. Xylenol	0.1
Guaiacol	0.1
Nitrobenzol	0.1
Pyridin	0.1
Vanillin	0.05
Average	0.54 c.m.

TABLE 1*b*.

The odorous substances arranged according to the "Erkenntnisschwelle" in solutions yielding an approximately equal, extremely weak electrical charge.

Substances arranged in ascending order of smell-intensity.	»Erkenntnis-schwelle" in centims to which the cylinder is moved out.
Caproic acid	9
Artificial moschus	8
Valerianic acid	5
Amylalcohol	5
Cumidin	5
p. Xylenol	5
Allylalcohol	3
m Xylidin	2.5
o. Toluidin	1.5
p. Toluidin	1.5
Iso-amylacetate	1.3
Terpineol	1
Skatol	1
Pseudocumol	1
Anilin	1
Thymol	1
Benzol	1
Toluol	1
Xylol	0.6
Indol	0.5
Naphthalin	0.5
m. Xylenol	0.4
Guaiacol	0.1
Nitrobenzol	0.1
Pyridin	0.1
Vanillin	0.1
Average	2.16 c.m.

In the latter case, it is true, the values are based upon the intensity of the sensation, however the psychological consciousness of the quality had been previously established.

As will be seen, the average olfaction-value of our 26 substances in a dilution with which the electrifying power is next to imperceptible, is 0.54 cm (determined after the minimum perceptibile without quality). The deviations vary within the tenfold of the mean values.

Apparently the liminal perceptibility of smell-capacity, concurs approximately with that of electrifying power. There is, indeed, a certain latitude of variation in the olfaction-values, while the electrifying power is considered the same for all, though probably it is not quite the same, because it is difficult to distinguish differences of subdivisious of one tenth of a scalemark.

One of us surmises that both the intensity of the smell and that of the electrical phenomenon depend in a more or less complicate way on

a. the volatility of the substances

TABLE II*a*.

Arrangement of 26 odorous substances (in the stalagmometer) in a solution yielding a just noticeable electrical charge. (at 15° C.).

Water	49.3
Naphthalin	49.3
Artificial moschus	49.6
Caproic acid	49.8
Anilin	50
Indol	50
Nitrobenzol	50
p. Xylenol	50
p. Toluidin	50
Guaiacol	50
Thymol	50.1
Allylalcohol	50.2
Toluol	50.2
Pseudocumol	50.5
Amylalcohol	50.5
m. Xylidin	50.5
m. Xylenol	50.6
Benzol	50.8
Vanillin	51
Valerianic acid	51
Terpineol	51.2
o. Toluidin	52
Skatol	52.2
Cumidin	52.2
Iso-amylacetate	52.5
Pyridin	54
Xylol	55
Average	$50.9 \left(\frac{1323.2}{26}\right)$

TABLE II*b*.

26 odorous substances arranged according to their boiling point.

Water	100°
Benzol	80°
Allylalcohol	97°
Toluol	111°
Iso-amylacetate	116°
Amylalcohol	116.3
Pyridin	116.7
Xylol	142°
Caproic acid	155°
Pseudocumol	169.8
Anilin	182.5
Valerianic acid	184
o. Toluidin	199.7
p. Toluidin	200.4
Nitrobenzol	205
Guaiacol	205.1
Terpineol	218
Naphthalin	218.2
p. Xylenol	220
m. Xylenol	225
m. Xylidin	226
Thymol	231.8
Cumidin	235°
Indol	253
Skatol	265
Vanillin	sublimes
Artificial moschus	??

b. the lowering of the surface-tension of water, which they bring about.

In view of this supposition it avails to know the boiling point of the odorous substances as well as the number of droplets of the diluted aqueous solutions. The subjoined tables (II*a* and II*b*) give us these data. They do not warrant the adoption of an immediate connection, though we may conclude from them that there is a more remote relation [1]).

The sign of the charge may also be of some influence. Whereas for 24 out of 26 substances examined in widely different concentrations, we invariably found a positive charge, which eventually disappears with progressing dilutions, a negative charge is yielded by caproic acid and valerianic acid in highly diluted solution (positive in somewhat concentrated solutions). In the extremest dilution, in which this negative charge is just noticeable, the smell-intensity of these substances, when compared with the average of our substances, appears to be very slight.

Whether the charge increases or not, or whether it decreases, through the addition of some common salt to the solution [2]), does not seem to interfere with the relative arrangement of our 26 substances. With all of them we observe an increase of the electrifying power, with the exception of naphtalin, indol and skatol, whose insignificant charge seems to remain constant, and of artificial moschus, pseudocumol, p. xylenol and thymol, whose charges are obviously getting weaker.

We conclude, therefore, merely from the facts, without attempting to find an explanation, that also of odorous substances, chosen at random, in approximately similar dilution, the smell-intensity and the electrifying power have reached their limen of perceptibility.

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[1]) Order of the number of droplets of the saturated solution:

Naphthalin 49.3, Artificial moschus 49.6, Toluol 50.3, Pseudocumol 50.5, Benzol 50.75, Allylalcohol (1.500)51, Vanilline 51, Indol 51.5, Skatol 52.2, Xylol 55, Nitrobenzol 55.5, Pyridin (1 %)-57.25, Cumidin 66.75, p. Xylenol 68.5, Anilin 69, p. Toluidin 69, Thymol 73, o. Toluidin 75.5, n. Xylidin 77, m. Xylenol 84, Caproic acid 84.5, Guaiacol 85, Terpineol 90.5, Valerianic acid 106, Isoamylacetate 115, Amylalcohol 131.

[2]) E. L. Backman, Researches Physiol Lab. Utrecht (5). Vol. 18, p. 349; 19, p. 210.