Physiology. — *"On Smelling during complete Exhaustion (resp. adaptation) for a given odour."* By K. KOMURO (Nagasaki). (Communicated by Prof. H. ZWAARDEMAKER.)

(Communicated at the meeting of March 26, 1921).

A rather considerable number of qualities (so-called specific energies) is to be distinguished in the sense of smell. This is borne out by exhaustion-experiments performed long ago by FRÖHLICH, ARONSOHN, ZWAARDEMAKER, HERMANIDES.

FRÖHLICH [1]) first fatigued his olfactory organ by a given odorous substance and then tried to find out whether this organ was still sensitive to other smells. In his discourse he wrote: "Wenn z. B. Valeriana Celtica gerochen wurde, so wurde darauf der so nahe stehende Geruch von Patchouli nicht wahrgenommen; wohl aber erregte Valeriana nach Patchouli noch einen sehr lebhaften Eindruck."

ARONSOHN [2]) has made a more careful study of the subject. He used some phials filled with different odorous substances. He kept smelling at them until his sense-organ had absolutely been blunted for the scent. Then he took another phial and tried to smell its odour, if possible, and he determined its intensity.

By their intensity he groups the odorous substances into three classes, viz. 1°. those of insistent intensity; 2°. those of decreased intensity, and 3°. those that become inodorous. When e.g. his sense-organ was exhausted for the tincture of iodine, it was still fully sensitive to the stimulus of ethereal oils and also ether; only faintly so to that of oil of citron, of sage, of nutmeg-blossom, of turpentine, of bergamot and of cloves. Nothing was smelled, however, of balsam of copaiba and of spiritus. Some more exhaustion-experiments were made for sulphammonium, camhpor and oleum juniperi. He describes his result as follows: "Verschiedene Geruchsqualitäten afficiren verschiedene Bezirke der Geruchsnerven derart, dass eine Classe von Riechstoffen einen Bezirk maximal erregt, einen zweiten Bezirk in niederen Grade, einen dritten gar nicht erregt."

Similar experiments have been performed by ZWAARDEMAKER [3]) in

[1]) FRÖHLICH, E. Sitzungsber. d. Kaiserl. Akad. d. Wissensch. Wien. Bd. VI. S. 322.

[2]) ARONSOHN, E. Archiv. f. Anat. u. Physiol. 1886. S. 361.

[3]) ZWAARDEMAKER, H. Die Physiologie des Geruchs. Leipzig. Engelmann. S. 255. 1895.

cases of toxic anosmia evolved by cocain and in a case of post-diphterial anosmia. His results were distributed over two tables. In toxic anosmia evolved by cocain the smell of oil of camphor, of nutmeg, of Roman chamomile, of lavender and of laurel was unimpaired, whereas oil of thyme, tinctura nucis toncae, oil of eucalyptus, of peppermint, oleum spicae, and oil of valerian was more or less obtused. Complete obtusion was attained with oil of cloves, of anise, of hyssop, of rosemary and with asafoetida.

HERMANIDES [1]) examined exhaustion by taking for an index the lengthening of the reaction-time it causes and tabulated his results as follows:

After Exhaustion with	Lengthening of Reaction-time	Constant Reaction-time
Isoamylacetate	Isoamylacetate Valerianic acid	Nitrobenzol
Nitrobenzol	Nitrobenzol Isoamylacetate	Valerianic acid
Valerianic acid	Valerianic acid Isoamylacetate	Nitrobenzol
Scatol	Scatol	Isoamylacetate Nitrobenzol Valerianic acid

E. L. BACKMAN [2]) objects to the idea of "exhaustion" and prefers the word "adaptation", which, however, he also wishes to avoid, because he bases the whole phenomenon upon his differential-hypothesis. He assumes namely that a smell-sensation can be aroused only when a scent can penetrate as far as the olfactory cells in an increasing or decreasing quantity, but not when the accession of the odorous molecules (HEYNINX's odorivectors)[3]) occurs equably through invariable supplies per diffusion. The olfactory stimulus arises only when a certain procentic increase of the number of intruding molecules has taken place. From this hypothesis it follows that, with complete exhaustion (adaptation), only with a certain procentic increase of the concentration of the odorous matter in the air that reaches the olfactory region, a just noticeable sensation must be obtained. BACKMAN's hypothesis on this point has entirely been confirmed by my experiments conducted in ZWAARDEMAKER's camera

[1]) HERMANIDES, J. Onderz. Physiol. Lab. Utrecht.. (5) Deel 10, p. 1.

[2]) BACKMAN, E. L. Exp. Undersökningar öfter Luktsinnets Fysiologi. Upsala. Läkare förendings Föfhandlingar. N. T. Bd. 22, p. 319, 1917.

[3]) HEYNINX, A. Essai d'olfactique physiologique. These Bruxelles, 1919, p. 2.

odorata, in which first exhaustion (adaptation) for a given odour was obtained, and directly after a measurement of smelling was taken. These experiments will be published in another paper.

For terpineol, guajacol, caproic acid, I made tests in which, after complete exhaustion (adaptation), the smell-measurement was made in perfumed air, which of itself did not set up a smell-sensation any longer.

In order to make a comparative estimate of the quantity of smell in the camera of 400 liters, I have determined, at the termination of my experiments, the minimum perceptibile in ZWAARDEMAKER'S smelling-box for the odour for which I had exhausted my sense-organ.

I then found that for terpineol the just noticeable concentration was $3.9.10^{-10}$ grms. per c.c. of air. It is called olfactie, so this definite small quantity of odourous matter per cc. represents the value of one olfactie of my individual unexhausted olfactory sense. At the commencement of the experiment the absolute quantity of odorivector per cc. corresponding with the minimum perceptibile, was presumably smaller, seeing that my smelling capacity for the odours used had certainly decreased a little during my experiments. On this account the term "exhaustion" is perhaps more correct than "adaptation". I will, therefore, use it for the present series of experiments [1]), although it should on the other hand be acknowledged that for the lower values the term is quite appropriate in connection with the constancy of the liminal values of differentiation and with the analogy to the sensation of light. (BACKMAN).

After evaporation of one drop of terpineol the camera of 400 liters in which the head of the observer is enclosed, contains per cc. of air 5.10^{-8} grms of odorous substance. This concentration represents 125 of my olfacties as could be established at the termination of my experiments. I remained in the perfumed air for 6 minutes. At the end of this period my olfactory sense had quite adapted itself to the condition, so that I was not aware of any sensation of smell. I did not perceive anything of the kind either when breathing deeply or when sniffing.

[1]) Olfactometrical determinations showed that the obtusion for terpineol and guajacol was rather considerable at the end of my experiments, when compared with the beginning; for caproic acid, however, there was none. This may be inferred from the length to which the cylinder had to be moved out for the minimum perceptibile. It was:

	at the outset	at the end
for terpineol	0.200 c.m.	0.300 c.m.
for guajacol	0.145 c.m.	0.300 c.m.
for caproic acid	0.110 c.m.	0.110 c.m.

In subsequent experiments this was repeated for guajacol.

The minimum perceptibile in ZWAARDEMAKER's camera amounted for my olfactory organ with guajacol to $6.4.10^{-10}$ grms per cc. of air. This concentration corresponds with the value of 1 olfactie.

After one drop of guajacol was evaporated the camera of 400 liters contained $8.2.10^{-8}$ grms per cc. of air, in other words 128 of my olfacties. I remained for 7 minutes in the perfumed air.

The same was repeated with caproic acid in a third series of experiments.

The minimum perceptibile for caproic acid in ZWAARDEMAKER's camera per cc. of air was $3.3.10^{-10}$ grms, corresponding with one olfactie.

After evaporation of 0.5 drop of caproic acid the camera which encloses the observer's head, contains per c.c. of air: $3.35.10^{-8}$ grms of this odorous substance. This concentration represents 118 of my olfacties. I remained for 6 minutes in the perfumed air before making measurements.

In these 6 minutes my organ got completely exhausted, so that no observations could be made either when breathing deeply or when sniffing.

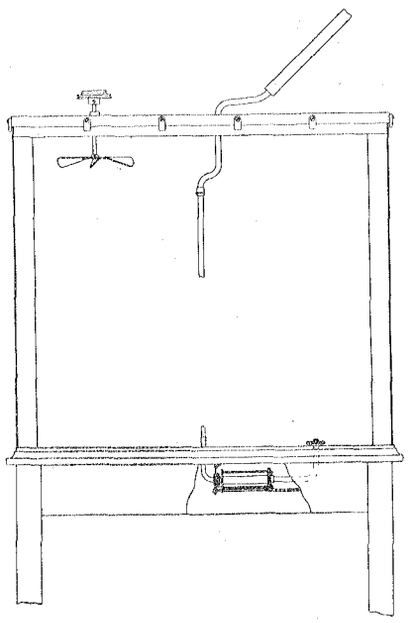
When making a measurement in an inodorous surrounding with the olfactometrical cylinders that I used, the min. perc. for my organ corresponded with

amylacetate	0.11 c.M.
nitrobenzol	0.15 „
terpineol	0.30 „
artif. moschus	0.11 „
allylalcohol	0.20 „
guajacol	0.30 „
caproic acid.	0.11 „
pyridin	0.10 „
scatol	0.22 „

However, performing the same determination in the perfumed air of the camera, the results are quite different.

With a view to making these determinations in the camera an olfactometer is attached to the bottom, through which an inspiration-tube of the olfactometer projects. This inside tube of the olfactometer can be freed from adhering odour by means of a current of air passing through the long movable glass-tube, which can be inserted or disconnected at will. During the measurement the turned up part

of the inspiration tube is passed into the forward half of the nostril, while the back part and the other nostril are left open. So the



Smelling Chamber of a capacity of 400 liters arranged for exhaustion-experiments.

Into this chamber, mounted on high legs, the observer's head is thrust through an opening below, which can further be closed by a sliding lid. Under this lid an olfactometer is applied. Through the camera runs a movable glass tube for a current of air to pass through. This current serves to clean the inside tube of the olfactometer in the intervals of the experiments. To the left is a rotating fan. (When the space is used as a camera inodorata a uviol-mercury lamp is burning to destroy the adsorbed odours through ultra-violet light.)

observer inspires the air from the olfactometer with the one nostril, and with the contralateral nostril he inhales the perfumed air of the camera. In order to perfume the air that passes through the olfactometer in the same degree as the air in the large camera a flexible tube is led from the camera to the olfactometer. This tube is taken up by an obturator applied to the outer cylinder of the olfactometer.

As the flexible tube consists of metallic rings held together by caoutchouc, it is necessary first to wash the tube out with tapwater without drying it in order to deodorize the caoutchouc.

These precautions enable us to make the measurements at the olfactometer while being assured that they take place in the perfumed air for which the sense-organ has been fatigued and which does not *per se* impart a smell sensation to the observer.

It is interesting now to determine the sensitiveness of the olfactory organ for guajacol with complete terpineol-exhaustion, for terpineol and guajacol with complete caproic acid-exhaustion.

This is shown in the subjoined tables:

Complete terpineol-exhaustion [1]).

	Min. perc. in olfacties.
Amylacetate	1.7
Nitrobenzol	1.4
Terpineol	∞
Art. Moschus	5.0
Allylalcohol	4.5
Guajacol	4.3
Caproic acid	4.2
Pyridin	1.5
Scatol	5.0

[1]) Time in which complete exhaustion was attained:

with terpineol	1 drop	6 min.,
with guajacol	1 drop	7 min.,
with caproic acid	0.5 drop	8 min.

It appears then that exhaustion is attained sooner for terpineol, then follows caproic acid, while guajacol comes last.

Complete guajacol-exhaustion.

	Min. perc. in olfacties.
Amylacetate	1.7
Nitrobenzol	1.3
Terpineol	4.9
Art. Moschus	5.2
Allylalcohol	8.5
Guajacol	∞
Caproic acid	11.5
Pyridin	1.5
Scatol	5.5

Complete caproic acid exhaustion.

	Min. perc. in olfacties.
Amylacetate	1.6
Nitrobenzol	1.3
Terpineol	3.3
Art. Moschus	5.1
Allylalcohol	5.5
Guajacol	5.3
Caproic acid	∞
Pyridin	1.5
Scatol	4.5

GENERAL CONCLUSION.

Amylacetate, nitrobenzol and pyridin are odours for which an olfactory organ that has been exhausted by the smell of terpineol, guajacol or caproic acid is blunted only very slightly. The liminal value is about $1^1/_2$ times higher than is normally the case. So the anosmia evolved is about $^2/_3$.

For other qualities of the series of 9 standard-odours (except that for which complete exhaustion exists) the organ is blunted to $^1/_3$ or $^1/_{11}$.

Chemistry. — "*On the Acceleration of Solubility of Metals in Acids by Reducible Compounds.*" By H. J. PRINS. (Communicated by Prof. J. BÖESEKEN.)

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It is a well-known fact that though there are a great many means available for the reduction of organic compounds, the choice of the reducer greatly contributes to the success of the reduction, so that it is not sufficient to bring hydrogen in status nascens in the presence of the substance that is to be reduced. It ensues from this that there must be a relation between the reducer and the compound that is to be reduced; if this relation were known it would be possible to make a choice with certainty from the available reducers for a definite purpose, or to find new reducers.

Some years ago it was pointed out[1]) that in case of reductions the velocity of solubility of the metal in the acid is enhanced by the reducible substance, and that evidently a cooperation, a coaction must take place between metal, acid, and reducible compound in order to bring about the reduction; which is then accompanied by a more rapid dissolving of the metal.

Definite examples of this have not been recorded, except in the literature[2]) of patents.

Such coactions, which are reckoned among the mutual inductions, are however, known in all kinds of other reactions, especially oxidation reactions. Besides it is known that metals dissolve more rapidly in the presence of oxidizers,[3]) in such cases it is, however, difficult to decide, whether one has to do with a mutual induction or a subsequent reaction, while the formation of primary oxides assumed by some scientists to take place in such reactions as inter-

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[1]) PRINS, Chem. Weekbl. **14**, 72 (also note) and id. 1004 (1917).
Ibid **11**, 476, 477 (1914).
Ibid **12**, 38 et seq. (1915).
Journ. f. prakt. Chem. N. F. **89**. 448 et seq. (1914).

[2]) LASSAR COHN, Arbeitsmeth. d. org. Chem.

[3]) VAN NAME, Chem. Centr.bl. (1914). I 20; (1918). I 257, 907.
SALKOWSKI, Chem. Ztg. **40**. 448 (1916).