strongly motile cells prove, like spirils, to be "mesoaërophilous", but they accumulate somewhat nearer to the meniskus than spirils would do, so that they approach the „macroaërophilous type". When continuing to grow in the glass-room, many cells stick to the glass and then display their mesoaërophilism with great distinctness. *A. chroococcum*, on the other hand, is macroaërophilous.

If the canal-water cultures, with mannite or other sugars as carbon food, are allowed to stand for some weeks at about 18° C., many, but not all, are crowded with an exceedingly rich flora and fauna, so that sugar solutions of 2 pCt. may literally become thick with microbic life, of which, besides *A. agilis* itself, spirils and other bacteria form the main portion, but where amoebae and other protozoa too, are present in great number.

It is a remarkable fact that oligonitrophilism can be the foundation of such a profuseness of life, if only care be taken for sufficient access of air.

Chemistry. — Professor BAKHUIS ROOZEBOOM presents a paper of Dr. C. H. WIND: "*On the irregularities of the cadmium standard cell.*"

1. Some cadmium standard cells constructed in accordance with the directions of the Physikalisch-Technische Reichsanstalt exhibit abnormal phenomena as shown by the observations made in that institution [1]), and also by the researches of COHEN [2]) and others.

COHEN investigated a cell made up as follows:

$$\text{Cd} \mid \text{dilute solution of } \text{Cd}\,\text{SO}_4 \mid \text{Cd-amalgam of } 14.3\ {}^0/_0,$$

and found in the case of two cells I and II which had been constructed in accordance with this type a difference in EMF. In the cell I it amounted to 56 mV at 0° and to 50 mV at 25°, with an almost linear slope; in cell II it amounted to 51 mV at 0° and to 50 mV at 25°, with a maximum of 52 mV at an intermediate temperature.

COHEN assumes provisionally [3]) that we are dealing here with different modifications or states of equilibrium of the 14.3 per cent amalgam.

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1) W. JÄGER u. R. WACHSMUTH — Wied. Ann. 59, p. 575, 1896; W. JÄGER — Wied., Ann. 65, p. 106, 1898; Dr. Ann. 4, p. 123, 1901.

2) E. COHEN — Versl. K. A. v. W. Amst. 9, p. 125, 1900.

3) id. — L. c. p. 137.

In fact he found that the cell II after being cooled for the first time from 25° to 0° showed at first a higher EMF (55 mV) which gradually passed into the lower value (51 mV) and that the amalgam I showed a contraction in the dilatometer at 0° while the volume of the amalgam II seemed to remain constant.

From these facts COHEN at first concluded that between 0° and 25° (more correctly 23°) the amalgam I is metastable and the amalgam II stable. Afterwards [1]) he has seen reason to modify this opinion and to look upon I as the stable and on II as the metastable form, although this would render the experience with the dilatometer rather obscure.

In his arguments, COHEN starts from the supposition that the amalgam in both cells had the same quantitative composition and in my opinion it is questionable whether this supposition agrees with the facts. I conceived a doubt about this when reading JÄGER's [2]) note on the dependence of the EMF of the cell

Cd-amalgam 14.3 % | solution of Cd SO_4 | Cd-amalgam x

on the molecular relation x of the mercury to the cadmium in the amalgam which forms the second pole. This research gave me an idea which may perhaps lead to an explanation of the irregularities observed.

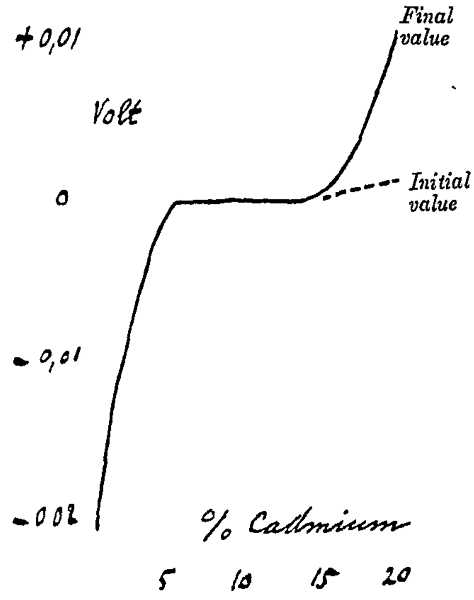

Fig. 1.

2. The curve (fig. 1) representing the EMF of JÄGER's cell in its dependence on the concentration of the variable amalgam pole, shows a part which is parallel to the axis of concentrations: the EMF has proved to be *nil* in the case of all cells with amalgams of 6 to 14,3 % of Cd as second pole.

From the phase rule it may be concluded that the variable amalgam pole will not have been homogeneous in the case of the

1) id. — Versl. K. A. v. W. Amst. 9, p. 363, 1900.
2) W. JÄGER — Wied. Ann. 65, p. 106, 1898.

compositions to which this horizontal part of the EMF line relates, but will have consisted of two phases in equilibrium. For it is evident from the course of the above EMF line that in the system Cd-amalgam | solution of $Cd\,SO_4$, if the cadmium content of the amalgam be $>$ 14,3 or $<$ 6 per cent and the temperature, external pressure and strength of solution are kept constant, one of the variables which, along with those above mentioned, determine the condition of the system must still be arbitrary; because a change in the cadmium content of the amalgam produces a (perfectly definite) change in the potential difference. Under these circumstances there is therefore a complete equilibrium in the system with one arbitrary variable. As there are four independent components (Cd, Hg, $Cd\,SO_4$, H_2O) whilst three of the quantities governing the condition of the system possess a previously given value, there must be $4 + 1 - 3 = 2$ phases in the system. One of those phases is the solution, the other is the amalgam. *Between the above mentioned limits of concentration* the potential difference is, according to JÄGER's measurements, *a perfectly fixed value.* We are consequently dealing *here* with an equilibrium in which none of the quantities determining the condition of the system is arbitrarily variable; the number of phases must have increased by one and the amalgam therefore have split up into two phases. The concentrations of these phases will be the limits of concentration of the region of constant EMF, viz. about 6 and 14.3 percent.

As far as it appears from JÄGER's communications he has not himself drawn these conclusions; nor is it at all sure from what he states that he has noticed any heterogeneities in his amalgams. LINDECK, however, states in an article also cited by JÄGER [1]: „Während bei Amalganen mit hohem Gehalte an Metall Schichten mit verschiedenem spezifischem Gewicht sich manchmal abzusetzen scheinen, ...". DR. E. COHEN, who does not mention anything in his paper about a possible splitting up into two phases, orally communicated to me that he considers this by no means impossible.

Prof. H. W. BAKHUIS ROOZEBOOM informed me that the two-phased equilibrium of cadmium amalgam, the existence of which he had long ago suspected, has been proved in his laboratory in the course of a not yet finished research by Dr. BIJL. Moreover this research has already shown that the limits of concentration for the amalgams, in which that kind of equilibrium is found, are pretty accurately 6 and 14.3 percent of cadmium.

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[1]) S. LINDECK — Wied. Ann. 35, p. 323, 1888.

3. If we admit the existence of two-phased equilibria in the cadmium amalgams, it is not difficult to suggest causes which may explain the singular phenomena occurring when experimenting with them.

Let us first consider the phenomenon [1]) observed by JÄGER that the EMF of his cell when the second amalgam pole contained 15 percent or more of cadmium, was *nil* immediately after the construction of the cell and arrived at its final value only after the lapse of several hours or even days. The explanation of this phenomenon offers little difficulty, especially when it is taken into consideration that these strong amalgams, as JÄGER observes, are already rather solid so that changes in the distribution of the cadmium can take place but very slowly.

It may be very well imagined that immediately after the construction of the cell, the amalgam poles are not quite homogeneous even when their percentage of cadmium is such that the true equilibrium would consist of one phase only; further that where the amalgam is in contact with the solution of $Cd\,SO_4$ some parts of it are particularly poor in cadmium and may even contain less than 6 percent. If this is really the case, these parts of the surface will possess a greater potential value in reference to the solution than the parts of the surface which are richest in cadmium. This will then cause electric currents in the solution from the richer parts of the surface to the poorer; and these currents will withdraw cadmium from the richer and deposit it on the poorer parts and by this way soon create a condition in which, at the surface layers of the amalgam which are in contact with the solution, no other concentrations occur than such as fall within the region of two-phased equilibria. By all this there will be, however, no equilibrium as yet between those surface layers and the interior of the amalgam with its high percentage of cadmium, and consequently diffusion will occur and in the long run lead to a homogeneous distribution of the cadmium in the amalgam and to a potential difference between amalgam and solution as corresponding to the final equilibrium.

4. The difference observed by COHEN between the two similarly constructed cells I and II (v. § 1) may be readily explained by supposing that COHEN in making the cells unconsciously used portions of a two-phased amalgam. It is then only necessary to assume that

[1]) L. c. p. 108.

he happened to use for the cell I a mixture of the two phases in which each of them was present in somewhat considerable quantity and for the cell II a mixture in which the phase containing least cadmium was represented only to a small degree. Indeed if this supposition be true both cells ought at the commencement to show the same EMF, but on cooling to 0° they might behave differently. There are again grounds in this case to expect two distinct states of equilibrium, a *provisional* one, which is established quickly after the lowering of temperature, and a *final* equilibrium, into which the provisional one gradually passes and which will continue to exist as long as the temperature is not again changed. For if the pole of the cell in question is a two-phased amalgam at the higher temperature it will after the fall in temperature still remain heterogeneous at first, while under the influence of local electric currents, as in the case of JÄGER, the potential difference which is established between the amalgam pole and the solution will be the one corresponding to the two-phased equilibrium of the lower temperature. In other words shortly after the fall of temperature we may equally expect in cells I and II the voltage belonging to a two-phased amalgam pole of the new temperature.

What will happen next, depends on the amount of cadmium in the amalgam pole, that is to say on the relative quantities of the two phases in it, and also on the shape of the curve limiting in the diagram of the EMF-isotherms the region of two phases (fig. 2).

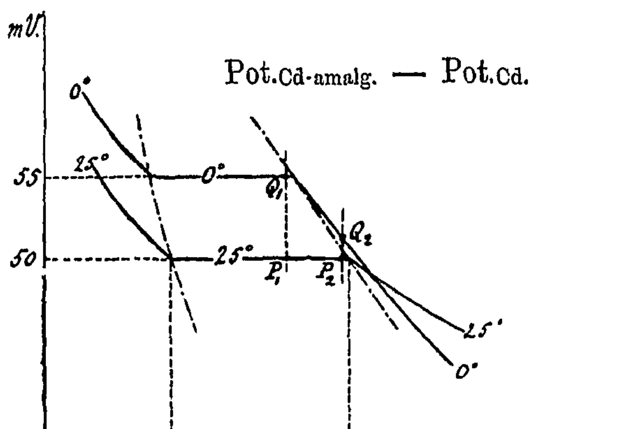

Fig. 2.

In the case of the amalgam pole I we have assumed that each of the two phases are present in not too small quantities so that the point which indicates its composition on the isotherm of 25° is situated somewhere in P_1 not too near one of the limiting points. The point Q_1 on the isotherm of 0° that lies in the same vertical with P_1 may then easily fall within the region of two phases; it will, however, generally speaking, indicate a considerable change in the ratio of the two phases for the final equilibrium. From this it follows first of all that the potential difference corresponding to the final equilibrium at the lower temperature will not differ from that corresponding to the provisional equilibrium, so that the *final voltage of the cell* will be the same as that shown shortly after the cooling. On the other hand, however, the *final equilibrium* will not be reached until the corresponding ratio of the phases has been fully established in the mixture, a process which will probably be a very slow one. If we now assume that this process is accompanied by contraction, the dilatometric experiment of COHEN with the amalgam I will be fully explained too.

In the case of the amalgam pole II we have assumed that the phase poor in cadmium was present only in a small quantity so that the point P_2 which represents the initial composition of this amalgam lies in the horizontal part of the isotherm of 25° but rather close to one of the limiting points. If we now suppose that here *the curve limiting the region of two phases approaches the EMF-axis as the temperature falls, as indicated in fig.* 2, then the vertical line drawn through P_2 may cut the isotherm of 0° somewhere in a point Q_2 on the descending branch. This point Q_2 gives the EMF belonging to the final equilibrium of the amalgam at 0° and also the nature of this equilibrium. If, therefore, our suppositions are correct, this equilibrium must be one-phased and the final EMF be lower than the one corresponding to the provisional equilibrium.

So it is quite clear why cell II, after cooling to 0° could at first show an EMF of 55 mV and afterwards only one of 51 mV. Whether the limiting curve really takes the above supposed course, may be decided by the experimental investigation of the two-phased region [1]).

Another peculiar fact in COHEN's investigation is this. The cell II, after having been again heated to 25° and having shown there the same EMF as the cell I, when once more cooled to 0° did not

[1]) From a little sketch forwarded to me a few days ago by Prof. BAKHUIS ROOZEBOOM I think I may conclude that my idea about the course of the limiting curve is correct.

at first possess the EMF 55 mV, as formerly, but immediately showed the EMF 51 mV [1]). This may be explained by assuming that the amalgam pole after having become homogeneous by the first cooling has remained so when the temperature increased (its state of equilibrium having perhaps been "metastable" towards the end), so that during the subsequent cooling there was not occasion for a distinct provisional equilibrium, as formerly.

5. It appears to me that many of the phenomena observed in the investigation of the WESTON-cell in the Physikalisch-Technische Reichsanstalt which have as yet remained obscure may be explained in an analogous manner by the existence of two-phased equilibria in the cadmium amalgam and by retardations in the attainment of the equilibria.

A result of some practical importance of the above considerations would be, that the Physikalisch-Technische Reichsanstalt by altering their prescription for the construction of cadmium standard cells so as to recommend now a percentage lower than 14.3 of cadmium — whether this was done on sufficient theoretical grounds or not — have found the right way of insuring a cell with a perfectly definite EMF, and so of making the cadmium element more capable of serving as a standard.

Botany. — S. L. SCHOUTEN: "*A pure culture of Saprolegniaceae*". (Communicated by Prof. F. A. F. C. WENT).

A new method which I devised for making pure cultures as well of bacteria as of other micro-organisms and of which a preliminary account appeared in the "Handelingen van het 7de Nederl. Nat. en Geneesk. Congres" amounts essentially to what follows.

On a cover glass, greased with a little vaseline and then passed through a flame 3 or 4 times, a drop is placed in which among others, the micro-organism occurs, which we wish to breed. At a distance of about 2 millimetres another drop is placed of the nutritive fluid in which we will produce the pure culture. Then the cover glass is laid on a moist chamber under the microscope. The right and left sides of this moist chamber have a horizontal slit, closed with olive-oil a little thickened with sulphuret of lead paste. Through

[1]) E. COHEN — Versl. K. A. v. W. Amst. 9, p. 129, 1900.
[2]) L. c. p. 110.