tion entirely to us, for which we hereby tender him our best thanks, and also for the many valuable hints we received from him as regards the technicalities of the investigation.

The allotropy of carbon, as was most natural so to say, was, after some experimenting investigations examined Röntgenographically, the accompanying photo is a reproduction of the interference-figures obtained by letting Cu-rays [1]) fall upon a bar of compressed graphite [2]) and upon a bar of diamond-powder [3]).

From them we notice, qualitatively too, how different the interference-figures of these two allotropic forms are, according to the quite different crystal-systems (diamond is regular, graphite is monoclinic) in which they are met with. We therefore expect that this method will bring light in many cases in which it is doubtful whether there is really allotropy, or where two materials that cannot be chemically separated are present side by side. Also in those cases in which it is doubtful whether we have to do with the amorphous or with the crystalline state, the Röntgen-investigation will, as DEBYE himself declares, enable us to make the matter clear.

At the same time we direct the attention to the possibility of making a qualitative Röntgen analysis of, say, a mixture or an alloy without any loss of material.

About the particulars of this investigation and the further results of it, we hope to be able to say something at some other time.

Chemistry. — *"Amygdalin as nutriment for Aspergillus niger."* By Dr. H. J. WATERMAN. (Communicated by Prof. J. BÖESEKEN.)

(Communicated in the meeting of January 27, 1917).

PURIEWITSCH [4]) has proved that the extract of the cells of *Aspergillus niger* splits up amygdalin into glucose, benzaldehyde and hydrogen cyanide, whereas the *living mycelium* of this species of mould behaves in quite a different manner towards amygdalin.

In the latter case benzaldehyde and hydrogen cyanide are not

1) For the αCu-line $\lambda = 1.549 \times 10^{-8}$.

2) As made by MOISSAN and prepared from pure C in the electrical furnace.

3) Average diameter of the parts 2 à 3 μ.

4) H PURIEWITSCH, Ueber die Spaltung der Glykoside durch die Schimmelpilze. Ber. d. deutsch. Bot. Ges. **16**, 368 (1898); Also compare: F. CZAPEK, Biochemie der Pflanzen, 1ster Band, 2e Aufl. 1913, p. 363—365; F. LAFAR, Handb. d. techn. Mykologie, Bd. IV, Spezielle Morphologie u. Physiologie der Hefen und Schimmelpilze, 1905—07, p. 250—251.

formed and FEHLING-reducing substances do not appear in the liquid containing amygdalin. It was demonstrated that in this case amygdalin was absorbed and utilized by the mycelium because as the quantity of mycelium increased the quantity of amygdalin in the solution at the same time diminished.

These apparently contradictory results of PURIEWITSCH and of other investigators in analogous cases have frequently been a subject of discussion. HÉRISSEY [1]) for instance says: "If during the metabolism amygdalin and corresponding glucosides, in a similar way as in vitro by emulsin, are first split up into compounds which are easily assimilated such as glucose, on one hand and into noxious compounds on the other hand, it may be expected that these poisons will be converted at once into other chemical compounds." But this is a matter of uncertainty, HÉRISSEY says and he does not give a definite opinion.

W. KRUSE [2]) is surprised at the said experiments of PURIEWITSCH and points to the fact that other investigators have not obtained the same results. The uncertainty about this subject made me take it up in order to try to clear it up.

Solutions containing 2 % amygdalin and the necessary inorganic nutriment were inoculated with spores of *Aspergillus niger*. The temperature during cultivation was 33°.

Many times in the course of development the quantity of dry substance on one hand and the polarisation of the solution on the other hand were determined from which the assimilated amygdalin could be calculated. The mould layer, after being washed with distilled water, was therefore dried at 105° to constant weight. (Tab. I p. 924)

My experiments confirmed the observation of PURIEWITSCH that amygdalin is assimilated by the living mycelium, whilst the production of young mycelium occurs at the cost of the assimilated amygdalin. (Table I). This table shows too that amygdalin is a better nutriment than glucose at least with regard to the dry weight of mould obtained.

This conclusion agrees with results which I obtained before, viz. that the presence of a benzolnucleus in the assimilated organic chemical compound increases the quantity of mould formed at the cost of this nutriment. [3])

Formerly I demonstrated with great probability that in a special

[1]) E. H. HÉRISSEY, Recherches sur l'émulsine. Thèse Paris 1899.

[2]) W. KRUSE, Allgemeine Mikrobiologie, 1910, p. 458.

[3]) H. J. WATERMAN, Zeitschr. f. Gärungsphysiologie, Bd. 3, Heft 1 (1913).

TABLE I.

Glucose as exclusive organic food			*Amygdalin* as exclusive organic food		
Composition of the culture liquid: 50 cm.³ of tapwater, in which dissolved 0,15 % NH_4NO_3, 0,15 % KH_2PO_4, 0,1 % magnesiumsulfate (crystallised). Temperature 33°.					
A. 2 % glucose (1000 mgr.)		Number of days after inoculation	B. 2 % amygdalin (1000 mgr.)		
Assimilated glucose (mgr.)	Obtained dry weight of mould (mgr.)		Assimilated amygdalin (mgr.)	In the nutrient solution neither glucose nor benzaldehyde were found.	Obtained dry weight of mould (mgr.)
1000	320	6	670		315
		12	670, 710		298, 215
		16	635		251
1000	242, 264	38	750		271
		42	680		200
		95	not determined		214, 237, 203

case sucrose can be assimilated without preceding dissociation into glucose and fructose. [1])

In this case, too, it might be supposed that the assimilation of amygdalin will not be preceded by a conversion into glucose, benzaldehyde and HCN outside the organism.

Benzaldehyde and to a small degree HCN too, especially in high concentrations, diminish or stop the development of *Aspergillus niger* in nutrient liquids containing glucose. (Table II).

The solutions *p* and *q* were prepared as follows:

p. 42,5 mgr. KCN dissolved in distilled water and filled up to 100 cm³. Added 10 cm³. of 0,98 × $^1/_{10}$ Normal sulfuric acid.

q. 100 cm³. of distilled water, added 10 cm³ of 0,981 × $^1/_{10}$ Normal sulfuric acid.

Both solutions were used *immediately after their preparation.*

The purpose of the experiments 7,8 and 9 was only to demonstrate that the quantity of sulfuric acid added in N°. 4, 5, and 6 could have no retarding influence. The phenomena of growth which were observed in N°. 2 after six days and in N°. 3 after ten days could not be attributed to the total evaporation of the benzaldehyde because the nutrient liquid of N°. 3 distinctly smelled of benzaldehyde even after 10 days.

[1]) Zur Physiologie der Essigbakterien, Centralbl. f. Bakteriologie, 2e Abt. Bd. 38, 451 (1913).

Retarding influence of benzaldehyde and hydrogen cyanide.
Culture liquid: 50 cm.[3] tapwater, in which dissolved 0,15 % NH_4NO_3, 0,15 % KH_2PO_4, 0,1 % magnesiumsulfate (crystallised) and 2 % glucose. Temperature 33°.

No.	Added	Course of development. After 1	3	4	6	7	10 days
1		beginning growth	vigorous growth, many spores	vigorous growth, many spores	vigorous growth, many spores	vigorous growth, many spores	vigorous growth, many spores
2	1 drop of pure benzaldehyde 1)	?	no growth	?	vigorous growth, hardly any spores		
3	3 drops of pure benzaldehyde 1)	no growth	no growth	no growth	no growth	no growth	beginning growth; The liquid has the smell of benzaldehyde
4	0,5 cm.[3] of a HCN containing liquid (*p*)	?	vigorous growth, rather many spores	vigorous growth, many spores	vigorous growth, many spores	vigorous growth, many spores	vigorous growth, many spores
5	2 cm[3]. of a HCN containing liquid (*p*)	?	vigorous growth, many spores				
6	5 cm.[3] of a HCN containing liquid (*p*)	no growth	beginning growth	rather vigorous growth, few spores			
7	0.5 cm.[3] of a H_2SO_4 containing liquid (*q*)	beginning growth	vigorous growth, many spores	vigorous growth, many spores			
8	2 cm.[3] of a H_2SO_4 containing liquid (*q*)						
9	5 cm.[3] of a H_2SO_4 containing liquid (*q*)						
10		beginning	vigorous growth	vigorous growth			

1) The substance present in the laboratory collection was purified by washing with distilled water and distillation.

From other experiments it has become evident that benzaldehyde when used in very slight concentrations, may serve as nutriment for *Aspergillus niger*.

From the above results it may also be expected that in amygdalin containing liquids to which emulsin has been added *Aspergillus niger* will not develop.

This follows too from the experiments which are united in Table III.

TABLE III.

50 cm.³ tapwater, in which dissolved 0,15 % NH_4NO_3, 0,15 % KH_2PO_4, 0,1 % magnesiumsulfate (crystallised). Temp. 33°.

N°.	Dissolved	Development	
		After 3	5 days
1, 2, 3	2 % glucose	rather vigor. growth, beginning formation of spores	vigorous growth, many spores
4, 5	2 % glucose + 0,04 % emulsin	vigorous growth, many spores	
6	2 % glucose + 0,1 % emulsin		
7, 8, 9	2 % amygdalin	rather vigor. growth, rather many spores	
10, 11	2 % amygdalin + 0,04 % emulsin	no growth, the smell of the liquid resembles benzaldehyde or (and) HCN.	just as after 3 days [1]
12	2 % amygdalin + 0,1 % emulsin		

The emulsin used (MERCK) had no retarding influence on the development of *Aspergillus niger* with glucose as source of carbon.

The retarding influence of emulsin stated in solutions containing amygdalin could therefore only be ascribed to the products of hydrolysis of the amygdalin viz benzaldehyde and HCN.

The above experiments prove that when important quantities of amygdalin, before being assimilated, are already dissociated into glucose, benzaldehyde and HCN outside the organism *Aspergillus niger* will not develop. It is proved, too, that this is caused especially by the retarding action of benzaldehyde.

The strong retarding action of benzaldehyde can on one side be explained by its strong solubility in fats (benzaldehyde in every proportion is miscible with olive oil) and on the other side by the possibility of a rapid conversion into benzoic acid. Benzaldehyde

[1]) After 30 days Nos. 10, 11 and 12: no growth, but the smell of benzaldehyde or (and) HCN can no more be stated.

will immediately overburden cells[1]). Only if care is taken that this does not happen benzaldehyde can be used as nutriment.

As follows from the above this is the case when we use very slight concentrations of benzalhyde. Amygdalin which is among the substances that do not cause overburdening phenomena can be converted *in* cells into glucose, benzaldehyde and HCN without any slackening influence on the growth[2]).

In the communications mentioned we have demonstrated that generally speaking it is not the nature of the substance absorbed but in the first instance the quantity, that causes overburdening of cells and the accompanying retarding of growth. In this way we have at the same time a specific for bringing narcotic substances into the organism without any harm to the latter.

For this purpose the narcotic substance should be combined with one or more other chemical compounds, so that a complex chemical compound results, which can not overburden cells, but from which the desired active substance may be formed *within* the cell.

Dordrecht, December 1916.

Chemistry. — "*In-, mono- and divariant equilibria.*" XIV. By Prof. F. A. H. SCHREINEMAKERS.

(Communicated in the meeting of January 27, 1917).

22. The occurrence of three indifferent phases; the equilibrium M is constant singular.

In the previous communications we have discussed the occurrence of two indifferent phases; now we shall briefly consider the occurrence of three indifferent phases.

Again we take the two reaction-equations:

$$a_1F_1 + \ldots + a_pF_p + a_{p+1}F_{p+1} + \ldots = 0 \quad . \quad . \quad . \quad (1)$$

and

$$\mu_1a_1F_1 + \ldots + \mu_pa_pF_p + \mu_{p+1}a_{p+1}F_{p+1} + \ldots = 0 \quad . \quad (2)$$

in which a_1 and μ_1 are positive and at the same time:

$$\mu_1 > \ldots > \mu_p > \mu_{p+1} > \mu_{p+2} > \ldots \quad . \quad . \quad . \quad . \quad (3)$$

When we put:

[1]) J. BÖESEKEN and H. J. WATERMAN, These Proceedings, January 24, 1912 p. 608; H. J. WATERMAN, Dissertation Delft, 1913.

[2]) When at the same moment any conversion into the just mentioned substances occurs too outside the cell of course retarding of growth will all the same be stated.