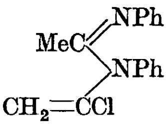
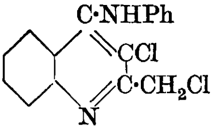
147. *The Action of Phosphorus Pentachloride on Acetanilide.*

By Otto Guido Backeberg.

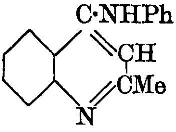
The base obtained by Wallach (*Annalen*, 1882, **214**, 193) by the interaction of equimolecular quantities of phosphorus pentachloride and acetanilide has been shown by von Braun and his collaborators (*Ber.*, 1927, **60**, 92) to be diphenylchlorovinylacetamidine (I). Von Braun (*Ber.*, 1930, **63**, 3191) found that ω-chloroacetanilide under similar conditions gave only 3-chloro-4-anilino-2-chloromethylquinoline (II), but the corresponding 4-anilinoquinaldine (III) could not be obtained from acetanilide, the product being always the compound (I).*



(I.)



(II.)



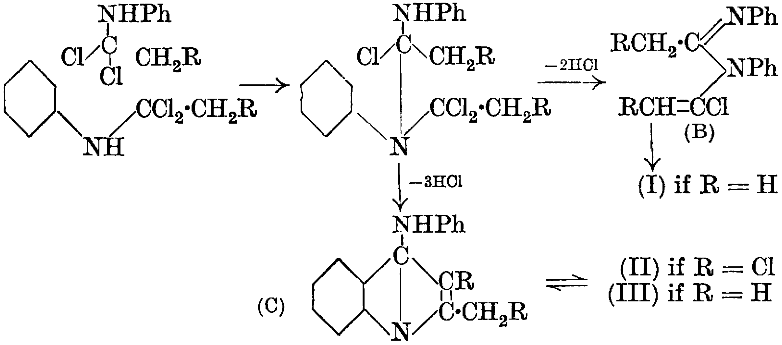
(III.)

* Von Braun reports (*Ber.*, 1931, **64**, 2466) that he has been able to obtain the compound (III) by the energetic action of phosphorus pentachloride on acetanilide, the details of the investigation to be published later.

Von Braun assumes (*Ber.*, 1931, **64**, 2466) that the chlorovinylacetamidine bases are intermediate products in the formation of these quinoline derivatives, and on this assumption he bases an explanation of their formation, but the formulæ (Ia) and (IIa) there listed (*loc. cit.*) contain quinquevalent carbon atoms which render the explanation untenable.

Experiment has now shown that the compound (III) can be obtained in small yield from equimolecular quantities of phosphorus pentachloride and acetanilide, and the following scheme offers a satisfactory explanation for its formation, and also for the formation of other similar quinoline derivatives :

$$\mathrm{NHPh{\cdot}CO{\cdot}CH_2R + PCl_5 \longrightarrow NHPh{\cdot}CCl_2{\cdot}CH_2R} \quad \text{(A)}$$



This scheme involves the condensation of two molecules of amidodichloride (A), which may lead to the formation of either a chlorovinylacetamidine base (B) as indicated by Stephen and Bleloch (J., 1931, 886) or to a quinoline derivative (C). Amidodichlorides are not stable much above the ordinary temperature (Stephen and Bleloch, *loc. cit.*) and this scheme requires that, as is actually the case, no rise in temperature should take place during the preparation of compounds of the type (C).

The investigation has been extended to a study of the action of excess of phosphorus pentachloride on acetanilide. Michael (*Amer. Chem. J.*, 1887, **9**, 217) has shown that with 3 mols. of phosphorus pentachloride two products may be obtained according to the conditions, a yellow solid, m. p. 227—229° (together with an oily product which was not further investigated), and colourless needles, m. p. 116·5—117°, to which he assigned the formulæ $C_{38}H_{36}N_4Cl_7$ and $C_8H_8N_2Cl_2$ respectively.

Repetition of Michael's experiments has shown that his yellow product is the hydrochloride, $C_{16}H_{13}N_2Cl_3$, of 3-chloro-4-anilino-2-chloromethylquinoline (II), and the oily by-product contains diphenylacetamidine. The above hydrochloride is also obtained if 2 mols. of phosphorus pentachloride are used, and it would appear that the third mol. employed by Michael dissolves in the phosphoryl chloride produced and takes no further part in the reaction, which may be explained as follows :—Acetanilideamidodichloride is first formed and is slowly chlorinated at the ordinary temperature by the second mol. of phosphorus pentachloride to ω-chloroacetanilideamidodichloride, which then condenses to the quinoline derivative (II), in accordance with the above scheme. If, on the other hand, as in Michael's second experiment, the temperature is raised, acetanilideamidodichloride is converted into the imidochloride by loss of hydrogen chloride, and the formation of both amidine and quinoline derivatives is no longer possible; the additional 2 mols. of phosphorus pentachloride are now available for chlorination and react readily at the temperature of the water-bath, so that the imidochloride is finally converted into ω-dichloroacetanilideimidochloride, which, when poured into water, is hydrolysed to ω-dichloroacetanilide, thus

$$\mathrm{NHPh{\cdot}COMe} + \mathrm{PCl_5} \longrightarrow \mathrm{NHPh{\cdot}CCl_2Me} \xrightarrow[(-\mathrm{HCl})]{\text{heat}} \mathrm{NPh{:}CClMe} \xrightarrow{2\mathrm{PCl_5}}$$

$$\mathrm{NPh{:}CCl{\cdot}CHCl_2} \xrightarrow{\mathrm{H_2O}} \mathrm{NHPh{\cdot}CO{\cdot}CHCl_2}$$

and Michael's compound, m. p. 116·5—117°, was in fact found to be ω-dichloroacetanilide (compare von Braun, Jostes, and Münch, *Annalen*, 1927, **453**, 118), while no basic product could be obtained from the reaction.

EXPERIMENTAL.

(All analyses, except those marked with an asterisk, were carried out by Pregl's micro-methods.)

The following experiments were carried out with phosphorus pentachloride and 10 g. of acetanilide.

1 *Mol. of phosphorus pentachloride.* The finely ground materials were thoroughly cooled during the initial reaction. The flask was sealed, and the pasty product kept at room temperature for 3 weeks with occasional shaking; a clear, dark red solution was then obtained. The flask was opened (a small quantity of hydrogen chloride escaped), and heated under reflux on the water-bath for 3 hours, much hydrogen chloride being evolved. The product was cooled and 100 c.c. of water were added and heated to boiling : a vigorous reaction occurred and the mixture became homogeneous. On cooling, yellow crystals separated, which were dissolved in dilute acetic acid and repeatedly boiled with charcoal. When the solution was made alkaline with ammonia, 4-anilinoquinaldine (III) (1 g.) separated, m. p. 156° alone

or in admixture with an authentic specimen (J., 1931, 2814) (Found: N, 12·1. Calc. for $C_{16}H_{14}N_2$: N, 12·0%).

3 *Mols. of phosphorus pentachloride* (Michael, *loc. cit.*). (a) The sealed mixture was kept at room temperature for 3 weeks: a yellow solid (6·5 g.) slowly separated from the dark red solution first formed. When the tube was opened, a large quantity of hydrogen chloride escaped. The solid was washed with ether, dissolved in dilute acetic–hydrochloric acid, and repeatedly boiled with charcoal. On cooling, yellow needles, m. p. 209°, separated; after these had been recrystallised from aqueous-alcoholic hydrogen chloride and dried over phosphoric oxide, the m. p. was 243—245° (decomp.) (von Braun, *loc. cit.*, gives 222°). Analysis showed the product to be the hydrochloride of 3-chloro-4-anilino-2-chloromethylquinoline (II) (Found: C, 56·6; H, 3·8; N, 8·2, 8·1; ionised Cl, 10·6*; *M*, by micro-Rast, 337·8. Calc. for $C_{16}H_{12}N_2Cl_2,HCl$: C, 56·6; H, 3·8; N, 8·25; ionised Cl, 10·45%; *M*, 339·4). The free base was obtained pure by neutralising a solution of the purified hydrochloride in cold alcohol with *N*/10-sodium hydroxide and phenolphthalein and adding water with stirring until precipitation occurred; m. p. 135—136° (von Braun, *loc. cit.*, gives "about 130°") (Found: N, 9·3; *M*, 300·2. Calc. for $C_{16}H_{12}N_2Cl_2$: N, 9·2%; *M*, 302·9). The picrate had m. p. 183° (von Braun gives 193°).

When the filtrate from the yellow solid was poured into water, a thick oil (about 3 c.c.) separated. This was boiled with dilute hydrochloric acid and the dark-coloured solution was repeatedly treated with charcoal and then made alkaline. The diphenylacetamidine (0·4 g.) obtained was crystallised from dilute alcohol; m. p. 131° alone or in admixture with an authentic specimen (Found: N, 13·4. Calc. for $C_{14}H_{14}N_2$: N, 13·3%).

(b) The mixture (2 g. of acetanilide) was kept over-night, then heated on the water-bath until evolution of hydrogen chloride ceased, and poured into water. The oil produced, which soon solidified, was dissolved in 750 c.c. of hot water (charcoal); on cooling, ω-dichloroacetanilide (1·5 g.) crystallised in long colourless needles, m. p. 117—118° alone or in admixture with an authentic specimen (Found: N, 7·0. Calc. for $C_8H_7ONCl_2$: N, 6·9%). No base separated when the filtrate from the reaction mixture was made alkaline.

2 *Mols. of phosphorus pentachloride.* The sealed mixture was left at room temperature for 3 weeks, and the yellow solid (8 g.) purified as before. Analysis showed this to be the hydrochloride of 3-chloro-4-anilino-2-chloromethylquinoline (II); m. p. 243—245° (decomp.) alone or in admixture with the compound previously described (Found: C, 56·6; H, 3·8; N, 8·4; ionised Cl, 10·5*%). The free

base was obtained as before, m. p. 135—136° alone or in admixture with the compound previously described (Found : N, 9·2%).

In conclusion the author records his appreciation of Prof. H. Stephen's interest in the investigation.

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