XXIV. THE REDUCTION OF PHENYL-ETHYLAMINE.

By ALBERT WEINHAGEN.

(*From the Federal Polytechnic Institute, Zurich, Switzerland.*)

(*Received August 31st, 1917.*)

The purpose primarily in view was to reduce several compounds closely allied to tyrosine by that method in which the reduction is brought about by shaking the compound in question with hydrogen and a catalyser in the shape of finely divided platinum or palladium. The catalysers were prepared by reducing solutions of the respective chlorides by means of formaldehyde and alkali [Willstätter and Hatt, 1912]¹. A point to be noted is that in all instances mentioned in the course of this paper where reduction did not take place, the catalyser employed was subsequently tested and found to be active. This goes to prove that the negative results in these instances are to be attributed to inherent reasons, rather than to inactivity of the catalyser. The test applied was to shake castor-oil in ethereal solution with hydrogen and the catalyser to be tested. In every case reduction proceeded very rapidly, the white, solid product of reduction simultaneously falling out of solution. Generally ten minutes sufficed for the complete reduction of 5 g. of the oil.

Previous to being subjected to reduction, the hydrochloride of phenylethylamine was purified and tested. This sample of the base had been prepared from phenylalanine by splitting off carbon dioxide. Recrystallised from alcohol, the hydrochloride was found to melt at 215°, thus proving its purity. The compound decolorised permanganate solution instantly. Its chloroplatinate (rhombs and flakes from water) was found to decompose at approximately 250°. The properties of the free base were likewise found to agree with the properties of phenylethylamine in all respects.

Of this hydrochloride, 0.6 g. was reduced by shaking at ordinary temperature in aqueous solution with hydrogen and a catalyser in the shape of finely divided platinum. The absorption of hydrogen proceeded but very slowly, so that the 253 cc. theoretically requisite for complete reduction had been absorbed only at the end of about 1.5 hours. Almost precisely at this point, the absorption stopped entirely. This is a decided proof that no leakage,

¹ Cf. H. Meyer's *Determination of Radicals in Carbon Compounds* (3d. original edition) for a detailed description of the method and its application.

but rather solely absorption had been taking place. Another 1.35 g. sample of the same hydrochloride was reduced in the same way. In this case also, the absorption stopped as soon as the requisite volume of hydrogen (570 cc.) had been absorbed. After filtering off the platinum, the solutions were evaporated, thus yielding the *hydrochloride* of the reduction-product in the shape of a white, crystalline mass. This compound was found to be readily soluble in water. It was purified by dissolving it in alcohol, and reprecipitating by means of ether. It melts at 252° , *i.e.* approximately 40° higher than the hydrochloride of unreduced phenylethylamine. The compound no longer decolorises permanganate solution—an additional sign that complete reduction has taken place. Millon's reagent causes a white precipitate which however readily redissolves when gently heated.

The chloroplatinate. With platinic chloride, a voluminous precipitate resulted. This salt was always obtained finely crystalline on recrystallising it from water. It decomposes and chars at $255\text{--}257^{\circ}$, previously becoming somewhat darker at 220° . While the chloroplatinate was being decomposed by magnesium, during the chlorine determination, a very strong basic odour became apparent.

0.1362 g. vac.-dry; 0.0000 g. H_2O ; 0.0399 g. Pt; 0.1751 g. AgCl.

0.1363 g. vac.-dry; 0.0000 g. H_2O ; 0.0398 g. Pt.

	Found	
Pt	29.29 %	29.20 %
Cl	31.80	

Calculated for hexahydrophenylethylamine chloroplatinate $(\text{C}_8\text{H}_{17}\text{NHCl})_2\text{PtCl}_4$	
	29.40 %
	32.04

The aurichloride. Recrystallised from water containing a few drops of hydrochloric acid, this salt takes the shape of large, very thin, striated, glistening flakes. It was dried in a vacuum desiccator. It melts somewhat indistinctly at about $135\text{--}138^{\circ}$.

0.1275 g.; 0.0000 g. H_2O ; 0.0538 g. Au

0.1421 g.; 0.0000 g. H_2O ; 0.0599 g. Au

Found 42.23 % 42.19 % Au

Calculated for $\text{C}_8\text{H}_{18}\text{N}$, AuCl_4 : 42.23 % Au

The picrate. Recrystallised from water, this at times formed prismatic needles, and at other times, transparent, glistening flakes. It was found to melt at $155\text{--}156^{\circ}$.

This examination of the reduction-product fully suffices to establish its identity as hexahydrophenylethylamine, for it and its derivatives agree in every respect with the data upon cyclohexylethylamine [Wallach, 1908], as obtained by the reduction of cyclohexylacetonitrile.

An additional attempt to reduce phenylethylamine was undertaken. In contradistinction to that of the two reductions just mentioned, the sample of base now employed represented the purchased synthetic product, in the shape of the hydrochloride. An attempt to reduce 1 g. of this by means of the afore-mentioned method showed that the compound would absorb no hydrogen whatsoever. Before repeating the attempt, the compound in question was thoroughly examined, in order to confirm its identity with phenylethylamine.

The hydrochloride crystallised from alcohol in thin flakes, melting at 214–216°, thus agreeing perfectly with the previous sample. The substance however decolorised permanganate solution but very slowly; a dilute solution requiring several hours. The base, liberated by alkali, represented an oil with an odour much like that of methylamine. The base quickly absorbs carbon dioxide from the air, thus producing a carbonate which forms thin flakes. The base dissolves in ether and in alcohol. The chloroplatinate, recrystallised from water, forms small, faintly yellow flakes, generally lozenge-shaped, joined and superimposed to form spear-like structures. The compound becomes darker at 210°, black at 220°, and then melts at about 255°. It is practically insoluble in alcohol, sparingly soluble in cold water, more readily soluble in hot water. As regards the chloroplatinate, it will be noted that Bernthsen (working with the synthetic base) found it to be more readily soluble in alcohol than in water, whereas Schulze and Barbieri (working with the base from phenylalanine) found it to be far more readily soluble in water. In addition a few minor discrepancies were evidently noted to exist between the bases mentioned. The picrate crystallises from water or alcohol, either in small plates or large, thick prisms, M.P. 169°. The aurichloride is readily formed upon gently heating the mixture of the components. Recrystallised from water acidulated with hydrochloric acid, it forms very thin, shapeless, faintly yellow flakes, M.P. 98–99° (air-dried). Millon's reagent and mercuric chloride form white precipitates with the compound.

According to this examination—as becomes apparent upon consulting the properties quoted for phenylethylamine and its salts—the base in question agrees with phenylethylamine in all respects, and is accordingly identical with it. Practically the sole difference noted between the synthetic base and that obtained from phenylalanine was the slightly differing behaviour towards permanganate solution. In judging this point, it is well to recall that Bernthsen, as opposed to Schulze and Barbieri (as has been pointed out), noted a difference between natural and synthetic phenylethylamine; this

slight difference being evident in the solubility of the respective chloroplatinates. Two additional attempts to reduce the present sample of phenylethylamine were made according to the afore-mentioned method of reduction, and with freshly prepared platinum and palladium catalysers. In neither case was any hydrogen whatsoever absorbed by the compound. For the time being, no explanation can be ventured for this apparent difference between the two samples of phenylethylamine here subjected to reduction.

Attempted reduction of tyrosine. The tyrosine employed was obtained by hydrolysis of Italian silk, by means of sulphuric acid. The purified product, m.p. 301–302°, was subjected to reduction by the above-mentioned method. Six attempts were made under various conditions and with various active catalysers, but in no case was any hydrogen whatsoever absorbed. In working up the tyrosine from these attempts, a small amount of phenylalanine was isolated in the shape of its copper-salt. Precipitated from alcohol by means of water, this salt formed pale blue, minute flakes.

0.1578 g. (air-dry); 0.0129 g. H₂O; 0.0297 g. CuO

0.1357 g. (air-dry); 0.0109 g. H₂O; 0.0256 g. CuO

	Cu	H ₂ O
Calculated for (C ₉ H ₁₀ O ₂ N) ₂ Cu, 2H ₂ O:	14.86 %	8.41 %
Found: 	15.02	8.18
	15.08	8.04

The amino-acid itself, upon being subjected to an extensive examination, proved itself absolutely identical with *dl*-phenylalanine [Abderhalden, 1911].

An additional attempt was made to reduce pure isolated phenylalanine (obtained from cheese) by this method of reduction, but the result was again negative.

Attempted reduction of p-hydroxyphenylethylamine. The *p*-hydroxyphenylethylamine here subjected to treatment by the above method, had been prepared from tyrosine by carefully heating small amounts in a partial vacuum, in order to split off the carbon dioxide. The purified hydrochloride of this base melted at 266–268° [cf. Takaoki Sazaki, 1914, who obtained a hydrochloride of m.p. 268–269°], its picrate at 200°, and all the tests applied agreed with the properties of *p*-hydroxyphenylethylamine. Several attempts to reduce this compound were undertaken, but in no case could reduction be effected.

REFERENCES.

- Abderhalden (1911). *Biochem. Handlex.* **4**, 677.
 Sazaki (1914). *Biochem. Zeitsch.* **59**, 434.
 Wallach (1908). *Annalen*, **359**, 287.
 Willstätter und Hatt (1912). *Ber.* **45**, 1471.