328. *Strychnine and Brucine. Part LI. Oxy*pseudo*strychnine.*

By C. A. Friedmann.

Both strychnine and *pseudo*strychnine, on catalytic oxidation in presence of ammoniacal solutions of a cobalt salt, afford a carbinol-amine, oxy*pseudo*strychnine, which contains one atom of oxygen more than *pseudo*strychnine.

Evidence is adduced for the conclusion that this base is either *pseudo*strychnine *N*-oxide or a substituted hydroxylamine containing the grouping C(OH)–O–N.

Before discovery of the elegant method of obtaining *pseudo*strychnine from strychnine *N*-oxide (Bailey and Robinson, *J.*, 1948, 703), attempts were made to improve upon the catalytic oxidation process (Leuchs, *Ber.*, 1937, **70**, 1543) by substitution of other catalysts for copper sulphate. During this work it was observed that a solution of strychnine in chloroform, when shaken in the presence of a cobalt salt and ammonia, rapidly absorbed two atoms of oxygen; under similar conditions *pseudo*strychnine absorbed one atom of oxygen, affording the same product.

The new base, $C_{21}H_{22}O_4N_2$, m. p. 246°, could be prepared in twenty-four hours and in yields of up to 70% by the use of oxygen freshly prepared from potassium chlorate and manganese dioxide. Obtained from this source, the oxygen contained chlorine and its oxides, which propably served as carriers, since the rate of absorption decreased rapidly if the oxygen had been stored over water for a few days.

Like *pseudo*strychnine, the new base, termed oxy*pseudo*strychnine, is a carbinol-amine and forms ethers on attempted recrystallisation from simple alcohols. These ethers are formed less readily, and are also less stable, than those from *pseudo*strychnine. Thus, when kept for 3—4 weeks in a desiccator, or when dried at 140°/15 mm. for three hours, they revert to the carbinol-amine, m. p. 246°, probably as a result of hydrolysis by the liberated water of crystallisation usually present.

Unlike *pseudo*strychnine, however, this base has not been obtained in two isomeric forms, nor does it afford either an *O*- or a *N*-acetyl derivative. It is not merely *pseudo*strychnine containing a molecule of water of crystallisation, as that substance, $C_{21}H_{22}O_3N_2,H_2O$, has been isolated from the mother-liquors and readily affords the known *pseudo*strychnine.

Oxy*pseudo*strychnine affords a perchlorate, methoperchlorate, and dihydro-derivative, all of which contain an atom of oxygen more than the corresponding *pseudo*strychnine derivatives. The ease with which the dihydro-derivative is formed indicates that the original strychnine double bond was not involved, *e.g.*, in epoxide formation.

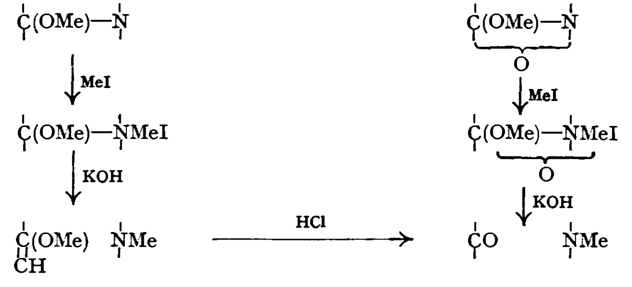
A diagnostic reaction for the character of the second oxygen atom has not been found, the base being inert to reagents for the usual oxygen-containing functional groups.

The most significant difference between the new base and *pseudo*strychnine is the comparative stability of the former to acid reducing agents, whereas *pseudo*strychnine in these circumstances is readily converted into strychnine.

Either zinc dust or tin with hydrochloric acid, and sulphur dioxide in chloroform are without action. Failure to react with the last reagent would suggest that the substance is not a *N*-oxide since strychnine *N*-oxide, in these circumstances, readily reverts to strychnine.

Alkaline reducing agents on the other hand, *e.g.*, metallic sodium in moist chloroform, readily convert it into *pseudo*strychnine.

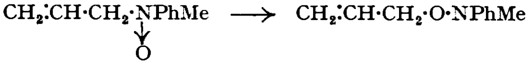
Like *O*-methyl*pseudo*strychnine, the methyl ether of the new base adds methyl iodide to form *O*-methyloxy*pseudo*strychnine methiodide. Treatment of this methiodide with alcoholic potassium hydroxide or sodium methoxide does not afford the expected methine but gives instead *N*-methyl*chanopseudo*strychnine, m. p. 263°, which in the parallel *pseudo*strychnine degradation can only be obtained by hydrolysis of the des-base under acid conditions:



The action of aqueous ammonia on methyloxy*pseudo*strychnine methiodide does not afford the *chano*-derivative, indicating that the substance is in fact a methiodide and not merely *N*-methyl*chanopseudo*strychnine hydriodide, $\overset{|}{\underset{|}{\mathrm{C}}}\mathrm{O}\ \ \overset{|}{\underset{|}{\mathrm{N}}}\mathrm{Me,HI}$.

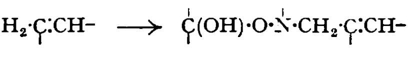
The fact that the new base can be obtained from *pseudo*strychnine by catalytic oxidation and that the two methoxy-methiodides can be equated in methyl*chanopseudo*strychnine emphasises the close relationship of the two series.

The most probable structures for the new base in the light of the available evidence are (*a*) that it is *pseudo*strychnine *N*-oxide which, for some reason, has unusual stability to acid reducing agents, or (*b*) that the initially formed *N*-oxide, being an allylamine oxide, is isomerised in the alkaline medium to a substituted hydroxylamine in a manner analogous to that in which methylallylaniline *N*-oxide has been shown to give phenylmethylallylhydroxylamine (Meisenheimer, *Ber.*, 1919, **52**, 1667):



$$\mathrm{CH_2{:}CH{\cdot}CH_2{\cdot}\underset{\downarrow\atop O}{N}PhMe} \longrightarrow \mathrm{CH_2{:}CH{\cdot}CH_2{\cdot}O{\cdot}NPhMe}$$

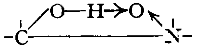
Oxy*pseudo*strychnine would then be obtained according to the scheme



$$\overset{|}{\underset{|}{\mathrm{C}}}\mathrm{(OH){\cdot}}\underset{\downarrow\atop \mathrm{O}}{\overset{|}{\mathrm{N}}}\mathrm{{\cdot}CH_2{\cdot}}\overset{|}{\underset{|}{\mathrm{C}}}\mathrm{{:}CH{-}} \longrightarrow \overset{|}{\underset{|}{\mathrm{C}}}\mathrm{(OH){\cdot}O{\cdot}}\overset{|}{\mathrm{N}}\mathrm{{\cdot}CH_2{\cdot}}\overset{|}{\underset{|}{\mathrm{C}}}\mathrm{{:}CH{-}}$$

*pseudo*Strychnine *N*-oxide has hitherto been unknown. Leuchs (*Ber.*, 1944, **77**, 403) has shown that treatment of *pseudo*strychnine with acidic hydrogen peroxide affords a neutral product which is not a *N*-oxide but contains the group ·CO—N< and does not give the Otto reaction.

If oxy*pseudo*strychnine is a *N*-oxide, it is necessary to account for the extreme stability towards acid reducing agents. The most probable explanation would be that chelation occurs in acid but not in alkaline medium, between the N→O and the contiguous hydroxyl group:



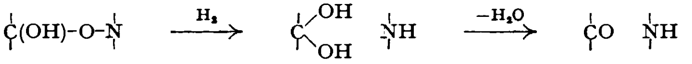
The additional assumption must then be made that the existence of N→O in the molecule does not materially affect ether formation at the *pseudo*strychnine hydroxyl group.

In other respects, too, oxy*pseudo*strychnine does not behave as a normal *N*-oxide. Thus, in distinction from strychnine *N*-oxide, it is almost completely insoluble in one-hundred times its weight of hot neutral 6% hydrogen peroxide. Boiling for an hour with this reagent affords mainly unchanged material, together with traces of a neutral product insoluble in dilute sulphuric acid. This neutral substance affords the Otto reaction; therefore aromatisation of the indole skeleton could not have occurred as in the case of Leuchs's " strychnone."

Acidic hydrogen peroxide, on the other hand, oxidises the base to a substance which has not been obtained pure, but is soluble in both acids and alkalis and may therefore be an amino-acid.

If, however, hydroxylamine formulation is postulated, then the stability of oxy*pseudo*strychnine towards acid reducing agents must be attributed to the closely knit ring system $\mathrm{-\overset{\ulcorner R_1 \urcorner}{\underset{\llcorner R_2 \lrcorner}{C{-}O{-}N}}}$, since normal trisubstituted hydroxylamines do not usually behave in this manner.

The formation of *pseudo*strychnine from oxy*pseudo*strychnine by reduction with metallic sodium would then probably proceed according to the scheme:

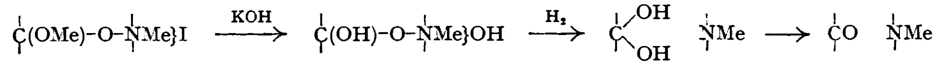


$$\overset{|}{\underset{|}{\mathrm{C}}}\mathrm{(OH){-}O{-}}\overset{|}{\underset{|}{\mathrm{N}}} \xrightarrow{\mathrm{H_2}} \overset{|}{\underset{|}{\mathrm{C}}}\!\begin{smallmatrix}\mathrm{OH}\\ \mathrm{OH}\end{smallmatrix}\ \ \overset{|}{\underset{|}{\mathrm{N}}}\mathrm{H} \xrightarrow{-\mathrm{H_2O}} \overset{|}{\underset{|}{\mathrm{C}}}\mathrm{O}\ \ \overset{|}{\underset{|}{\mathrm{N}}}\mathrm{H}$$

*pseudo*Strychnine

Whether the substance is a *N*-oxide or a hydroxylamine, the mode of formation of *N*-methyl*chanopseudo*strychnine from *O*-methyloxy*pseudo*strychnine methiodide is not clear. The *N*-oxide formulation would require the methiodide to contain the grouping $\overset{|}{\underset{|}{\mathrm{C}}}\mathrm{(OMe){-}}\overset{|}{\underset{|}{\mathrm{N}}}\mathrm{(OMe)\}I}$, which on treatment with alkali should yield $\overset{|}{\underset{|}{\mathrm{C}}}\mathrm{(OMe){-}}\overset{|}{\underset{|}{\mathrm{N}}}\mathrm{(OMe)\}OH}$. Isomerisation to a *N*-methyl *chano*-compound is, on this basis, without precedent unless the assumption is made that treatment with alkali is accompanied by reduction and migration of a methyl group from O to N.

The hydroxylamine structure, on the other hand, whilst also requiring the assumption of reduction during treatment with alkali, would proceed without migration of a methyl group :



An obvious difference between the two possible structures is that, on the basis of the hydroxylamine formulation, the *O*-methyl methiodide should contain one *O*- and one *N*-methyl group, whereas the *N*-oxide structure would require two *O*-methyl groups. Zeisel estimation was, however, inconclusive, as at 360° it indicated only 1·3 methyl groups.

A definite formulation for the structure of oxy*pseudo*strychnine cannot be indicated at this stage since neither structure satisfactorily explains all the transformations. Further evidence will be sought.

EXPERIMENTAL.

*Oxy*pseudo*strychnine*.—Strychnine (50 g.), dissolved in chloroform (200 c.c.), was shaken, in the dark, in presence of freshly prepared oxygen (from potassium chlorate and manganese dioxide) with a catalyst consisting of cobalt chloride (30 g.), ammonia (25 c.c.; *d* 0·88), and water (300 c.c.).

After 8 hours, 1·5 l. of oxygen had been absorbed, and in 30 hours 3·2 l. (two atomic equivalents), the greenish-blue aqueous layer becoming reddish-brown. Thereafter absorption ceased.

The reaction mixture was acidified with 2N-hydrochloric acid, the chloroform removed on a steam-bath, and the resulting solution diluted with water (200 c.c.). After 4 hours at 0°, the liquid was filtered from a little neutral material and the filtrate made alkaline with aqueous ammonia. A pale brown base separated (m. p. 235—245°) which was dissolved in 2N-hydrochloric acid (200 c.c.) and, after treatment with Norite, was reprecipitated with concentrated aqueous ammonia from the cold solution.

The resulting white precipitate was collected, well washed with water, and redissolved in the minimum of 0·1N-hydrochloric acid. To this solution was added sodium acetate (10 g.), followed by a saturated solution of potassium hydrogen carbonate. The precipitated *oxy*pseudo*strychnine*, which separated in a still acid medium, was collected and well washed with water. After being dried at 100°, it was recrystallised from ether–chloroform to give fine, white needles (35 g.), m. p. 245—246° (after drying at 100°) (Found : C, 65·2; H, 6·5. $C_{21}H_{22}O_4N_2,H_2O$ requires C, 65·6; H, 6·25%).

*pseudo*Strychnine (8 g.), m. p. 233°, dissolved in chloroform (50 c.c.), when treated with a catalyst consisting of cobalt chloride (4 g.) and aqueous ammonia (5 c.c.; *d* 0·88) in water (200 c.c.), in presence of freshly prepared oxygen, absorbed 300 c.c. (one atomic equivalent) in 9 hours. The product was worked up as above and afforded oxy*pseudo*strychnine (6 g.), m. p. 246°, which was not depressed on admixture with the material prepared as above.

O-*Methyloxy*pseudo*strychnine*.—A solution of oxy*pseudo*strychnine (1 g.) in methyl alcohol (10 c.c.) was boiled for 5 minutes. Water was added to the hot solution until it became slightly turbid. On cooling, long needles separated, which were collected and dried at 80°/15 mm. (yield, 0·8 g.; m. p. 181—182°). When dried at higher temperatures, *e.g.*, 120°, the methyl ether reverted to the base, m. p. 246°, which, on recrystallisation from 80% methanol, again afforded the *methyl ether*, m. p. 181—182° (Found : C, 66·5; H, 6·55. $C_{22}H_{24}O_4N_2,H_2O$ requires C, 66·3; H, 6·5%).

On recrystallisation from absolute methyl alcohol, a methyl ether not containing water of crystallisation was isolated, having m. p. 174—175° (Found : C, 69·8; H, 6·7. $C_{22}H_{24}O_4N_2$ requires C, 69·5; H, 6·3%), $[\alpha]_D^{20}$ −90° (*c*, 0·0765 in chloroform).

O-*Ethyloxy*pseudo*strychnine*.—Oxy*pseudo*strychnine (1 g.) was refluxed with absolute ethyl alcohol (30 c.c.) for 3 hours. The resulting clear solution was concentrated to small volume (5 c.c.) from which, on cooling, white needles of the *ethyl ether*, m. p. 202—204° (0·75 g.), separated (Found : C, 70·5; H, 6·95; N, 7·5. $C_{23}H_{26}O_4N_2$ requires C, 70·0; H, 6·6; N, 7·1%).

*Methyl*pseudo*strychnine Hydrate*.—The still acid mother-liquors from which oxy*pseudo*strychnine had been precipitated were basified with aqueous ammonia, and the resulting precipitate was collected and extracted with 50% methanol (150 c.c.). The cooled solution was filtered from unchanged strychnine and concentrated to small bulk. On cooling, yellowish crystals of *methyl*pseudo*strychnine hydrate* separated, having m. p. 150—152°, which, after treatment with charcoal in methyl alcohol and 3 further crystallisations from 50% methanol, had m. p. 157—158° (0·4 g.) (Found : C, 68·7; H, 6·45; N, 6·85. $C_{22}H_{24}O_3N_2,H_2O$ requires C, 69·1; H, 6·8; N, 7·3%). These crystals had m. p. 135—138° when mixed with methyloxy*pseudo*strychnine, m. p. 174—175°. On dissolution in dilute hydrochloric acid and reprecipitation with aqueous ammonia, this substance afforded *pseudo*strychnine, m. p. 233°, which could be converted into methyl*pseudo*strychnine, m. p. 198—200°, by recrystallisation from methyl alcohol.

*Methyldihydro-oxy*pseudo*strychnine*.—Oxy*pseudo*strychnine (1 g.), dissolved in dilute acetic acid (30 c.c.), was shaken with platinum oxide (0·1 g.) in an atmosphere of hydrogen. 150 C.c. were absorbed in 30 minutes and a further 25 c.c. in 60 minutes (1 mol.). The resulting solution was filtered from the catalyst, and the base precipitated with aqueous ammonia and dried. The dihydro-compound had m. p. 199° and was converted into the *methyl ether* by recrystallisation from 80% methyl alcohol, forming colourless needles (0·9 g.) of m. p. 142—143° (Found : C, 66·2; H, 6·7. $C_{22}H_{26}O_4N_2,H_2O$ requires C, 66·0; H, 7·0%). The Otto reaction was positive.

*Oxy*pseudo*strychnine Perchlorate*.—Methyloxy*pseudo*strychnine (0·3 g.), m. p. 181°, was dissolved in hot 5% perchloric acid (10 c.c.) and set aside. White needles separated, which were taken up in hot water (10 c.c.) containing one drop of perchloric acid. After being then boiled for two minutes, the solution was filtered and set aside. White prisms separated which were collected and dried at 100°/15 mm. They had m. p. *ca.* 260° (decomp.) (0·28 g.) (Found: C, 54·2; H, 5·3; N, 6·0. $C_{21}H_{22}O_4N_2,HClO_4$ requires C, 53·95; H, 4·9; N, 6·0%).

Preparation of the perchlorate in cold solution and recrystallisation from cold water containing three drops of perchloric acid by evaporation of the solvent at 20°/15 mm. afforded the same perchlorate (Found : C, 53·8 ; H, 5·2 ; N, 6·0%).

*Oxy*pseudo*strychnine Methoperchlorate.*—Methyloxy*pseudo*strychnine (1 g.) was warmed for 15 minutes with a solution of methyl sulphate (1 c.c.) in benzene (10 c.c.). The methosulphate separated as an oily gum, on cooling of the solution. The benzene solution was decanted, and the residue was washed 3 times with pure benzene and then treated with 5% perchloric acid (20 c.c.) on the water-bath for 15 minutes. On cooling, white prisms separated, which were recrystallised from water containing a few drops of perchloric acid; yield, 1·1 g.; m. p. 240° (Found : C, 55·1; H, 5·0. $C_{21}H_{22}O_4N_2,CH_3ClO_4$ requires C, 54·9; H, 5·2%).

Attempted isomerisation of oxy*pseudo*strychnine by repeated boiling in concentrated hydrochloric acid and reprecipitation from the hot solution with aqueous ammonia (*d* 0·88) afforded only unchanged oxy*pseudo*strychnine, m. p. 246°.

Action of Cobalt Chloride Catalyst and Oxygen on N-*Methyl*chanopseudo*strychnine.*—*N*-Methylchano*pseudo*strychnine (5 g.) in chloroform (50 c.c.) was treated with a catalyst made from cobalt chloride (5 g.) and aqueous ammonia (5 c.c.; *d* 0·88) dissolved in water (150 c.c.). Shaking for one week in presence of freshly prepared oxygen did not result in any absorption of the gas.

*Reduction of Oxy*pseudo*strychnine.*—(i) *With zinc dust and hydrochloric acid.* Oxy*pseudo*strychnine (1 g.) was dissolved in 2N-hydrochloric acid (50 c.c.) and zinc dust (5 g.) added during 30 minutes. The reaction mixture was heated on a steam-bath for 5 hours, at the end of which no further reaction could be observed. The resulting product was diluted with water (150 c.c.), filtered, and made alkaline with aqueous ammonia. The ensuing precipitate was collected, dried, and extracted with chloroform. The extract, after removal of solvent, was twice recrystallised from methanol whereafter it had m. p. 181—182° (0·7 g.) and showed no depression of the m. p. on admixture with methyloxy*pseudo*strychnine.

(ii) *With tin and hydrochloric acid.* Substitution of granulated tin for zinc dust in the above reduction afforded only unchanged oxy*pseudo*strychnine.

(iii) *With sulphur dioxide.* Oxy*pseudo*strychnine (2 g.) was dissolved in moist chloroform (30 c.c.), and sulphur dioxide was bubbled through the solution for 1 hour. The resulting product, after removal of chloroform, was taken up in N-hydrochloric acid (25 c.c.) and reprecipitated with aqueous ammonia. The precipitate was collected, dried, and recrystallised from chloroform to which sufficient ether to induce turbidity had been added. White needles separated (1·8 g.), which had m. p. 245—246° and were identical (mixed m. p.) with the starting material.

(iv) *With sodium.* Oxy*pseudo*strychnine (1 g.) was dissolved in moist chloroform (20 c.c.), and freshly cut sodium (0·5 g.), from which most of the kerosene had been removed, was added in the form of a pellet wrapped in a piece of copper gauze. When the gas evolution had ceased, the wire gauze was removed and the chloroform evaporated on the water-bath. Dilute hydrochloric acid (10 c.c.) was added, the solution filtered, and the filtrate basified with aqueous ammonia. The white precipitate was dried and recrystallised from chloroform–ether, to give white needles, m. p. 233°. These were identical (mixed m. p.) with *pseudo*strychnine. Recrystallisation from methyl alcohol afforded colourless needles, m. p. 198—200°, identical with methyl*pseudo*strychnine.

Behaviour towards Hydrogen Peroxide.—A suspension of methyloxy*pseudo*strychnine (1 g.) in neutral 6% hydrogen peroxide (100 c.c.) was boiled under reflux for an hour. The hot solution was filtered from unchanged material (0·97 g.), and the filtrate concentrated under reduced pressure to 15 c.c. After being kept overnight in a refrigerator, the crystals which had separated (0·008 g.) were collected and dried. They had m. p. 222—225°, unchanged by recrystallisation from methanol. This substance was insoluble in dilute acids and was unaffected by sulphur dioxide in chloroform. It probably contained N(*b*)–CO. There was insufficient material for analysis, but it was shown to afford a positive Otto reaction.

A solution of methyloxy*pseudo*strychnine (0·75 g.) in 6% hydrogen peroxide (100 c.c.) and concentrated hydrochloric acid (2 c.c.) was boiled for 20 minutes, the solution becoming dark red. After concentration to 20 c.c., the solution was almost neutralised with aqueous ammonia, a brown amorphous product separating which redissolved in excess of aqueous ammonia.

Treatment of this amorphous product for an hour with charcoal in methyl-alcoholic hydrochloric acid gave, after removal of suspended matter and adjustment of the acidity to pH 6, a pale brown amorphous material which darkened when kept and could not be obtained pure, but could, in view of its solubility in both dilute acids and alkalis, be an amino-acid.

O-*Methyloxy*pseudo*strychnine Methiodide.*—Methyloxy*pseudo*strychnine (1·8 g.), m. p. 181°, after being kept in a desiccator over sulphuric acid for 1 week, was treated for 3 days at room temperature with dry, freshly distilled methyl iodide (15 c.c.). The excess of reagent was removed on the water-bath, and the residue taken up in methanol containing a few drops of N/5-sodium thiosulphate. The solution was concentrated to small volume, filtered, and allowed to cool. White prisms separated, which were recrystallised from 80% methanol to give a ***methiodide*** (2 g.), m. p. 224—226° (after drying on a water-bath) (Found : C, 49·3; H, 5·5; N, 5·5; OMe and NMe, 3·5. $C_{23}H_{27}O_4N_2I,2H_2O$ requires C, 49·5; H, 5·6; N, 5·0; OMe and NMe, 5·4%). The mother-liquor afforded 0·05 g. of the same methiodide, but no compound analogous to *N*-methyl*chanopseudo*strychnine hydriodide could be obtained. A solution of this methiodide, when treated with aqueous ammonia, gave no free base and was therefore not a hydriodide.

Treatment with Alcoholic Potassium Hydroxide.—Methyloxy*pseudo*strychnine methiodide (2 g.) in methanol (25 c.c.) was treated with potassium hydroxide (2 g.) in boiling water (5 c.c.). After 5 minutes a voluminous precipitate (1·3 g.) separated. The crude material, after being dried at 100°, had m. p. 260° and on recrystallisation from methanol m. p. 263°. It was (mixed m. p.) identical with *N*-methyl*chanopseudo*strychnine and was unchanged by prolonged boiling with 10% hydrochloric acid.

*Attempted Acetylation of Oxy*pseudo*strychnine.*—Dry oxy*pseudo*strychnine (1 g.), m. p. 246°, was refluxed with acetic anhydride (10 c.c.) and pyridine (3 c.c.) for 3 hours. The reaction mixture was poured into water and neutralised with aqueous ammonia. The resulting precipitate was collected, dried, washed with ether, and recrystallised from 80% methanol. The product (0·8 g.) had m. p. 180° and was identical (mixed m. p.) with methyloxy*pseudo*strychnine.

Replacement of the acetic anhydride and pyridine by (i) acetic anhydride alone, (ii) acetic anhydride and anhydrous sodium acetate, (iii) acetic anhydride and one drop of sulphuric acid, (iv) acetyl chloride, or (v) acetyl chloride and acetic anhydride yielded only unchanged material in each case.

*Attempted Dehydration of Oxy*pseudo*strychnine.*—Oxy*pseudo*strychnine (0·5 g.) was heated at 130°/15 mm. for 3 hours. The product was recrystallised from anhydrous chloroform–ether, to yield unchanged starting material. Oxy*pseudo*strychnine (2 g.) and anhydrous potassium hydrogen sulphate were therefore heated together for 30 minutes at 175°, and the resulting brown mixture was poured into water, made alkaline, and extracted with chloroform. The resulting brown base was dissolved in methanol and treated with charcoal. Removal of the charcoal and concentration of the brown solution afforded an amorphous solid which gave an amorphous perchlorate and an amorphous picrate, unsuitable for analysis.

Attempted dehydration of methyloxy*pseudo*strychnine by heating it at 140°/15 mm. for 30 minutes afforded oxy*pseudo*strychnine, m. p. 246—247°, which, on recrystallisation from 80% methanol, had m. p. 181—182° and was identical with the starting material.

Oxy*pseudo*strychnine did not react with either an alcoholic solution of potassium ferricyanide or an ethereal solution of methylmagnesium iodide. Refluxing with neutralised alcoholic solutions of semicarbazide hydrochloride or hydroxylamine hydrochloride afforded only unchanged material. Clemmensen reduction with amalgamated zinc and 15% hydrochloric acid did not result in any reduced product. The base did not reduce ammoniacal silver nitrate or Fehling's solution.

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THE DYSON PERRINS LABORATORY, OXFORD. [*Received, February 2nd,* 1950.]