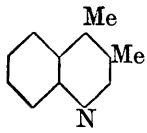
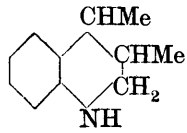
CCCXX.—*Stereoisomerism in Substituted* 1 : 2 : 3 : 4-*Tetrahydroquinolines. Part II.*

By SYDNEY GLENN PRESTON PLANT and REGINALD JOHN ROSSER.

IN Part I (J., 1929, 1861) the preparation of two stereoisomeric (*cis-* and *trans-*) tetrahydro-bases during the reduction of both 2 : 3-dimethyl- and 2 : 3-diphenyl-quinoline has been described and the connexion between these results and those obtained with more complex systems of a related type (see, *e.g.*, Perkin and Plant, J., 1928, 639) has been indicated. In view of the interesting results which have been more recently obtained during a study of the reduction of certain quinoline derivatives containing a third ring attached in the 3 : 4-position (Blount, Perkin, and Plant, J., 1929, 1975), it became desirable to extend these investigations in various directions. In the first place, the reduction of 3 : 4-dimethylquinoline (I) to the corresponding 3 : 4-dimethyl-1 : 2 : 3 : 4-

tetrahydroquinoline (II) under different conditions has been examined. The previous study of this reaction appears to be


(I.)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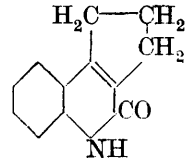
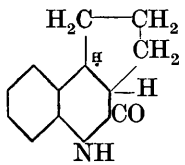

(III.)

confined to a single observation by Fischer and Meyer (*Ber.*, 1890, **23**, 2628), who reduced the base (I) with sodium and absolute alcohol, but the authors give no details concerning the primary product, which they converted into the methiodide of 1 : 3 : 4-trimethyl-1 : 2 : 3 : 4-tetrahydroquinoline. In the present work use has been made of the following reducing agents : (*a*) tin and alcoholic hydrochloric acid, (*b*) sodium and alcohol, (*c*) electrolysis in dilute sulphuric acid solution, and (*d*) zinc and alcoholic hydrochloric acid. It was found that the reduction of the base is a slow process and requires prolonged action of the reducing agent, and in most experiments a certain amount of unchanged 3 : 4-dimethylquinoline was recovered from the product. Although two stereoisomeric forms of (II) are possible, only one modification has been isolated under all the conditions investigated, and no definite indication has been observed of the presence of any appreciable quantity of the second form. The fact that only one tetrahydrobase, which is an oil giving a *phenylcarbamyl* derivative (m. p. 107—108°), a picrate (m. p. 143—145°), and a hydrochloride (m. p. 156—158°), is produced in this reaction is surprising in view of the results described in Part I.

It was observed by Blount, Perkin, and Plant (*loc. cit.*) that the reduction of 5-keto-2 : 3 : 5 : 6-tetrahydro-α-quinindene (III) with sodium amalgam in boiling alcohol led to the formation of both stereoisomeric modifications of 5-keto-2 : 3 : 4 : 5 : 6 : 13-hexahydro-α-quinindene (IV), but the further reduction by sodium and alcohol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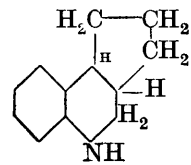
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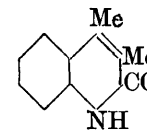
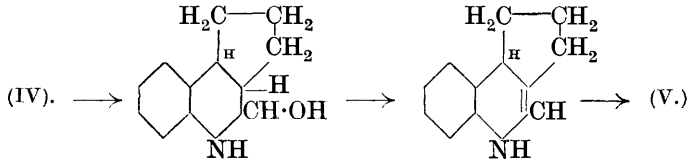
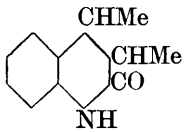

(VI.)

of a mixture of these stereoisomerides gave a single modification only of 2 : 3 : 4 : 5 : 6 : 13-hexahydro-α-quinindene (V), a reaction

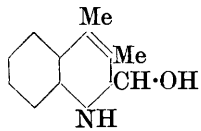
which could be explained if the latter stage was assumed to involve the following steps :



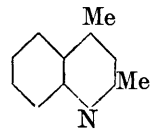
It became of interest, therefore, to study the reduction along similar lines of the analogous, but simpler, compound, 2-keto-3 : 4-dimethyl-1 : 2-dihydroquinoline (VI). The only recorded investigation in this direction appears to be contained in a single remark by Knorr (*Annalen*, 1888, **245**, 358) that the reduction of (VI) with sodium and alcohol gives dimethyltetrahydroquinoline, but no description of the product is given. The reduction of (VI) with sodium amalgam in boiling alcohol has now been found to yield a mixture of the two possible stereoisomeric modifications of 2-*keto*-3 : 4-*dimethyl*-1 : 2 : 3 : 4-*tetrahydroquinoline* (VII), which have been called (A), m. p. 127—128°, and (B), m. p. 117°, respectively. The amounts of the forms (A) and (B) produced were in the ratio of approximately 6 : 1. The interesting observation has also been made that, when the stereoisomeride (A) is treated with phosphorus oxychloride, oxidation takes place and the product is 2-chloro-3 : 4-dimethylquinoline. This reaction is analogous to that described by Aeschlimann (J., 1926, 2902) in which 2-keto-1 : 2 : 3 : 4-tetrahydroquinoline-4-carboxylic acid is converted by phosphorus pentachloride into 2-chloroquinoline-4-carboxylic acid. The further reduction of this mixture of the two stereoisomeric forms of (VII)



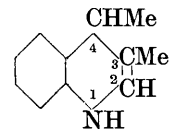
(VII.)



(VIII.)



(IX.)



(X.)

by the action of sodium and alcohol led to a product from which one only of the two possible modifications of 3 : 4-dimethyl-1 : 2 : 3 : 4-tetrahydroquinoline (II), identical with that described above, could be isolated. The reaction is, therefore, in some aspects very similar to that described by Blount, Perkin, and Plant. It was found, however, that the product also contained a small quantity of 3 : 4-dimethylquinoline, and it now becomes possible to make interesting deductions concerning the course of the reaction. It was discovered, on investigation, that the reduced base (II) was quite unchanged by treatment with sodium and boiling alcohol,

which makes it clear that the 3 : 4-dimethylquinoline must have appeared in the reduction process either as an intermediate product or from a side reaction. If it appears in the former rôle, its presence in the product is easily understood, since it has already been observed that the complete reduction of this base to its tetrahydro-derivative is a slow process. It now appears quite likely that the mechanism of the reduction of (VII) to (II) involves the following steps: (VII)⟶(VIII)⟶(I)⟶(II). The transformation of (VII) to (VIII) could result from a series of isomeric changes and the whole procedure accounts satisfactorily for the conversion of the two forms of (VII) into one form only of (II), since the reduction of (I) has already been shown to yield a single tetrahydro-base. It is clear that these views can be applied equally well to the reaction of Blount, Perkin, and Plant, and are preferable to the suggestions of these authors, which have no such experimental basis.

In view of the differences observed during the reduction of 2 : 3-dimethyl- and 3 : 4-dimethyl-quinoline, it became of interest to investigate the reduction of 2 : 4-dimethylquinoline (IX) under various conditions, although this substance has no analogue amongst the more complex polycyclic systems referred to above. Moreover, the incomplete state of the existing knowledge of this reaction also made it desirable to extend these investigations in this direction. Thus, although several authors have prepared "2 : 4-dimethyl-1 : 2 : 3 : 4-tetrahydroquinoline" by various routes, and the possibility of stereoisomerism in this substance has been recognised, there appears to have been no definite characterisation of the two forms (see, *e.g.*, Ferratini, *Gazzetta*, 1893, **23**, ii, 122; *Ber.*, 1893, **26**, 1811; Fischer and Meyer, *loc. cit.*; Ciamician, *Ber.*, 1896, **29**, 2460; von Braun, Gmelin, and Schultheiss, *Ber.*, 1923, **56**, 1338). The most far-reaching investigation into this reaction hitherto recorded is the work of Thomas (J., 1912, **101**, 725), who reduced the base (IX) with sodium and alcohol to an oily mixture of the two stereoisomeric modifications of 2 : 4-dimethyl-1 : 2 : 3 : 4-tetrahydroquinoline, but an attempt to separate them by crystallisation of the benzoylation product failed. However, the two forms are racemates, and, with the aid of *d*- and *l*-α-bromocamphor-π-sulphonic acids, Thomas succeeded in isolating the four optically active tetrahydro-bases, which he called *d*- and *l*-2 : 4-dimethyltetrahydroquinoline and *d*- and *l*-*iso*-2 : 4-dimethyltetrahydroquinoline respectively. A mixture of equal quantities of the first two gave a hydrochloride, m. p. 220—222°, and there can be no doubt that this racemate is identical with the tetrahydro-base (A) described below. During the present investigation the base (IX) has been reduced

(*a*) with sodium and alcohol, (*b*) with tin and alcoholic hydrochloric acid, (*c*) electrolytically, and (*d*) with zinc and alcoholic hydrochloric acid, and the two inactive stereoisomeric modifications of 2 : 4-dimethyl-1 : 2 : 3 : 4-tetrahydroquinoline have now been isolated in various proportions by methods described in the experimental section. Both modifications are liquids, but the tetrahydro-base (A) gave a hydrochloride (m. p. 228°), an *acetyl* derivative (m. p. 50—51°), a picrate (m. p. 139—141°), a phenylcarbamyl derivative (m. p. 121—122°), and a benzoyl derivative (m. p. 115°), whilst the tetrahydro-base (B) gave a *hydrochloride* (m. p. 178—179°), an *acetyl* derivative (m. p. 97—98°), a picrate (m. p. 188—190°), and a phenylcarbamyl derivative (m. p. 112—113°).

Of the quinoline compounds investigated, the 3 : 4-dimethyl derivative alone has failed to yield two stereoisomeric tetrahydrobases under the conditions employed. This fact can be explained if it is assumed, as is probable, that 3 : 4-dimethyl-1 : 4-dihydroquinoline (X) is an intermediate product in the reduction process. The carbon atoms 3 and 4 are now united by a single bond, and a consideration of the tetrahedral arrangements shows that, since the methyl group occupies a larger volume than a hydrogen atom, the 4-methyl radical will tend to displace the adjacent 3-methyl radical from its symmetrical position with respect to the 2 : 3-double linkage. The completion of the reaction, which involves the addition of a hydrogen atom to the 3-carbon atom, will, in consequence of this displacement, tend to take place more readily in one of the two alternative ways. The application of these considerations to the other quinoline derivatives investigated shows that in no case is there any probability of the similar displacement of a methyl group from a symmetrical position with respect to the double linkage.

The results described in Part I and in this communication make it apparent that in the reactions studied the relative proportions of the stereoisomerides produced vary considerably with the nature of the reducing agent. In a given reaction, relatively considerable quantities of both modifications are most likely to be formed if sodium and alcohol are used, and this observation has already been successfully applied to a more complex system of this type (Plant and Rosser, this vol., p. 1840).

EXPERIMENTAL.

Reduction of 3 : 4-*Dimethylquinoline.*—3 : 4-Dimethylquinoline has been prepared by Knorr (*loc. cit.*) from 2-keto-3 : 4-dimethyl-1 : 2-dihydroquinoline by distillation over hot zinc dust, but it has been found more satisfactory in the preparation of considerable quantities

to proceed along lines similar to those used by the same author (*Annalen*, 1886, **236**, 99) for the conversion of 2-keto-4-methyl-1 : 2-dihydroquinoline into lepidine. A mixture of the keto-compound (5·4 g.) and phosphorus oxychloride (20 c.c.) was boiled under reflux for ½ hour, poured on ice, and made alkaline with ammonia. The 2-chloro-3 : 4-dimethylquinoline (5 g.) obtained was heated in a sealed tube with red phosphorus (3 g.) and hydriodic acid (55 c.c. of *d* 1·7) for 20 hours at 175—180°. After being cooled, the solid product was collected, washed with water, and dissolved in boiling water. The hot, filtered solution was made alkaline with aqueous sodium hydroxide, and, on standing, 3 : 4-dimethylquinoline, which separated as an oil, soon solidified. After crystallisation from petroleum (b. p. 60—80°), it was obtained in colourless prisms, m. p. 73—74° (Knorr gives m. p. 65°) (Found : C, 84·3; H, 7·0. Calc. : C, 84·1; H, 7·0%). The yield was almost quantitative. The picrate of 3 : 4-dimethylquinoline separated from alcohol in yellow needles, m. p. 215—217° (Knorr gives m. p. 205°), and the hydrochloride, prepared by passing dry hydrogen chloride into an ethereal solution of the base, was obtained from absolute alcohol in colourless needles, m. p. 290° (decomp.) (Knorr does not record the m. p.).

(a) *With tin and alcoholic hydrochloric acid.* A mixture of 3 : 4-dimethylquinoline (2 g.), alcohol (50 c.c.), and granulated tin (58 g.) was boiled under reflux on the steam-bath for 90 hours, concentrated hydrochloric acid (160 c.c.) being added in portions at intervals. The whole was then filtered whilst hot, the residue was washed with boiling alcohol, and the united filtrates were steam-distilled to remove the alcohol. The residual liquid was made alkaline with potassium hydroxide (120 g. in concentrated aqueous solution) and again distilled in steam. The oily distillate was extracted with ether and dried with potassium carbonate and the base obtained by removal of the ether was heated at 60° with an equal weight of phenylcarbimide in benzene in a sealed tube for 3 hours. The resulting solution was shaken with dilute hydrochloric acid to extract a small quantity of basic material, and the benzene was then removed in steam. After the residue had been extracted with ether and dried with sodium sulphate, it was ultimately crystallised from benzene. First a little carbanilide separated, and then 1-*phenylcarbamyl*-3 : 4-*dimethyl*-1 : 2 : 3 : 4-*tetrahydroquinoline* was obtained. After recrystallisation from alcohol, it was isolated in colourless prisms, m. p. 107—108° (Found : C, 77·2; H, 7·1. $C_{18}H_{20}ON_2$ requires C, 77·1; H, 7·1%). The benzene mother-liquor, on being concentrated, yielded a further small quantity of this phenylcarbamyl derivative, and the residue,

after complete removal of the solvent, was hydrolysed by treatment with boiling aqueous-alcoholic potassium hydroxide for 15 hours. The product was isolated by steam distillation, the first portion of the distillate, which contained much alcohol, being acidified with hydrochloric acid, and then, after removal of the alcohol, made alkaline. The united liquids were shaken with ether, and the base so obtained was treated with picric acid in hot alcohol. On cooling, a small quantity of the picrate (m. p. 217°) of 3 : 4-dimethylquinoline separated, but no indication was obtained of the presence of a derivative of the second form of 3 : 4-dimethyl-1 : 2 : 3 : 4-tetrahydroquinoline.

The pure phenylcarbamyl derivative was hydrolysed with aqueous-alcoholic alkali, as described above, and an oily base obtained. When this was dissolved in hot alcoholic picric acid, there separated first, on cooling, a small quantity of the picrate (m. p. 217°) of 3 : 4-dimethylquinoline, which was produced, no doubt, by oxidation during the process of hydrolysis. The alcoholic solution subsequently yielded the picrate of 3 : 4-dimethyl-1 : 2 : 3 : 4-tetrahydroquinoline in orange-coloured prisms, m. p. 143—145°. The corresponding base was obtained, by shaking this with dilute aqueous ammonia and ether, as a colourless oil which could not be made to solidify. Its hydrochloride was prepared by passing dry hydrogen chloride into its solution in ether, and isolated from alcohol–ether in large colourless prisms, m. p. 156—158°.

(b) *With sodium and alcohol.* A boiling solution of 3 : 4-dimethylquinoline (1·5 g.) in absolute alcohol (75 c.c.) was treated gradually with sodium (15 g.), a further quantity of alcohol being subsequently added to dissolve all the sodium. After the addition of water (75 c.c.), the whole was steam-distilled. The first portion of the distillate was acidified with hydrochloric acid, the alcohol present removed in steam, the base liberated with alkali, and the mixture added to the main portion of the distillate. The basic product was extracted with ether, the extract was dried with potassium carbonate, and, after the removal of the solvent, a colourless oil (1·3 g.) was obtained. This was dissolved, together with picric acid (1·85 g.), in hot alcohol, and, on cooling, a yellow picrate separated. When this was recrystallised from alcohol, a very small quantity of the picrate (m. p. 211—213°) of unchanged 3 : 4-dimethylquinoline separated first, and then the picrate (m. p. 143—145°) of 3 : 4-dimethyl-1 : 2 : 3 : 4-tetrahydroquinoline was isolated. A further quantity of the latter derivative was obtained on concentrating the mother-liquor, and the total amount (3 g.) indicated the formation exclusively of the single modification of the tetrahydro-base already described.

(c) *Electrolytic reduction.* A solution of the base (4 g.) in sulphuric acid (250 c.c. of 20%) was submitted to electrolytic reduction at 95—100°, lead electrodes and a current of 5 amps. (approximately 0·02 amp. per sq. cm. of cathode) being used during 26 hours. After being made alkaline with sodium hydroxide, the product was extracted with ether, and examined by conversion into the picrate as described above. Although the yield of base was small, it gave the picrates of 3 : 4-dimethylquinoline and the 3 : 4-dimethyl-1 : 2 : 3 : 4-tetrahydroquinoline already obtained, whilst no evidence was procured of the presence of a second form of the latter substance.

(d) *With zinc and alcoholic hydrochloric acid.* A mixture of the base (6 g.), alcohol (150 c.c.), and zinc dust (100 g.) was boiled for 60 hours under reflux on the steam-bath, whilst concentrated hydrochloric acid (200 g.) was added gradually in portions. The whole was then filtered whilst hot, the alcohol removed by distillation, and the residue made alkaline with sodium hydroxide (180 g. in concentrated aqueous solution). The basic product was steam-distilled, extracted with ether, and dried with potassium carbonate. After removal of the ether, the oily residue (4·8 g.) was examined by conversion into the picrate as described above. The product which separated first from alcohol in small quantity appeared to be essentially the picrate of unreduced 3 : 4-dimethylquinoline, although its m. p. (190—192°, after recrystallisation) was somewhat low. However, a mixed m. p. determination gave the value 205—209°, and conversion into the corresponding hydrochloride led to a product which melted indefinitely at 269—272° and, when mixed with the hydrochloride of 3 : 4-dimethylquinoline (m. p. 290°), it melted over the intermediate range. The alcoholic mother-liquor readily yielded the picrate (m. p. 143—145°) of the 3 : 4-dimethyl-1 : 2 : 3 : 4-tetrahydroquinoline described above, its identity being confirmed not only by a mixed m. p. determination, but by conversion into the phenylcarbamyl derivative of the corresponding base. The ultimate residue from the alcoholic solution was very small, and no indication was obtained of the presence of a derivative of a second form of the tetrahydro-base.

Reduction of 2-*Keto*-3 : 4-*dimethyl*-1 : 2-*dihydroquinoline.*—A mixture of 2-keto-3 : 4-dimethyl-1 : 2-dihydroquinoline (13·5 g., prepared from ethyl methylacetoacetate and aniline as described by Knorr, *loc. cit.*) and alcohol (600 c.c.), to which a little sodium bicarbonate had been added, was kept boiling and vigorously stirred for 40 hours, whilst sodium amalgam (1500 g. of 4%) was added gradually, a stream of carbon dioxide being passed throughout the operations. After the hot mixture had been filtered, and the

residue washed with boiling alcohol, the united liquids were heated on the steam-bath to remove alcohol. After dilution with water, the solid product (12·5 g.), m. p. 105—110°, was collected and crystallised several times from alcohol, 2-*keto*-3:4-*dimethyl*-1 : 2 : 3 : 4-*tetrahydroquinoline* (*A*) being obtained in colourless prisms, m. p. 127—128° (Found : C, 75·4; H, 7·5. $C_{11}H_{13}ON$ requires C, 75·4; H, 7·4%). The mother-liquors were then evaporated and the residue was crystallised from carbon tetrachloride, yielding colourless prisms, m. p. 100—108°. After these had been recrystallised four or five times from alcohol, 2-*keto*-3 : 4-*dimethyl*-1 : 2 : 3 : 4-*tetrahydroquinoline* (*B*) was isolated in colourless plates, m. p. 117° (Found : C, 75·2, 75·7; H, 7·3, 7·5%). A mixture with the stereoisomeride (A) melted indefinitely at 100—110°. From the quantities isolated, it was estimated that the amounts of the (A) and (B) forms present in the reduction product were in the ratio of approximately 6 : 1. When the stereoisomeride (A) (0·9 g.) was heated for ½ hour with phosphorus oxychloride (4 c.c.), and the resulting mixture was poured on ice, made alkaline with ammonia, and allowed to stand, 2-chloro-3 : 4-dimethylquinoline (m. p. 130°) was obtained. Its identity was established by a mixed m. p. determination with an authentic specimen of this compound, prepared by the interaction of phosphorus oxychloride and 2-keto-3 : 4-dimethyl-1 : 2-dihydroquinoline (compare Knorr, *loc. cit.*).

The crude mixture (3·2 g.) of these two stereoisomerides (A) and (B), prepared as described above, was dissolved in boiling absolute alcohol (150 c.c.) and treated gradually with sodium (24 g.). After the addition of a little alcohol to remove undissolved sodium, a small quantity of water was added, and some of the alcohol was removed by heating on the steam-bath. The product was isolated by dilution with water and extraction with ether. After the solution had been dried with potassium carbonate, and the solvent removed, the oily residue was treated with an equivalent of hot alcoholic picric acid; on cooling, a mixture of picrates separated. When this was recrystallised from alcohol, the picrate (m. p. 215—217°) of 3 : 4-dimethylquinoline separated first : its identity was established by conversion into the corresponding base (m. p. 73—74°) and determination of the m. p. of a mixture of this with an authentic specimen of 3 : 4-dimethylquinoline. The alcoholic mother-liquor then yielded the picrate (m. p. 143—145°) of the 3 : 4-dimethyl-1 : 2 : 3 : 4-tetrahydroquinoline described above. No indication was obtained of the presence in the solution of a derivative of a second form of the latter base.

When the tetrahydro-base derived from this picrate was submitted to further treatment with sodium in alcoholic solution and

the product was examined in the usual way, no trace of 3 : 4-dimethylquinoline was detected.

Reduction of 2 : 4-Dimethylquinoline.—(a) *With sodium and alcohol.* A solution of 2 : 4-dimethylquinoline (10 g., prepared from aniline and acetylacetone as described by, *e.g.*, Combes, *Bull. Soc. chim.*, 1888, **49**, 90) in boiling absolute alcohol (250 c.c.) was treated gradually with sodium (44 g.). After ½ hour's boiling, any undissolved sodium was removed by the addition of alcohol, a little water added, and the mixture steam-distilled. The first portion of the distillate was acidified with hydrochloric acid, the alcohol removed in steam, and the residue made alkaline and added to the main part of the steam distillate. The oily product was extracted with ether, dried with potassium carbonate, and, after removal of the solvent, dissolved in dry ether and treated with dry hydrogen chloride. The mixture of hydrochlorides which separated from the solution was crystallised from absolute alcohol, and the *hydrochloride* of 2 : 4-dimethyl-1 : 2 : 3 : 4-tetrahydroquinoline (A) was obtained in colourless prisms, melting, after recrystallisation, at 228° (Found : C, 67·1; H, 8·3. $C_{11}H_{15}N$,HCl requires C, 66·8; H, 8·1%). After the separation of further quantities of this hydrochloride by concentration of the mother-liquor, the remaining solutions, together with the ethereal mother-liquor from the preparation of the mixed hydrochlorides, were evaporated, and the residue was decomposed with alkali. The basic product was collected in ether, dried with potassium carbonate, and, after removal of the ether, treated with boiling acetic anhydride (45 g.) for 20 hours. This solution was stirred into dilute aqueous sodium carbonate and left for some time, and the resulting solid was crystallised from alcohol, 1-*acetyl*-2 : 4-*dimethyl*-1 : 2 : 3 : 4-*tetrahydroquinoline* (*B*) being obtained in colourless prisms, m. p. 97—98° (Found : C, 77·1; H, 8·6. $C_{13}H_{17}ON$ requires C, 76·8; H, 8·4%). After the isolation of further quantities of this acetyl derivative by concentration of the mother-liquor, the residual product was hydrolysed by treatment with boiling aqueous-alcoholic potassium hydroxide for 4 days. After removal of the alcohol on the steam-bath, the residue was extracted with ether, and the ethereal solution was shaken with dilute hydrochloric acid. Evaporation of the ether then left a negligible quantity of material, indicating that hydrolysis was complete. The acid solution was consequently made alkaline, and the basic product was extracted with ether, dried with potassium carbonate, and, after concentration of the ethereal solution, treated with hydrogen chloride. The solid product was crystallised from absolute alcohol, a further quantity of the hydrochloride (A) (m. p. 228°) being obtained. The residue was then quite small, and the

total amounts of the two products obtained indicated that the tetrahydro-bases (A) and (B) were present in the original mixture in the proportion of approximately 2 : 3.

When the hydrochloride (m. p. 228°) was decomposed with alkali, 2 : 4-dimethyl-1 : 2 : 3 : 4-tetrahydroquinoline (A) was obtained as a colourless oil. Its 1-*acetyl* derivative, prepared by boiling its solution in acetic anhydride for 15 hours, separated from petroleum (b. p. 60—80°) in large flat prisms, m. p. 50—51° (Found : C, 76·5; H, 8·2. $C_{13}H_{17}ON$ requires C, 76·8; H, 8·4%). A mixture with the acetyl derivative (B), described above, melted at 45—47°. The picrate of the tetrahydro-base (A) separated from petroleum (b. p. 40—60°) in yellow prisms, m. p. 139—141°, the 1-phenylcarbamyl derivative, prepared with phenylcarbimide, separated from petroleum (b. p. 40—60°) in slender needles, m. p. 121—122°, and the 1-benzoyl derivative, prepared by shaking the base with benzoyl chloride and aqueous sodium hydroxide, separated from alcohol in colourless plates, m. p. 115°.

2 : 4-Dimethyl-1 : 2 : 3 : 4-tetrahydroquinoline (B) was obtained from the acetyl derivative (m. p. 97—98°) described above by hydrolysis with boiling aqueous-alcoholic potassium hydroxide for 30 hours, and separated as an oil on dilution with water. Its *hydrochloride* was obtained by passing dry hydrogen chloride into a solution of the base in ether, and was isolated from alcohol–ether in large colourless prisms, m. p. 178—179° (Found : C, 67·1; H, 8·2. $C_{11}H_{15}N,HCl$ requires C, 66·8; H, 8·1%). Its picrate crystallised from alcohol in yellow prisms, m. p. 188—190°; a mixture with the picrate of the base (A) melted indefinitely at 130—133°. The 1-phenylcarbamyl derivative, prepared by the action of phenylcarbimide on the base, separated from alcohol in large colourless prisms, m. p. 112—113°, and a mixture with the stereoisomeric phenylcarbamyl derivative melted at 95—100°.

(b) *With tin and alcoholic hydrochloric acid.* A boiling mixture of 2 : 4-dimethylquinoline (4 g.), alcohol (100 c.c.), and granulated tin (75 g.) was treated with concentrated hydrochloric acid (160 c.c.), which was added in portions over a period of 72 hours. The hot mixture was filtered, cooled, made alkaline with sodium hydroxide (150 g. in concentrated aqueous solution), and steam-distilled. The basic product was examined by the procedure described above, the hydrochloride (A) and acetyl derivative (B) being isolated, but the amounts obtained indicated that the tetrahydro-base (A) greatly preponderated in the reaction mixture, the quantity of the base (B) representing less than 10% of the total yield.

(c) *Electrolytic reduction.* A solution of 2 : 4-dimethylquinoline (4 g.) in sulphuric acid (200 c.c. of 20%) was electrolysed during

12 hours at 95°, lead electrodes and a current of 4·7 amps. (0·03 amp. per sq. cm. of cathode) being used. It was then made alkaline with sodium hydroxide and steam-distilled. Although the total yield of basic product was poor, it was examined by the method already described, and appreciable quantities of both the hydrochloride (A) and the acetyl derivative (B) were obtained. From the residue after steam distillation a considerable quantity of an amorphous solid was extracted with ether, but attempts to crystallise it failed, and its nature has not been determined.

(d) *With zinc and alcoholic hydrochloric acid.* A mixture of 2 : 4-dimethylquinoline (4 g.), alcohol (140 c.c.), and zinc dust (130 g.) was boiled for 5 days, whilst concentrated hydrochloric acid (250 c.c.) was added in portions at intervals. The hot mixture was then filtered, made alkaline, and steam-distilled. Owing to the presence of some unreduced 2 : 4-dimethylquinoline in the basic product it was necessary to modify the usual method of investigation. The mixture was first boiled with acetic anhydride for 10 hours, the resulting solution being shaken with aqueous sodium carbonate and extracted with ether. The extract was shaken with dilute hydrochloric acid, which removed the unreduced tertiary base, and the mixed acetyl derivatives, after being recovered from the ethereal solution, were hydrolysed by the action of boiling aqueous-alcoholic potassium hydroxide for 3 days. When the resulting basic mixture was examined by conversion into the hydrochlorides as described above, both the hydrochloride (A) and the acetyl derivative (B) were isolated. The amounts obtained indicated that the tetrahydro-bases (A) and (B) were present in the reaction mixture in the proportion of approximately 5 : 1.

THE DYSON PERRINS LABORATORY,
OXFORD.

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