47. *Cinnolines. Part III.*[1] *The Basic Centre of Cinnoline.*

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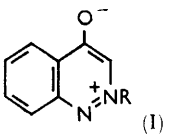
Alkylation of 4-hydroxycinnoline gives the anhydro-base of the 2-alkyl-4-hydroxycinnolinium hydroxide. Reduction with lithium aluminium hydride then gives the 2-alkyl-1,2,3,4-tetrahydrocinnoline. When these bases are warmed with picric acid solution they are converted into 2-alkylcinnolinium picrates. The same salts are obtained by quaternisation of cinnoline with methyl, ethyl, and benzyl halides, followed by treatment with picric acid. Thus the basic centre of cinnoline is at N-2, and not at N-1 as previously considered. 1,2,3,4-Tetrahydro-1-methylcinnoline similarly gives 1-methylcinnolinium picrate.

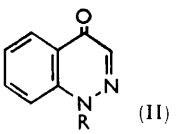
Methylation of 4-hydroxycinnoline has been shown [1] to give mainly the 2-methyl derivative (I; R = Me) and also some 1-methyl-4-cinnolone (II; R = Me). Ethylation and benzylation have now been examined.

[1] Part II, Ames and Kucharska, *J.*, 1963, 4924.

Alkylation of 3- or 4-hydroxycinnoline with sodium ethoxide and benzyl chloride gave the 2-benzyl derivative (III or I, respectively; R = CH_2Ph) (in neither case was an isomeric product isolated). Reduction of both products with lithium aluminium hydride gave 2-benzyl-1,2,3,4-tetrahydrocinnoline (IV; R^1 = H, R^2 = CH_2Ph). The position of the benzyl group was proved by reduction of the benzoyl derivative (IV; R^1 = Bz, R^2 = CH_2Ph) with zinc and acetic acid, followed by benzoylation, to give diamide (V; R = CH_2Ph) which was also synthesised from *N*-benzyl-*o*-nitrophenylacetamide (cf. Part II [1]).

The structures of both benzyl derivatives of the hydroxycinnolines were also confirmed by reduction. The anhydro-base (I; R = CH_2Ph), on reduction with zinc and ammonia solution, gave *o*-aminoacetophenone,[1] and treatment with phosphorus and hydriodic


(I)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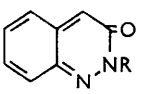
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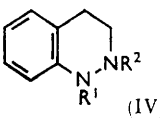
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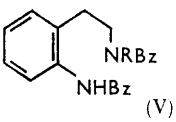
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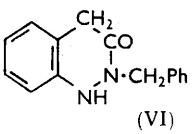
(VI)

acid yielded 4-hydroxycinnoline. 2-Benzyl-3-cinnolone (III; R = CH_2Ph) gave benzylamine as well as ammonia on reduction with phosphorus and hydriodic acid, but oxindole was not isolated.[2] Reduction of the cinnolone with zinc and ammonia solution [2] yielded the dihydro-derivative (VI), the structure of which was shown by further reduction with lithium aluminium hydride to 2-benzyl-1,2,3,4-tetrahydrocinnoline.

Treatment of 4-hydroxycinnoline with ethyl sulphate and alkali gave two *N*-ethyl derivatives (I and II; R = Et), the yield of the latter being very small. The structure of the anhydro-base (I; R = Et) was again established by reduction with zinc and ammonia solution to *o*-aminoacetophenone. Reduction of the anhydro-base with lithium aluminium hydride gave 2-ethyl-1,2,3,4-tetrahydrocinnoline (IV; R^1 = H, R^2 = Et), the structure of which was proved by reductive cleavage of the benzoyl derivative (IV; R^1 = Bz, R^2 = Et) with zinc and acetic acid, followed by benzoylation, to give diamide (V; R = Et). The latter was also synthesised from *N*-ethyl-*o*-nitrophenylacetamide.

During experiments on the reduction of hydroxycinnolines with lithium aluminium hydride, it was observed that addition of ethyl acetate to the reaction mixture before addition of alkali led to the formation of 2-ethyl-1,2,3,4-tetrahydrocinnoline. Neither 1,2,3,4-tetrahydrocinnoline nor the 1-ethyl derivative could be isolated. Similar *N*-ethylations have been reported in the reduction of amides under these conditions.[3]

Acetylation of 1,2,3,4-tetrahydrocinnoline was found to give the 2-acetyl derivative since reduction with lithium aluminium hydride again gave 2-ethyl-1,2,3,4-tetrahydrocinnoline. The basic centre of tetrahydrocinnoline would be expected to be at N-2, as in the acylation of other arylhydrazines.[4]

Treatment of 1,2,3,4-tetrahydro-2-methylcinnoline with ethereal picric acid gave the picrate which, on recrystallisation from ethanol, was unexpectedly oxidised to 2-methylcinnolinium picrate. 2-Benzyl- and 2-ethyl-1,2,3,4-tetrahydrocinnoline were rather more resistant to oxidation but, when boiled for some time with alcoholic picric acid, they were also converted into the 2-alkylcinnolinium picrates. In contrast no oxidation was observed when 1,2,3,4-tetrahydrocinnoline picrate was recrystallised.[5] This surprisingly

[2] Cf. Part II; also Neber, Knöller, Herbst, and Trissler, *Annalen*, 1929, **471**, 113.
[3] Wright, *J. Org. Chem.*, 1960, **25**, 1033; 1962, **27**, 1042.
[4] Cf. Jolles in "Chemistry of Carbon Compounds," Elsevier, London, 1954, Vol. III, p. 366.
[5] Ames and Kucharska, *J.*, 1962, 1509.

easy oxidation was of particular value in correlating the structures of the tetrahydro-compounds with those of the alkylcinnolinium salts since the *N*-alkyltetrahydrocinnolines darkened and resinified rapidly and attempts to oxidise them to crystalline products with other oxidising agents have so far been unsuccessful.

As far as we are aware, oxidations of this type by picric acid have not been described previously, although various other oxidations have been effected with picric acid. For instance, in palladium-catalysed reactions involving hydrogen transfer, picric acid is converted into picramic acid.[6] Glucose and ascorbic acid are also oxidised by alkaline solutions of picric acid, presumably with formation of picramic acid,[7,8] and creatinine is oxidised to methylguanidine by alkaline picric acid.[9] Perhaps a closer analogy with the present observations on alkyltetrahydrocinnolines (*i.e.*, trisubstituted hydrazines) is provided by the report by Kubota, Nara, and Onishi of the reduction of picric acid to picramic acid by hydrazine in ethanol in the presence of copper.[10]

2-Methyl-, 2-benzyl-, and 2-ethyl-cinnolinium picrate obtained by this process were the same as the quaternary picrates prepared by quaternisation of cinnoline with the alkyl halide and treatment of the resulting salt with an excess of picric acid solution. Thus the basic centre in cinnoline for quaternisation must be at N-2. The mild conditions involved in all these reactions seems very unlikely to cause rearrangement of the alkylcinnoline system. This view was confirmed by similar conversion of 1,2,3,4-tetrahydro-1-methylcinnoline into 1-methylcinnolinium picrate, which was distinct from the 2-isomer.

Extensive work to locate the basic centre of cinnolines has been described in the literature, but most of this work involved substituted cinnolines. Longuet-Higgins and Coulson [11] calculated the charge distribution in cinnoline and inferred that N-1 would be the basic centre. Pullman,[12] in discussing the basic centre of purine, pointed out that such calculations refer to the isolated, unreacting molecules and do not necessarily correlate with the chemical reactivity or basicity of the molecule.

Atkinson and Simpson [13] studied the quaternisation of 4-methylcinnoline and inferred from the enhanced reactivity of the 4-methyl group in the salt that quaternisation had occurred at N-1. Similar study of the quaternary salt of 3-methylcinnoline, however, led Alford and Schofield [14] to suggest that quaternisation might occur at N-2. These observations are not conclusive evidence but, in any case, they do not conflict with the present results since the basic centre of a methylcinnoline may not be that of cinnoline itself.

Earlier work was reviewed by Atkinson and Taylor [15] who also described the hydrogenation of cinnoline methiodide under alkaline conditions to give ammonia (free from methylamine) and 1-methylindole. This result appears to be in direct contrast to the present work but the evidence is not altogether satisfactory for the following reasons. First, Simpson [16] had shown that the alkylcinnolinium salts are decomposed under mild alkaline conditions to give the parent cinnoline, and cinnolines are known to give ammonia and indoles on catalytic hydrogenation.[17] Secondly, the 1-methylindole, formation of which is therefore crucial, was isolated as the picrate but only the m. p. was given without either

[6] Linstead, Braude, Mitchell, Wooldridge, and Jackman, *Nature*, 1953, **169**, 100; Braude, Jackman, and Linstead, *J.*, 1954, 3548.
[7] Schachkjeldian, *J. Russ. Phys. Chem. Soc.*, 1928, **60**, 1517.
[8] Levine and Merlis, *Bull. Creighton Univ. School Med.*, 1947, **4**, 14 (*Chem. Abs.*, 1948, **42**, 2932).
[9] Archibald, *J. Biol. Chem.*, 1962, **237**, 612.
[10] Kubota, Nara, and Onishi, *J. Pharm. Soc. Japan*, 1956, **76**, 801.
[11] Longuet-Higgins and Coulson, *J.*, 1949, 971.
[12] Pullman, *Tetrahedron Letters*, 1963, 231.
[13] Atkinson and Simpson, *J.*, 1947, 808; cf. Simpson, "Condensed Pyridazine and Pyrazine Rings," Interscience Publ., Inc., New York, 1953, p. 13.
[14] Alford and Schofield, *J.*, 1953, 1811.
[15] Atkinson and Taylor, *J.*, 1955, 4236.
[16] Simpson, *J.*, 1947, 1653; also Morley and Simpson, *J.*, 1949, 1354.
[17] See Jacobs in "Heterocyclic Compounds," Vol. VI, ed. Elderfield, Wiley, New York, 1957, p. 159.

a mixed m. p. or analytical data. Finally, if 1-methylindole was indeed obtained, the yield was small and a rearrangement or re-methylation may have occurred to some extent under the drastic conditions of the hydrogenation.

Finally, it should be pointed out that some of the earlier work on quaternisation of substituted cinnolines depended on conversion into 1-alkyl-4-cinnolones, the structures of which were assumed without experimental evidence.[15,16] In view of the formation of anhydro-bases of 2-alkyl-4-hydroxycinnolinium hydroxide from 4-hydroxycinnoline, similar alkylation may occur in the case of substituted 4-hydroxycinnolines and these structures therefore warrant re-examination.

Experimental

Evaporations were carried out under reduced pressure. Light petroleum refers to the fraction of b. p. 60—80°.

N-*Benzylation of* 4-*Hydroxycinnoline*.—4-Hydroxycinnoline (14·6 g.) and benzyl chloride (30 c.c.) were added successively to a boiling solution of sodium ethoxide (from sodium, 5 g., and ethanol, 500 c.c.). The mixture was left for 2 days, treated with water (1 l.), and extracted repeatedly with chloroform. Evaporation of the extracts gave the *anhydro-base* of 2-*benzyl*-4-*hydroxycinnolinium hydroxide* (18·2 g.) as pale yellow needles, m. p. 153—155° (from ethyl acetate) (Found: C, 76·5; H, 5·0; N, 11·8. $C_{15}H_{12}N_2O$ requires C, 76·2; H, 5·1; N, 11·9%).

3-Hydroxycinnoline (2 g.) was treated similarly, to give 2-*benzyl*-3-*cinnolone* (0·8 g.), yellow needles, m. p. 143—145° (from benzene–light petroleum) (Found: C, 76·1; H, 5·2; N, 11·6%).

2-*Benzyl*-1,2,3,4-*tetrahydrocinnoline*.—A solution of 2-benzyl-3-cinnolone (4·4 g.) in benzene (150 c.c.) was added dropwise to lithium aluminium hydride (3 g.) in ether (300 c.c.), and the mixture was refluxed for 4 hr. After addition of 5N-sodium hydroxide (5 c.c.), the mixture was refluxed for 1 hr. and filtered, the solid being washed with hot ethyl acetate. Extraction of the filtrates with 2N-hydrochloric acid, basification, isolation with ethyl acetate, and distillation gave the *base* (2 g.), b. p. 148—150°/0·25 mm. (Found: C, 79·6; H, 7·0; N, 13·1. $C_{15}H_{16}N_2$ requires C, 80·3; H, 7·2; N, 12·5%). 2-*Benzyl*-1,2,3,4-*tetrahydrocinnoline hydrochloride* formed needles, m. p. 190—195°, from ether–ethanol (Found: C, 68·8; H, 6·6; N, 10·8. $C_{15}H_{16}N_2$,HCl requires C, 69·0; H, 6·5; N, 10·7%). 1-*Benzoyl*-2-*benzyl*-1,2,3,4-*tetrahydrocinnoline* (prepared by action of benzoyl chloride–pyridine at room temperature) formed prisms, m. p. 149—151°, from ethyl acetate–light petroleum (Found: C, 80·1; H, 6·4; N, 8·5. $C_{22}H_{20}N_2O$ requires C, 80·5; H, 6·1; N, 8·5%).

Reduction of the *N*-benzyl derivative (6 g.) of 4-hydroxycinnoline in the same manner gave the same product (4·6 g.) (Found: C, 79·7; H, 7·2; N, 12·6%). The infrared spectra of the two samples were identical and the hydrochloride and benzoyl derivative from each had the same m. p. and mixed m. p.

Reduction of 1-*Benzoyl*-2-*benzyl*-1,2,3,4-*tetrahydrocinnoline*.—The benzoyl compound (0·5 g.) in hot acetic acid (10 c.c.) was added to zinc dust (3 g.) in acetic acid (20 c.c.) containing concentrated hydrochloric acid (1 drop). and the mixture was refluxed for 3 hr. The solution was decanted, basified, and extracted with ethyl acetate; evaporation gave some starting material and an oil, which was taken up in light petroleum. After removal of the solvent, the oil was benzoylated (Schotten–Baumann), to give N-(2-benzamidophenethyl)-*N*-benzylbenzamide, m. p. 145—146° (from ethyl acetate–light petroleum). The m. p. was undepressed on admixture with the authentic sample described below.

N-*Benzyl*-o-*nitrophenylacetamide*.—*o*-Nitrophenylacetyl chloride (from acid, 20 g.) in ether (100 c.c.) was added to a stirred, cooled solution of benzylamine (26 g.) in ether (200 c.c.). After 30 min., the solid was collected, washed with water, and recrystallised from ethanol–chloroform to afford the *amide* (20 g.), m. p. 141—142° (Found: C, 66·9; H, 5·3; N, 10·8. $C_{15}H_{14}N_2O_3$ requires C, 66·7; H, 5·2; N, 10·4%).

N-Ethyl-o-*nitrophenylacetamide*, prepared similarly, formed needles, m. p. 137—138°, from ethanol (Found: C, 57·8; H, 6·1; N, 13·9. $C_{10}H_{12}N_2O_3$ requires C, 57·7; H, 5·8; N, 13·5%).

2-*Amino*-N-*benzylphenethylamine*.—Hydrogenation of the nitro-compound (20 g.) in ethanol (200 c.c.) with 10% palladised charcoal (2 g.), followed by filtration, evaporation, and recrystallisation from ethanol, gave N-*benzyl*-o-*aminophenylacetamide* (14 g.), m. p. 131—132° (Found: C, 74·8; H, 6·6; N, 11·7. $C_{15}H_{16}N_2O$ requires C, 75·0; H, 6·7; N, 11·7%). This

(10 g.) in 1,2-dimethoxyethane (150 c.c.) was reduced with lithium aluminium hydride (4 g.) in the same solvent (100 c.c.). After the solution had refluxed for 4 hr., ether (250 c.c.) and 5N-sodium hydroxide (5 c.c.) were added, and the mixture was refluxed for 1 hr. Isolated as in the previous case, the basic fraction was distilled to give o-*amino*-N-*benzylphenethylamine* (4·1 g.), b. p. 147—148°/0·05 mm. (Found: C, 79·4; H, 8·4; N, 12·0. $C_{15}H_{18}N_2$ requires C, 79·6; H, 8·0; N, 12·4%). Benzoylation by the Schotten–Baumann method gave *N*-(2-*benzamidophenethyl*)-*N*-*benzylbenzamide*, needles m. p. 143—144° (from ethyl acetate–light petroleum) (Found: C, 80·2; H, 5·8; N, 6·0. $C_{29}H_{26}N_2O_2$ requires C, 80·2; H, 6·0; N, 6·4%).

Similarly were prepared N-*ethyl*-o-*aminophenylacetamide*, m. p. 79—80°, from ethyl acetate–light petroleum (Found: C, 66·9; H, 7·9; N, 16·1. $C_{10}H_{14}N_2O$ requires C, 67·4; H, 7·9; N, 15·7%), and N-(2-*benzamidophenethyl*)-N-*ethylbenzamide*, m. p. 105—107°, from ethyl acetate–light petroleum (Found: C, 77·5; H, 6·4; N, 7·3. $C_{24}H_{24}N_2O_2$ requires C, 77·4; H, 6·5; N, 7·5%). The intermediate diamine was not isolated.

Reductions of Anhydro-base of 2-Benzyl-4-hydroxycinnolinium Hydroxide.—(*a*) The anhydro-base (2 g.), zinc dust (6 g.), ethanol (50 c.c.), and 48% hydrobromic acid (1 drop) were refluxed on a steam-bath while aqueous ammonia (20 c.c.; *d* 0·88) was added gradually. The mixture was refluxed for 6 hr., filtered, and concentrated to small volume. Isolation of the basic fraction and distillation gave 2-aminoacetophenone (0·5 g.) b. p. 108°/15 mm. The phenylhydrazone had m. p. and mixed m. p. 105—106°.

(*b*) The anhydro-base (1 g.) was refluxed with red phosphorus (1 g.) and 55% hydriodic acid (10 c.c.) for 6 hr. Filtration, neutralisation with 2N-sodium hydroxide, and extraction with ether yielded 4-hydroxycinnoline, m. p. and mixed m. p. 225—227°.

Reductions of 2-Benzyl-3-cinnolone.—(*a*) A mixture of the cinnolone (1 g.), red phosphorus (1 g.), and 55% hydriodic acid (10 c.c.) was refluxed for 7 hr., cooled, filtered, basified, and distilled. The basic distillate was extracted with ether; evaporation of the extracts and addition of ethereal picric acid gave benzylamine picrate, m. p. and mixed m. p. 197—198°. The aqueous layer of the distillate was acidified with concentrated hydrochloric acid, evaporated to dryness, and treated with aqueous picric acid to give ammonium picrate, m. p. and mixed m. p. 274—276°.

(*b*) The cinnolone (2 g.), ethanol (50 c.c.), zinc dust (6 g.), and aqueous ammonia (20 c.c.; *d* 0·88) were refluxed for 6 hr. Zinc was collected and washed with ethyl acetate; evaporation of the combined filtrates and recrystallisation from ethyl acetate–light petroleum furnished 2-*benzyl*-1,2,3,4-*tetrahydro*-3-*oxocinnoline* (1·3 g.), m. p. 118—119° (Found: C, 75·6; H, 5·8; N, 11·5. $C_{15}H_{14}N_2O$ requires C, 75·6; H, 5·9; N, 11·8%).

This amide (1·2 g.) in 1,2-dimethoxyethane (75 c.c.) was added to lithium aluminium hydride (2 g.) in the same solvent (75 c.c.), and the mixture was refluxed for 4 hr. Isolated as in previous reductions, the basic fraction was distilled to give 2-*benzyl*-1,2,3,4-*tetrahydrocinnoline* (0·4 g.), b. p. 146—147°/0·25 mm. (hydrochloride, m. p. and mixed m. p. 190—195°).

Ethylation of 4-Hydroxycinnoline.—A solution of 4-hydroxycinnoline (5 g.) in 4N-potassium hydroxide (120 c.c.) was stirred at 50° while ethyl sulphate (5 c.c.) was added. The mixture was warmed at 70° for 15 min. and more 4N-potassium hydroxide (15 c.c.) was added. Extraction of the cooled solution with chloroform and evaporation of the extracts gave a solid (2 g.), m. p. 124—134°. Recrystallisation from benzene–light petroleum gave the *anhydro-base* of 2-*ethyl*-4-*hydroxycinnolinium hydroxide* (1·2 g.), yellow needles, m. p. 137—138° (Found: C, 68·7; H, 5·7; N, 16·2. $C_{10}H_{10}N_2O$ requires C, 69·0; H, 5·8; N, 16·1%).

Chromatography of the mother-liquors in benzene–light petroleum on a 4 in. column of alumina gave 1-*ethyl*-4-*cinnolone* as colourless needles, m. p. 85—87° (from light petroleum) (Found: C, 68·4; H, 5·9; N, 16·1%).

Reductions of Anhydro-base of 2-Ethyl-4-hydroxycinnolinium Hydroxide.—(*a*) Reduction of the anhydro-base with zinc and ammonia solution, as in the case of the *N*-benzyl compound, gave 2-aminoacetophenone (phenylhydrazone, m. p. and mixed m. p. 104—105°).

(*b*) The *N*-ethyl compound (3 g.) in benzene (100 c.c.) was added to lithium aluminium hydride (1·5 g.) in ether (100 c.c.), and the mixture was refluxed for 4 hr. Ether (100 c.c.) and 5N-sodium hydroxide (5 c.c.) were added and the mixture was refluxed for 1 hr. more. The solid was collected and washed with hot ethyl acetate, and the combined filtrate and washings were extracted with 2N-hydrochloric acid. Basification, isolation with ethyl acetate, and distillation yielded slightly impure 2-*ethyl*-1,2,3,4-*tetrahydrocinnoline* (1·3 g.), b. p 78—79°/0·2 mm. which darkened rapidly (Found: C, 71·1; H, 8·7; N, 17·4. $C_{10}H_{14}N_2$ requires C, 72·3; H, 8·5;

N, 19·3%). 1-Benzoyl-2-ethyl-1,2,3,4-tetrahydrocinnoline, prepared by the Schotten–Baumann method, crystallised from ethyl acetate–light petroleum and had m. p. 130—132°, undepressed on admixture with the sample described below.

Reduction of 1-*Benzoyl*-2-*ethyl*-1,2,3,4-*tetrahydrocinnoline*.—The benzoyl derivative (0·5 g.), zinc dust (1·5 g.), acetic acid (30 c.c.), and concentrated hydrochloric acid (1 drop) were heated on a steam-bath for 3 hr. The solution was decanted into an excess of 2N-sodium hydroxide and extracted with ethyl acetate. Evaporation and benzoylation of the residue (Schotten–Baumann) gave *N*-(2-benzamidophenethyl)-*N*-ethylbenzamide, m. p. 103—105° (from ethyl acetate–light petroleum). The m. p. was undepressed on admixture with the sample described above.

Reductive Alkylation of 3-*Hydroxycinnoline with Lithium Aluminium Hydride and Ethyl Acetate*.—3-Hydroxycinnoline (8 g.) was placed in a Soxhlet thimble and extracted by refluxing for 3 hr. with a solution of lithium aluminium hydride (10 g.) in 1,2-dimethoxyethane (250 c.c.). Ethyl acetate (50 c.c.) was added gradually and the mixture was left overnight and then refluxed for 3 hr. After addition of ether (250 c.c.) and 5N-sodium hydroxide (10 c.c.), the mixture was refluxed for 1 hr., cooled, and filtered, the solid being washed with hot ethyl acetate. The combined filtrates were evaporated and the residue was dissolved in ethyl acetate and extracted repeatedly with 2N-hydrochloric acid. Basification of the extracts and isolation with ethyl acetate gave 2-ethyl-1,2,3,4-tetrahydrocinnoline (2·4 g.), b. p. 89—90°/0·6 mm. The *benzoyl derivative* formed prisms, m. p. 130—131°, from light petroleum (Found: C, 77·0; H, 6·8; N, 10·3. $C_{17}H_{18}N_2O$ requires C, 76·7; H, 6·8; N, 10·5%). The m. p. was undepressed on admixture with the sample described above. 2-*Ethyl*-1,2,3,4-*tetrahydrocinnoline hydrochloride* crystallised from ether–ethanol and had m. p. 192—195° (Found: C, 60·6; H, 7·7; N, 14·4; Cl, 17·7. $C_{10}H_{15}ClN_2$ requires C, 60·4; H, 7·6; N, 14·1; Cl, 17·9%).

2-*Acetyl*-1,2,3,4-*tetrahydrocinnoline*.—1,2,3,4-Tetrahydrocinnoline [5] was treated with acetic anhydride–pyridine at room temperature. Evaporation yielded the *amide*, prisms, m. p. 83—84° (from ethyl acetate–light petroleum) (Found: C, 67·8; H, 6·5; N, 16·4. $C_{10}H_{12}N_2O$ requires C, 68·2; H, 6·9; N, 15·9%).

The compound (2·1 g.) in benzene (75 c.c.) was added to lithium aluminium hydride (1 g.) in ether (75 c.c.); the mixture was refluxed for 3 hr. and 5N-sodium hydroxide (3 c.c.) was added. After the suspension had been refluxed for 1 hr., it was filtered and the basic product isolated as before. Distillation gave 2-ethyl-1,2,3,4-tetrahydrocinnoline (1·25 g.), b. p. 81—82°/0·1 mm. The benzoyl derivative had m. p. and mixed m. p. 132—133°.

2-*Alkylcinnolinium Picrates from* 2-*Alkyl*-1,2,3,4-*tetrahydrocinnolines*.—1,2,3,4-Tetrahydro-2-methylcinnoline [1] was added to ethereal picric acid, to give the *picrate*, m. p. 100° (decomp.) (Found: C, 48·1; H, 3·9; N, 18·6. $C_{15}H_{15}N_5O_7$ requires C, 47·8; H, 4·0; N, 18·6%). Attempted recrystallisation of this picrate from ethanol–ether furnished 2-*methylcinnolinium picrate*, m. p. 132—133° (Found: C, 48·8; H, 3·2; N, 18·3. $C_{15}H_{11}N_5O_7$ requires C, 48·3; H, 3·0; N, 18·8%).

2-Benzyl-1,2,3,4-tetrahydrocinnoline (0·5 g.) and picric acid (1 g.) in methanol (20 c.c.) were refluxed for 10 min. Addition of ether precipitated 2-benzylcinnolinium picrate which was recrystallised from ether–ethanol and had m. p. 120—121°, undepressed on admixture with the sample described below.

A solution of 2-ethyl-1,2,3,4-tetrahydrocinnoline (0·5 g.) and picric acid (1 g.) in methanol (20 c.c.) was refluxed for 1 hr. Addition of ether and recrystallisation from ether–ethanol gave 2-*ethylcinnolinium picrate*, m. p. 109—111° (Found: C, 49·3; H, 3·5; N, 18·1. $C_{16}H_{13}N_5O_7$ requires C, 49·6; H, 3·4; N, 18·1%).

2-*Alkylcinnolinium Picrates from Cinnoline*.—Cinnoline methiodide [18] (0·5 g.) was warmed with saturated ethanolic picric acid (10 c.c.). On cooling, 2-methylcinnolinium picrate separated (m. p. and mixed m. p. 133—134°).

Cinnoline (0·25 g.), 2-methoxyethanol (20 c.c.), and benzyl chloride (3 c.c.) were warmed at 95° for 3 hr. The crude, oily quaternary salt obtained by evaporation was warmed with ethanolic picric acid, to give 2-*benzylcinnolinium picrate*, m. p. 120—121·5° (Found: C, 56·2; H, 3·8; N, 16·2. $C_{21}H_{15}N_5O_7$ requires C, 56·1; H, 3·4; N, 15·6%).

A mixture of cinnoline (0·25 g.), ethanol (25 c.c.), and ethyl iodide (2·5 c.c.) was refluxed for 3 hr. Addition of ether and repeated recrystallisation from ethanol–ether furnished 2-*ethylcinnolinium iodide*, orange needles, m. p. 173—174° (Found: C, 41·7; H, 3·7; N, 9·8.

[18] Busch and Rast, *Ber.*, 1897, **30**, 521.

$C_{10}H_{11}N_2I$ requires C, 42·0; H, 3·8; N, 9·8%). The ethiodide, with ethanolic picric acid, gave 2-ethylcinnolinium picrate, m. p. and mixed m. p. 108—111°.

1-*Methylcinnolinium Picrate*.—A mixture of 1,2,3,4-tetrahydro-1-methylcinnoline picrate [1] (0·25 g.) and 2% methanolic picric acid (25 c.c.) was refluxed for 15 min. Addition of ether and recrystallisation from ethanol–ether gave 1-*methylcinnolinium picrate*, needles, m. p. 155—156° (decomp.) (Found: C, 48·7; H, 3·1; N, 18·8. $C_{15}H_{11}N_5O_7$ requires C, 48·3; H, 3·0; N, 18·8%).

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