156. *Cinnolines. Part XII. 4-Methylcinnolines.*

By C. M. Atkinson and J. C. E. Simpson.

The preparation of 4-methylcinnolines is described. Conversion of these substances into 4-*p*-dimethylaminostyryl-1-ethylcinnolinium iodides discloses activity of the 4-methyl group, and indicates that N^1 is the basic centre in these compounds.

An important aspect of cinnoline chemistry—and one which exemplifies what is still largely an unexplored problem in relation to polynitrogenous ring-systems in general—is the question of the location of the basic centre of the heterocyclic nucleus. Busch and Rast (*Ber.*, 1897, **30**, 521) stated that the parent substance, cinnoline (I), is a strong base, and it might therefore be supposed, from analogy with the difference in basicity between *iso*quinoline and quinoline, that N^2 and not N^1 participates in the formation of salts of cinnoline derivatives. However, it was by no means certain that mere casual comparisons of this type would prove reliable, and more direct chemical evidence was therefore sought.

As one line of attack, a study has been made of the effect of substitution at C^4 on the ease with which various cinnoline bases may be converted into quaternary salts, together with an investigation of the alkaline decomposition of the salts so formed. A discussion of this work is reserved for a later paper in this series, and in the present communication we describe preliminary results obtained from an alternative approach to the problem, namely the preparation and study of 4-methylcinnolines (II). Compounds of this type should exhibit the methyl-group reactivity characteristic of quinaldines or lepidines if N^1 is the basic centre, but not if N^2 is the point of maximum electron availability.


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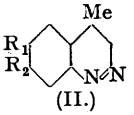
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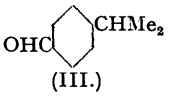
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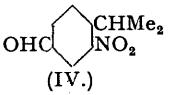
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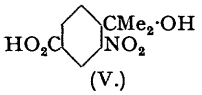
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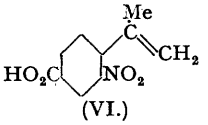
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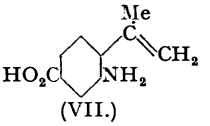
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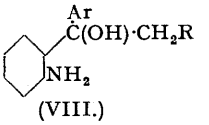
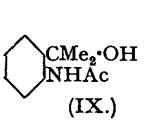

(VIII.)

The only example of a 4-methylcinnoline in the literature is the 7-carboxylic acid (II; $R_1 = H$; $R_2 = CO_2H$), prepared by Widman (*Ber.*, 1884, **17**, 722) from cuminal (III) *via* the intermediates (IV—VII). In repeating this work we found that the crude acid was most conveniently purified through the *ethyl* ester (II; $R_1 = H$; $R_2 = CO_2Et$). Although each stage of the synthesis proceeded reasonably smoothly, the cost of the starting material renders the compound somewhat inaccessible in quantity, and we therefore turned our attention to the preparation of other 4-methylcinnolines.

We have found that *o-iso*propenylanilines can be readily prepared by the action of methylmagnesium iodide on anthranilic methyl esters or *o*-aminoacetophenones, followed by dehydration of the resultant carbinols with phosphoric anhydride. These carbinols were surprisingly resistant to hot dilute sulphuric acid, in contrast to the ease with which diarylcarbinols of type (VIII) can thus be dehydrated (Stoermer and Fincke, *Ber.*, 1909, **42**, 3115; Stoermer and Gaus, *ibid.*, 1912, **45**, 3104; Simpson and Stephenson, *J.*, 1942, 353; Simpson, *J.*, 1943, 447; 1946, 673); for example, *o*-aminophenyldimethylcarbinol remained unchanged unless conditions were so severe as to produce sulphonation. On the other hand, the carbinol (V) is smoothly dehydrated by cold concentrated sulphuric acid, and according to Widman the amine derived from (V) also can be easily dehydrated. This contrast between the behaviour of our monoaryl-carbinols prepared from *o*-aminoacetophenones and that of the monoaryl-carbinol (V) and compounds of type (VIII) suggested that the introduction of

electron-attractive groups into the aniline nucleus might facilitate dehydration, and would in any event be expected to retard sulphonation. Accordingly the *substance* (IX) was nitrated;



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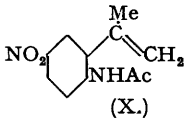
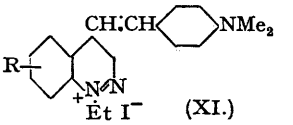


(X.)



(XI.)

the product, obtained in rather poor yield, gave analytical data indicating that dehydration had accompanied nitration, and is therefore probably 2-(*5-nitro-2-acetamidophenyl*)*propylene* (X). The reaction did not seem to be readily adaptable to large-scale work, and for this reason, and also because the phosphoric anhydride method appeared to be of general applicability, this approach was not further investigated.

Diazotisation of the *o-iso*propenylanilines yielded the corresponding cinnolines, and by this method we prepared * 4-*methyl*- (II; $R_1 = R_2 = H$), 6-*chloro*-4-*methyl*- (II; $R_1 = Cl$, $R_2 = H$), and 7-*chloro*-4-*methyl-cinnoline* (II; $R_1 = H$, $R_2 = Cl$). Two noteworthy features of these reactions were, first, that appreciable amounts of strongly-coloured green or blue substances are produced (this does not occur during the formation of 4-hydroxycinnolines or of 4-arylcinnolines), and, secondly, that the cyclisations are considerably faster than those which yield 4-hydroxycinnolines. The favourable influence on cinnoline-formation of an α-methyl group in the aminoethylene, in contrast to the inhibitory effect of an α-hydrogen atom (*J.*, 1946, 673), gives additional support to the mechanism previously advanced for the Widman–Stoermer reaction (Schofield and Simpson, *J.*, 1945, 520), and would seem to be due to the hyperconjugative effect of the methyl group.

Condensation of the *ethiodides* of the 4-methylcinnolines with *p*-dimethylaminobenzaldehyde proceeded in the absence of a catalyst, giving the corresponding 4-p-*dimethylaminostyryl*-1-*ethylcinnolinium iodides* (as XI); these substances were blue dyes, which were, however, fugitive to acid and strong alkali. It is clear that quaternary-salt formation confers high reactivity on the 4-methyl group, and the quaternary nitrogen in these compounds is accordingly N^1 and not N^2. It may well be that N^1 is the basic centre of all simple cinnolines which may be prepared by the three standard synthetic routes so far available (Schofield and Simpson, *loc. cit.*), because these reactions of necessity give rise to derivatives, containing a 4-substituent, which may be regarded as exercising a controlling influence on the availability of electrons at N^1. Further evidence, however, is required before any statement can be made regarding the basic centre in compounds unsubstituted at C^4, *e.g.*, cinnoline itself and the 3-hydroxycinnoline mentioned (without details) by Neber, Knöller, Herbst, and Trissler (*Annalen*, 1929, **471**, 113); the preparation and study of 3-methylcinnolines should be illuminating in this respect.

Experimental.

(Melting points are uncorrected.)

Preparation of 4-*Methylcinnoline*-7-*carboxylic Acid.*—The following conditions were evolved from the early literature. Cuminal (50 g.) was added during 40 minutes to a mixture of nitric acid (230 c.c., *d* 1·52) and concentrated sulphuric acid (260 c.c.) at 0—5° with mechanical stirring. The solution was allowed to reach 10° by removal from the freezing mixture and poured on ice (2·5 kg.), and the crude 3-nitro-4-*iso*propylbenzaldehyde purified by digestion with aqueous sodium carbonate and water; yield, 63·5 g. (97%), m. p. 51° (Widman, *Ber.*, 1882, **15**, 166, gives m. p. 54° for the recrystallised compound). Although comparable yields were obtained in five consecutive runs, the reaction is capricious, as several later experiments gave only 60% yields of crystalline product (acids of different origin were used in these experiments, but the conditions were otherwise seemingly identical in the two series). The nitro-aldehyde (20 g., m. p. 50—51°) was refluxed with aqueous potassium permanganate (5%, 2 l.), added in portions during 10—12 hours. The product obtained by concentration and acidification of the filtered solution was usually almost pure 3-nitro-4-(1-hydroxy*iso*propyl)benzoic acid (yield, *ca.* 50%; m. p. 185—187°; Widman, *Ber.*, 1882, **15**, 2547, gives m. p. 190—191°), but occasionally it was contaminated with 3-nitro-4-*iso*propylbenzoic acid, m. p. 158° (lit. m. p., 157—158°) (Found: C, 53·5; H, 5·0. Calc. for $C_{10}H_{11}O_5N$: C, 53·3; H, 4·9%), which was readily removed from the crude product by extraction with benzene. The hydroxy-acid (20 g.) was added during ½ hour to concentrated sulphuric acid (100 c.c.); after a further hour, the clear solution was poured on ice, and 3-nitro-4-*iso*propenylbenzoic acid (13·8 g., 75%), m. p. 153—154° (lit. m. p., 154—155°), isolated by dissolution of the crude product in aqueous sodium hydroxide, acidification, and crystallisation from aqueous alcohol. A solution of this substance (5 g.) in ammonia (*d* 0·88, 2 c.c.; water, 14 c.c.) was added with shaking during 10 minutes to a suspension prepared from ferrous sulphate (50 g.), water (100 c.c.), and ammonia

* In an article which appeared after this paper had been prepared for publication, Jacobs, Winstein, Henderson and Spaeth (*J. Amer. Chem. Soc.*, 1946, **68**, 1310) describe the preparation of 4-methylcinnoline by a similar route, and, *inter alia*, its condensation with benzaldehyde.

(*d* 0·88, 25 c.c.); after being heated on the steam-bath for ½ hour, the solution was filtered and the filtrate and washings were concentrated (reduced pressure) to 250 c.c. Addition of concentrated hydrochloric acid (150 c.c.) precipitated the hydrochloride (4·4 g.), m. p. 240° (decomp.), of 3-amino-4-*iso*propenylbenzoic acid, which was more easily handled than the free amino-acid (needles, m. p. 93—94°). Addition of the reducing mixture to the nitro-acid, as recommended by Widman (*Ber.*, 1883, **16**, 2567), gave poor and variable yields.

Diazotisation and ring-closure was best effected with a minimum amount of acid (cf. Widman, *loc. cit.*); a solution of the amino-acid hydrochloride (5 g.) in water (50 c.c.) was treated with aqueous sodium nitrite (10%, 18 c.c.), the solution being kept barely acid to Congo-red with hydrochloric acid. After 1 hour at room temperature no coupling reaction with β-naphthol could be obtained; the crude cinnoline acid [4·2 g., m. p. 235° (decomp.)] was collected and purified by crystallisation, or preferably *via* the ester, as follows. A suspension of the acid (9·1 g.) in alcohol (90 c.c.) was saturated with dry hydrogen chloride; the clear blue solution was refluxed for ½ hour and then again saturated at room temperature. Most of the alcohol was driven off and the ester isolated by treatment with excess of aqueous sodium carbonate and extraction with ether, from which *ethyl 4-methylcinnoline-7-carboxylate* (7 g.) separated in golden plates, m. p. 117° (leaflets from hot water) (Found: C, 67·1; H, 5·7; N, 13·1. $C_{12}H_{12}O_2N_2$ requires C, 66·7; H, 5·6; N, 13·0%). Hydrolysis of the ester (3 g.) with aqueous potassium hydroxide (10%, 60 c.c.) (3 hours' reflux) and acidification with acetic acid (50%, 40 c.c.) gave 4-methylcinnoline-7-carboxylic acid (2·5 g.), which formed almost colourless needles, m. p. 251—253° (decomp.), from alcohol [Widman, *loc. cit.*, gives m. p. 230° (decomp.)] (Found: C, 63·8; H, 4·4; N, 15·25. Calc. for $C_{10}H_8O_2N_2$: C, 63·8; H, 4·3; N, 14·9%), very sparingly soluble in water and aqueous sodium phosphate, but fairly easily soluble in dilute hydrochloric acid and in saturated aqueous sodium acetate.

Reaction between 4-Methylcinnoline-7-carboxylic acid and o-*Nitrobenzaldehyde.*—A mixture of *o*-nitrobenzaldehyde, the acid, anhydrous zinc chloride (1·5 g. of each), and acetic acid (6 c.c.) was heated slowly to 120° and maintained at this temperature for 1 hour. The mixture was digested with warm hydrochloric acid (25 c.c., 2N) and the solid material [1·2 g., m. p. 283—285° (decomp.)] filtered off, washed, and crystallised from acetic acid, giving deep yellow micro-crystals, m. p. 285° (decomp.), insoluble in aqueous sodium carbonate or hydroxide (Found: C, 61·5; H, 3·9; N, 12·85. $C_{17}H_{11}O_4N_3,\frac{1}{2}H_2O$ requires C, 61·8; H, 3·65; N, 12·7%). The product from another experiment formed greenish micro-crystals, m. p. 297—298° (without decomp.), which did not depress the m. p. of the foregoing material (Found: C, 62·55; H, 3·45; N, 13·3, 13·25%).

Preparation of o-iso*Propenylanilines.*—(*a*) A solution of methyl anthranilate (50 g.) in ether (500 c.c.) was added with stirring during ¾ hour to methylmagnesium iodide [from magnesium (40 g.), methyl iodide (240 g.), and ether (750 c.c.)]. After ½ hours' refluxing, the product was decomposed with iced ammoniacal ammonium chloride, and the oily carbinol (53 g.) isolated by ether-extraction. The same yield of carbinol resulted from similar manipulation of *o*-aminoacetophenone (10 g.) in ether (80 c.c.) and methylmagnesium iodide [from magnesium (10 g.), methyl iodide (54 g.), and ether (150 c.c.)]. Acetylation of each sample (cold acetic anhydride) gave o-*acetamidophenyldimethylcarbinol*, which formed small colourless needles, m. p. 146—147°, from benzene–ligroin (b. p. 40—60°) (Found: C, 68·0; H, 7·65; N, 7·2. $C_{11}H_{15}O_2N$ requires C, 68·4; H, 7·8; N, 7·25%). Addition of this substance (0·5 g.) during ¼ hour to a mixture of nitric acid (*d* 1·487) and concentrated sulphuric acid (5 : 2, v/v, 3 c.c.) at — 15° gave a clear solution which was poured on ice after a further ¼ hour; the crude product obtained by basification with ammonia was crystallised from aqueous alcohol and from ligroin (b. p. 40—60°), yielding lustrous yellow leaflets (0·34 g., m. p. 88—89°) of 2-(5-*nitro*-2-*acetamidophenyl*)-*propylene* (Found: C, 60·2; H, 5·6; N, 13·05. $C_{11}H_{12}O_3N_2$ requires C, 60·0; H, 5·5; N, 12·7%). *o*-Aminophenyldimethylcarbinol (30 g.) was dehydrated with phosphoric anhydride (60 g.) in benzene (300 c.c.) under reflux (3 hours). The solution was poured on ice, the gummy residue made alkaline with ammonia, and the whole extracted with ether, yielding crude *o-iso*propenylaniline as an oil (28 g.).

(*b*) Methyl 4-chloroanthranilate was obtained in 68% yield by the following improvement of Hunn's method (*J. Amer. Chem. Soc.*, 1923, **45**, 1024). A cold suspension of the acid (100 g.) in methyl alcohol (98%, 1 l.) was saturated with dry hydrogen chloride; after 1 hour's refluxing, the solution was again saturated at room temperature, concentrated, and poured into excess of dilute aqueous ammonia. The ester formed colourless needles, m. p. 68—70° (Hunn gives m. p. 68·5°) after crystallisation from ligroin (b. p. 60—80°). Treatment of the ester (30 g.) in ether (300 c.c.) with methylmagnesium iodide [from magnesium (20 g.), methyl iodide (115 g.), and ether (500 c.c.)] as above yielded the crude *o*-amino-carbinol (30 g.) as an oil, which with cold acetic anhydride gave the N-*acetyl* derivative (colourless prisms from benzene), m. p. 151—153° (Found: C, 58·15; H, 6·1. $C_{11}H_{14}O_2NCl$ requires C, 58·0; H, 6·2%). Dehydration of the amino-carbinol (28 g.) as above gave an oil (26 g.), which on treatment with hot acetic anhydride, followed by decomposition and isolation of the product with ether, yielded 2-(4-*chloro*-2-*acetamidophenyl*)*propylene* as colourless polyhedra, m. p. 68—70° after crystallisation from ligroin (b. p. 40—60°) (Found: C, 63·0; H, 5·35. $C_{11}H_{12}ONCl$ requires C, 63·0; H, 5·8%).

(*c*) Treatment of 5-chloro-2-aminoacetophenone (20 g.; Simpson *et al.*, *J.*, 1945, 646) in ether (300 c.c.) with methylmagnesium iodide [from magnesium (13 g.), methyl iodide (80 g.), and ether (400 c.c.)] as above gave 5-*chloro*-2-*aminophenyldimethylcarbinol* (19 g.), which formed yellow needles, m. p. 83—84°, from ether–ligroin (b. p. 40—60°) (Found: C, 58·3; H, 6·35; N, 8·65. $C_9H_{12}ONCl$ requires C, 58·2; H, 6·5; N, 7·5%). The N-*acetyl* derivative (cold acetic anhydride), m. p. 136—137°, formed colourless micro-crystals from benzene–ligroin (b. p. 40—60°) (Found: C, 58·65; H, 6·2. $C_{11}H_{14}O_2NCl$ requires C, 58·0; H, 6·2%), and the N-*benzoyl* derivative (pyridine–benzoyl chloride) crystallised from aqueous alcohol in small colourless prisms, m. p. 148—153° (this extended melting point seemed to be characteristic of the substance) (Found: C, 66·3; H, 5·5; N, 5·2. $C_{16}H_{16}O_2NCl$ requires C, 66·3; H, 5·6; N, 4·8%). The amino-carbinol (12 g.) and sulphuric acid (18N, 160 c.c.) were heated for 1 hour on the steam-bath. Dilution with water, basification, and extraction with ether gave 2-(5-chloro-2-aminophenyl)propylene as an oil (12 g.); the N-*benzoyl* derivative separated from aqueous alcohol in fine colourless needles, m. p. 126—127° (Found: C, 71·4; H, 5·4; N, 5·65. $C_{16}H_{14}ONCl$ requires C, 70·7; H, 5·2; N, 5·15%).

Preparation of 4-Methylcinnolines from o-iso*Propenylanilines.*—(*a*) The crude product prepared in (*a*) above (12 g.) was dissolved in hydrochloric acid [concentrated acid (20 c.c.) and 2N acid (80 c.c.)] and a small amount of insoluble oil removed with ether. The suspension obtained by cooling the acid solution to 5° was diazotised with solid sodium nitrite (5·1 g.); a clear, deep green solution was formed, and on being warmed to 60° the coupling reaction became negative and the colour changed to red. Addition of saturated aqueous sodium acetate precipitated an oil which was collected with ether; the extract, after being washed with sodium hydroxide and water, was dried and concentrated, and the bright green residue repeatedly extracted with hot ligroin (b. p. 60—80°), from which 4-methylcinnoline separated in slender yellow needles, m. p. 74—75° (yield, 6 g.) [Jacobs *et al.* (*loc. cit.*) give m. p. 72·5—74°] (Found: C, 74·9; H, 5·35; N, 20·0. Calc. for $C_9H_8N_2$: C, 75·0; H, 5·6; N, 19·45%), moderately soluble in ether, and easily in water and ethanol. The recrystallised base gave a deep red solution in dilute hydrochloric acid, but the colour was apparently due to traces of impurity, as material recovered from oxidation with permanganate (*q.v.*) no longer gave this colour. *4-Methylcinnoline picrate*, prepared in alcoholic solution, formed fern-like aggregates of green needles, m. p. 179—180° (Found: C, 48·05; H, 2·85. Calc. for $C_{15}H_{11}O_7N_5$: C, 48·25; H, 3·0%) [Jacobs *et al.* (*loc. cit.*) give m. p. 176—177°]. Treatment of 4-methylcinnoline methosulphate with diazotised aniline in faintly alkaline medium (cf. Koenigs and Bueren, *J. pr. Chem.*, 1936, **146**, 119) gave a purple amorphous product which could not be purified either as the salt or as the dye base.

(*b*) A solution of the olefin (20 g.) described in (*b*) above in hydrochloric acid (2N, 160 c.c.) was diazotised with solid sodium nitrite (6·2 g.); *7-chloro-4-methylcinnoline* (11·7 g.), isolated and purified as in the preceding paragraph, crystallised from ligroin (b. p. 60—80°) in minute yellow leaflets, m. p. 119—120° (Found: C, 60·1; H, 4·0; N, 15·35. $C_9H_7N_2Cl$ requires C, 60·5; H, 3·9; N, 15·7%).

(*c*) The suspension of hydrochloride obtained by mixing crude 2-(5-chloro-2-aminophenyl)propylene (12 g.) and hydrochloric acid (50 c.c., 6N) was diazotised with aqueous sodium nitrite (10%, 48 c.c.). On heating to 70°, an intense purple colour developed, and the coupling power of the solution rapidly disappeared. The solution was filtered from some purple-black tar, which was extracted with warm dilute hydrochloric acid, and filtrate and washings were then treated with excess of sodium acetate. Treatment as above gave the crude cinnoline (5·7 g., m. p. 123—128°), which was purified by dissolving it in benzene and percolating through a column of alumina (Merck); crystallisation from hot ligroin (b. p. 60—80°) furnished *6-chloro-4-methylcinnoline* (3·6 g.) in almost colourless needles, m. p. 136—137° (Found: C, 60·0; H, 3·85; N, 16·4; Cl, 19·65. $C_9H_7N_2Cl$ requires C, 60·5; H, 3·9; N, 15·7; Cl, 19·9%). The *picrate* (from alcohol) formed felted clusters of green needles, m. p. 154—156° (decomp.) (Found: N, 17·5. $C_{15}H_{10}O_7N_5Cl$ requires N, 17·2%).

Quaternary Salts of 4-Methylcinnolines.—The salts were readily formed when the cinnolines were refluxed in alcohol with excess of alkyl iodide for 2—3 hours, and were isolated without difficulty and in good yield by concentration of the solutions. *4-Methylcinnoline ethiodide* separated from alcohol–ether in fine red needles, m. p. 152—154° (Found: C, 43·8; H, 4·5. $C_{11}H_{13}N_2I$ requires C, 44·0; H, 4·4%). *6-Chloro-4-methylcinnoline ethiodide*, red prismatic needles from alcohol, had m. p. 204° (decomp.) (Found: C, 40·25; H, 3·9. $C_{11}H_{12}N_2ClI$ requires C, 39·5; H, 3·6%). *7-Chloro-4-methylcinnoline ethiodide* formed dark red needles, m. p. 185°, from alcohol–ether (Found: C, 39·45; H, 3·65%); the *methiodide*, red needles from methanol–ether, had m. p. 202° (decomp.) (Found: C, 37·2; H, 3·2. $C_{10}H_{10}N_2ClI$ requires C, 37·4; H, 3·15%). *4-Methyl-7-carbethoxycinnoline ethiodide*, m. p. 208° (decomp.), formed soft red needles from alcohol (Found: C, 45·3; H, 4·5. $C_{14}H_{17}O_2N_2I$ requires C, 45·15; H, 4·6%). Halogen estimations with these compounds were unsatisfactory.

4-p-Dimethylaminostyryl-1-ethylcinnolinium Iodides.—4-Methylcinnoline ethiodide (1 g.) was dissolved in warm acetic anhydride (16 c.c.) and *p*-dimethylaminobenzaldehyde (0·5 g.) added, and the deep blue solution refluxed gently (bath temp., 160°). Crystalline material separated after 10 minutes, and the amount did not visibly increase after 2 hours' refluxing. The crude product (0·23 g., m. p. 240—245°) was recrystallised from alcohol, *4-p-dimethylaminostyryl-1-ethylcinnolinium iodide* separating in needles, m. p. 252° (Found: C, 55·95; H, 5·1; N, 9·8. $C_{20}H_{22}N_3I$ requires C, 55·65; H, 5·15; N, 9·7%). Analogous styrylcinnolinium salts were also prepared by this method from the other ethiodides already described, but the condensations were more satisfactory when a 10% alcoholic solution of the ethiodide was refluxed for 2 hours with the theoretical amount of *p*-dimethylaminobenzaldehyde in the absence of catalyst, because, although the condensations were incomplete (unchanged aldehyde could be detected by smell), and the crude yields were about the same (*ca.* 30%) in each method, the products by using alcohol were much purer than those obtained by using acetic anhydride. *6-Chloro-4-p-dimethylaminostyryl-1-ethylcinnolinium iodide* formed needles, m. p. 248—250° (decomp.) from alcohol (Found: C, 50·1; H, 4·7; N, 8·0. $C_{20}H_{21}N_3ClI,\frac{1}{2}H_2O$ requires C, 50·6; H, 4·7; N, 8·85%). The *7-chloro*-isomer (needles from alcohol) had m. p. 246° (decomp.) (Found: C, 51·6; H, 4·8; N, 8·6. $C_{20}H_{21}N_3ClI$ requires C, 51·5; H, 4·55; N, 9·0%), and *7-carbethoxy-4-p-dimethylaminostyryl-1-ethylcinnolinium iodide*, after digestion with 50% aqueous alcohol to remove unchanged ethiodide, formed needles, m. p. 250° (decomp.) from alcohol (Found: C, 55·0; H, 5·35; N, 8·4. $C_{23}H_{26}O_2N_3I$ requires C, 54·9; H, 5·2; N, 8·35%). All these dyes exhibited a green reflex in the solid state, and gave deep blue solutions in alcohol; the colours were discharged by acid and by strong alkali.

Oxidation of 4-Methylcinnoline.—A solution of the base (1 g.) in water (20 c.c.) was treated at 28° with aqueous potassium permanganate (80 c.c.), added during 40 minutes with mechanical stirring. The initially rapid oxidation appeared to slow down considerably towards the end of the addition; a further 5 c.c. were added, and after a few minutes a little alcohol was added and the mixture filtered. Ether-extraction of the alkaline filtrate and washings gave a product from which 4-methylcinnoline [0·2 g., m. p. and mixed m. p. 74—75° (Found: C, 75·1; H, 5·65%); picrate, m. p. and mixed m. p. 179—180°] was recovered by digestion with ligroin (b. p. 60—80°). The alkaline solution, after concentration, gave no precipitate on acidification; addition of sodium acetate until the solution was no longer acid to Congo-red, followed by picric acid, gave a *picrate* (0·3 g.), which separated from hot water (charcoal) in long yellow needles, m. p. 342°, which tended to explode on analysis [Found: C, 27·3; H, 1·6; N, 15·8. $(C_6H_6O_{12}N_4)_x$ requires C, 27·4; H, 1·7; N, 16·0%].

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