576. *The Preparation of* 5-*Methyl*-1 : 4-*diazaindene* (5-*Methyl*-4-*azaindole*) *and its* 2-*Methyl and* 2-*Phenyl Derivatives: Some Reactions of* 2 : 5-*Dimethyl*-1 : 4-*diazaindene.*

By J. C. Clayton and J. Kenyon.

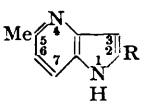
The preparation of 5-methyl-1 : 4-diazaindene and its 2-methyl and 2-phenyl derivatives is described. Some reactions of these compounds, particularly of 2 : 5-dimethyl-1 : 4-diazaindene, are also described.

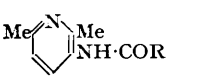
In spite of the interest in the chemistry of indole and its derivatives, remarkably little attention has been paid to its pyridine analogues the diazaindenes (*Bz*-azaindoles).

7-Methyl-1 : 6-diazaindene was isolated by Perkin and Robinson (*J.*, 1912, **101**, 1775) as a degradation product of the alkaloids harmine and harmaline, and 2-methyl-1 : 6-diazaindene has been synthesised by Koenigs and Fulde (*Ber.*, 1927, **60**, 2106). More recently Clemo and

Swan (*J.*, 1945, 603; 1948, 198) prepared a number of derivatives of 1 : 4-, 1 : 5-, and 1 : 7-diazaindene, as well as 1 : 4-diazaindene itself, by cyclisation of the appropriate acylaminopicolines, *i.e.*, application, to the pyridine series, of Madelung's indole synthesis (*Ber.*, 1912, **45**, 1128). Attempts to apply the Fischer indole synthesis to a pyridylhydrazone have proved unsuccessful (Fargher and Furness, *J.*, 1915, **107**, 698).

The present communication records the synthesis of 5-methyl-1 : 4-diazaindene and its 2-methyl and 2-phenyl derivatives (I; R = H, Me, or Ph).

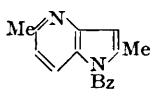
(I.) 



(II.)

3-Amino-2 : 6-lutidine was prepared from 2 : 6-lutidine by a modification of Plazek's procedure (*Ber.*, 1939, **72**, 577). Cyclisation of 3-formamido-2 : 6-lutidine (II; R = H) by sodium ethoxide (cf. Clemo and Swan, *loc. cit.*) gave (I; R = H) in small yield, which was not improved by use of potassium alkoxides (cf. Tyson, *J. Amer. Chem. Soc.*, 1941, **63**, 2024; Marion and Ashford, *Canadian J. Res.*, 1945, **23**, *B*, 26). On the other hand, 2 : 5-dimethyl- (I; R = Me) and 5-methyl-2-phenyl-1 : 4-diazaindene (I; R = Ph) were readily obtained in good yields by the action of sodium ethoxide on 3-acetamido- (II; R = Me) and 3-benzamido-2 : 6-lutidine (II; R = Ph) respectively.

The 1 : 4-diazaindenes form highly crystalline picrates as well as salts with mineral acids, but, unlike indole and its simple derivatives, they are relatively high-melting, stable, and odourless. They show no positive pine-splint reaction nor do they react with Ehrlich's reagent, although 5-methyl-1 : 4-diazaindene does give a pale red colour when kept for some days in the reagent. The diazaindene ring structure—like that of indole—is very sensitive to the more vigorous oxidising agents, such as permanganate and chromic acid, which, however, always gave intractable products. Whereas 2- and 3-methylindole undergo oxidation to the corresponding carboxylic acids by fusion with potassium hydroxide (Ciamician and Gatti, *Ber.*, 1888, **21**, 1929), treatment of (I; R = Me) with fused potassium hydroxide completely disrupts the molecule, potassium carbonate being obtained in a quantity equivalent to 80% of the original material. The stability of the ring system is increased by benzoylation, and 1-benzoyl-2 : 5-dimethyl-1 : 4-diazaindene (III) can be oxidised to 3-benzamido-6-methylpyridine-2-carboxylic acid (IV).



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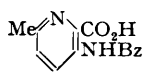

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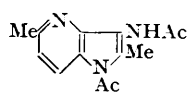


(V.)

With acetic anhydride or benzoyl chloride 2 : 5-dimethyl-1 : 4-diazaindene (I; R = Me) yields solely the 1-acyl derivatives, whereas attempts to prepare the acyl derivatives of 5-methyl-2-phenyl-1 : 4-diazaindene (I; R = Ph) were unsuccessful. Hydrolysis of the acyl derivatives by alcoholic sodium hydroxide proceeds readily at normal temperatures.

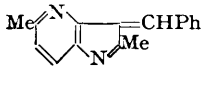
With nitric acid, 1-benzoyl-2 : 5-dimethyl-1 : 4-diazaindene (III) yields the 3-nitro-compound, the orientation being proved by oxidation to (IV) and hydrolysis to 2 : 5-dimethyl-3-nitro-1 : 4-diazaindene, which was also obtained, albeit in small yield, by the direct nitration of (I; R = Me). Catalytic reduction of the 3-nitro-compound yielded 3-amino-2 : 5-dimethyl-1 : 4-diazaindene, an unstable compound, which was characterised by the formation of a dihydrochloride, a dipicrate, and the diacetyl derivative—3-acetamido-1-acetyl-2 : 5-dimethyl-1 : 4-diazaindene (V).

Like 2-methylindole (Wagner, *Annalen*, 1887, **242**, 384), 2 : 5-dimethyl-1 : 4-diazaindene (I; R = Me) couples with benzenediazonium chloride to yield the 3-benzeneazo-derivative, the structure of which is proved by formation of acetanilide and (V) on catalytic reduction and subsequent acetylation. Both 2 : 5-dimethyl-1 : 4-diazaindene (I; R = Me) and its benzoyl derivative (III) give 3-bromo-derivatives, and the halogen derivative of the latter can be hydrolysed to that of the former. Oxidation of the benzoyl-bromo-derivative with potassium permanganate yields 3-benzamido-6-methylpyridine-2-carboxylic acid (IV), thereby establishing the position of the bromine atom.

Like indole and its 2-methyl derivative, 2 : 5-dimethyl-1 : 4-diazaindene with chloroform and potassium hydroxide gives a (? 3-)formyl derivative; no chloronaphthyridine could be isolated,

the by-product that might be expected by analogy with the formation of chloroquinolines from indoles in similar reactions (cf. Clemo and Swan, *J.*, 1945, 603).

An alcoholic solution of equimolecular proportions of (I; R = Me) and benzaldehyde in the presence of a little sodium hydroxide deposits a compound A, $C_{20}H_{26}O_2N_2$. Catalytic reduction of A gives rise to B, $C_{16}H_{16}N_2$ whilst oxidation of A with potassium permanganate yields C, $C_{16}H_{14}ON_2$, which can in turn be reduced to B. It appears that A is formed by the loss of the elements of water from the reactants and becomes solvated with two molecules of ethyl alcohol. Although the unsolvated material could not be obtained, indirect evidence of the presence of the solvent was obtained by a Zerewitinoff estimation (three active hydrogen atoms), as well as by the formation of ethyl benzoate on treatment with benzoyl chloride. Condensation with the 5-methyl group was rendered highly improbable by the failure of 5-methyl-2-phenyl-1 : 4-diazaindene and 3-acetamido-2 : 6-lutidine to react with benzaldehyde under similar conditions. By analogy with reactions of indole and alkylindoles, the structures (VI) (cf. Burr and Gartner, *J. Amer. Chem. Soc.*, 1924, **46**, 1224), (VII) (cf. Scholtz, *Ber.*, 1913, **46**, 2138), and (VIII) were con-



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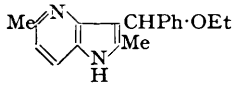

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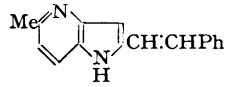
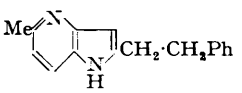
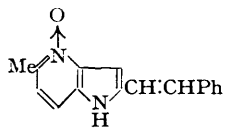


(VIII.)

sidered for unsolvated A. Structure (VI) is unlikely since the corresponding indole derivatives are highly coloured and unstable, whereas A is colourless and stable; it was eliminated by the synthesis of 3-benzyl-2 : 5-dimethyl-1 : 4-diazaindene, which differed from the reduced compound B. (VII) seems unlikely because (i) there are two molecules of ethyl alcohol of crystallisation in A and (ii) catalytic hydrogenation would involve fission of an ether and formation of 3-benzyl-2 : 5-dimethyl-1 : 4-diazaindene. Thus (VIII) alone is consistent with the experimental results, whence it follows that B and C are (IX) and (X) respectively.

(IX.)





(X.)

Attempts to synthesise (VIII) and (IX) by cyclisation of 3-cinnamamido-2 : 6-lutidine and 3-β-phenylpropionamido-2 : 6-lutidine were unsuccessful.

Experimental.

All m. p.s are uncorrected. Picrates were prepared in, and crystallised from, alcohol unless otherwise stated. Light petroleum had b. p. 80—100°.

3-*Amino*-2 : 6-*lutidine*.—3-Nitro-2 : 6-lutidine was prepared in 94% yield by treatment of 2 : 6-lutidine in 12% oleum with potassium nitrate for 48 hours on the steam-bath; the amino-compound was obtained by catalytic reduction in anhydrous ethanol at 70°/100 atm., using Raney nickel (cf. Plazek, *Ber.*, 1939, **72**, 577).

3-*Formamido*-2 : 6-*lutidine*.—A solution of 3-amino-2 : 6-lutidine (5 g.) in formic acid (25 ml.; 98%) was heated under reflux for 15 minutes and excess of formic acid removed under reduced pressure. The residual yellow oily *formyl* derivative distilled at 300°/760 mm. and solidified to a buff-coloured mass which recrystallised from ethyl acetate as colourless tiny needles, m. p. 97—98° (4·5 g., 73%) (Found: C, 64·0; H, 6·7; N, 18·6. $C_8H_{10}ON_2$ requires C, 64·0; H, 6·7; N, 18·65%). The *picrate* forms bright yellow prisms, m. p. 193° (Found: C, 44·3; H, 3·4; N, 18·9. $C_8H_{10}ON_2,C_6H_3O_7N_3$ requires C, 44·3; H, 3·4; N, 18·5%).

5-*Methyl*-1 : 4-*diazaindene*.—3-Formamido-2 : 6-lutidine (2 g.) was added to a solution of sodium ethoxide (2 g.) in ethanol (50 ml.) and the mixture evaporated to small bulk and heated in a metal-bath at 200° under hydrogen. The temperature of the bath was slowly raised to 210°, whereupon 3-amino-2 : 6-lutidine (0·8 g.) distilled over. After 15 minutes at 310° the mixture was cooled and mixed with water (10 ml.); the insoluble residue was removed by filtration, dried, and sublimed at 150°/12 mm. to give 5-*methyl*-1 : 4-*diazaindene*, m. p. 182—184° (0·2 g., 12%) (Found: C, 72·2; H, 6·3; N, 21·0. $C_8H_8N_2$ requires C, 72·7; H, 6·1; N, 21·2%). The *picrate* forms bright yellow needles, m. p. 215—216° (Found: N, 19·1. $C_8H_8N_2,C_6H_3O_7N_3$ requires N, 19·4%).

3-*Acetamido*-2 : 6-*lutidine*.—A mixture of 3-amino-2 : 6-lutidine (20 g.), anhydrous potassium carbonate (20 g.), and acetyl chloride (30 g.) in ether (1 l.) was heated under reflux for 1 hour and then evaporated to dryness. To the residue a solution of potassium carbonate (20 g.) in water (200 ml.) was added and excess of ether removed. At 0° a mass of colourless crystals of the *monohydrate*, m. p. 79—80°, of 3-acetamido-2 : 6-lutidine separated (Found: C, 60·0; H, 7·2; N, 15·3. $C_9H_{14}O_2N_2$ requires C, 59·5; H, 7·7; N, 15·4%). By heating this at 90°/12 mm. for 1 hour the anhydrous *compound*, m. p.

118—119° (26 g., 87%), was obtained (Found : C, 65·9; H, 7·5; N, 17·2. $C_9H_{12}ON_2$ requires C, 65·8; H, 7·3; N, 17·1%). The *picrate* forms yellow prisms, m. p. 194° (Found : C, 46·5; H, 3·85; N, 17·0. $C_9H_{12}ON_2,C_6H_3O_7N_3$ requires C, 45·8; H, 3·8; N, 17·7%).

2 : 5-*Dimethyl*-1 : 4-*diazaindene*.—A solution of sodium (1·7 g.) and 3-acetamido-2 : 6-lutidine (5 g.; thoroughly dried at 90° *in vacuo*) in anhydrous ethanol (50 ml.) was evaporated to dryness and the residue heated at 200° under dry hydrogen. The temperature of the bath was slowly raised to 320° and maintained thereat for 15 minutes, the mixture darkening and a vigorous evolution of gas occurring. To the cooled mixture, water (100 ml.) was added and the insoluble pale yellow residue filtered off, dried, and sublimed at 150°/0·5 mm.; the resulting 2 : 5-*dimethyl*-1 : 4-*diazaindene* formed needles, m. p. 211° (2·4 g., 55%) (Found : C, 74·0; H, 6·85; N, 19·1. $C_9H_{10}N_2$ requires C, 74·0; H, 6·85; N, 19·15%). The *hydrochloride*, obtained by passing dry hydrogen chloride into a solution of the base (0·5 g.) in dry ethanol, evaporating the solution, and crystallising the residue from alcohol and benzene, formed glistening needles, m. p. 200—201° (0·57 g., 91%) (Found : N, 15·0; Cl, 19·4. $C_9H_{10}N_2$,HCl requires N, 15·3; Cl, 19·4%).

Addition of nitric acid (*d* 1·5; 0·25 ml.) to the base (0·5 g.) in acetic acid (5 ml.) precipitated the *nitrate*, needles, m. p. 259° (decomp.) (0·63 g., 90%) (Found : C, 51·4; H, 5·7; N, 19·9. $C_9H_{10}N_2,HNO_3$ requires C, 51·6; H, 5·3; N, 20·1%). The *picrate* separates as yellow prisms, m. p. 211° (decomp.) (Found : C, 48·0; H, 3·5. $C_9H_{10}N_2,C_6H_3O_7N_3$ requires C, 48·0; H, 3·5%).

A solution of the base (0·5 g.) in acetic anhydride (10 ml.) was heated under reflux for 5 minutes and the excess of anhydride removed *in vacuo*. The 1-*acetyl* derivative separated from light petroleum as needles, m. p. 98° (0·5 g., 78%) (Found : C, 69·9; H, 6·3; N, 14·9. $C_{11}H_{12}ON_2$ requires C, 70·2; H, 6·4; N, 14·9%).

Benzoyl chloride (1·6 ml.) was added dropwise to a cooled solution of the base (2 g.) in dry pyridine (15 ml.); after 30 minutes the solution was poured into water. The resulting 1-*benzoyl*-2 : 5-*dimethyl*-1 : 4-*diazaindene hydrate* separated from aqueous ethanol as fine needles, m. p. 81—82° (3·0 g., 84%) (Found : C, 71·6; H, 6·1; N, 10·5; active H, 0·74. $C_{16}H_{14}ON_2,H_2O$ requires C, 71·5; H, 6·0; N, 10·45; active H, 0·74%). The *hydrochloride* was obtained when a solution of 2 : 5-dimethyl-1 : 4-diazaindene in benzoyl chloride was kept at room temperature for 24 hours; it crystallised from ethanol–light petroleum in needles, m. p. 191—192° (Found : C, 66·5; H, 5·5; N, 9·7. $C_{16}H_{14}ON_2$,HCl requires C, 67·0; H, 5·2; N, 9·75%). The *picrate* separates from glacial acetic acid as yellow lances, m. p. 205° (Found : N, 14·7. $C_{16}H_{14}ON_2,C_6H_3O_7N_3$ requires N, 14·6%).

3-*Benzamido*-2 : 6-*lutidine*.—To a solution of 3-amino-2 : 6-lutidine (5 g.) in dry pyridine (40 ml.), benzoyl chloride (6 g.) was added dropwise with shaking. After 1 hour at room temperature the solution was poured into water (250 ml.), a colourless oil being deposited. This re-dissolved and on storage 3-*benzamido*-2 : 6-*lutidine* separated as shining needles which, recrystallised from aqueous ethanol, had m. p. 169—170° (5 g., 54%) (Found : C, 74·0; H, 6·4; N, 12·0. $C_{14}H_{14}ON_2$ requires C, 74·3; H, 6·2; N, 12·4%). The *picrate* separates as minute yellow prisms, m. p. 225° (Found : C, 52·7; H, 3·65; N, 15·2. $C_{14}H_{14}ON_2,C_6H_3O_7N_3$ requires C, 52·7; H, 3·7; N, 15·3%).

5-*Methyl*-2-*phenyl*-1 : 4-*diazaindene*.—3-Benzamido-2 : 6-lutidine (3 g.) was cyclised by the method described above for the preparation of 5-methyl-1 : 4-diazaindene, yielding 5-*methyl*-2-*phenyl*-1 : 4-*diazaindene* as needles, m. p. 281—282° (1·86 g., 67%) (Found : C, 80·2; H, 5·8; N, 13·7. $C_{14}H_{12}N_2$ requires C, 80·6; H, 5·8; N, 13·5%). The *picrate* which was crystallised with some difficulty from ethanol forms golden yellow plates, m. p. 274—275° (decomp.) (Found : N, 15·7. $C_{14}H_{12}N_2,C_6H_3O_7N_3$ requires N, 16·0%).

Oxidation of 1-*Benzoyl*-2 : 5-*dimethyl*-1 : 4-*diazaindene*.—To a solution of the benzoyl derivative (1 g.) in acetone (60 ml.) and water (20 ml.), potassium permanganate (4·25 g.) was added. The mixture was heated until a vigorous reaction ensued; this was moderated by the addition of water (40 ml.) in small portions. At the end of the reaction, excess of permanganate was destroyed with ethanol and the mixture filtered; the colourless filtrate was evaporated to small bulk under reduced pressure and the residual liquor adjusted to pH 4—5 by addition of acetic acid. The solid 3-*benzamido*-6-*methylpyridine*-2-*carboxylic acid* which separated crystallised from dioxan in needles, m. p. 218° (0·2 g., 21%) (Found : C, 65·7; H, 4·8; N, 11·5. $C_{14}H_{12}O_3N_2$ requires C, 65·6; H, 4·7; N, 10·9%).

1-*Benzoyl*-2 : 5-*dimethyl*-3-*nitro*-1 : 4-*diazaindene*.—1-Benzoyl-2 : 5-dimethyl-1 : 4-diazaindene (2 g.) rapidly dissolved when added in small portions to cold nitric acid (*d* 1·5; 20 ml.). After 1½ hours the solution was poured into water (200 ml.) and the pH adjusted to 6 by addition of aqueous ammonia. The sticky yellow solid which separated was dried and recrystallised from ethyl acetate–light petroleum. The resulting 3-*nitro*-derivative formed pale cream prisms, m. p. 164—165° (1·3 g., 60%) (Found : N, 14·5. $C_{16}H_{13}O_3N_3$ requires N, 14·25%). The *picrate* forms yellow prisms, m. p. 140—141° (Found : N, 15·9. $C_{16}H_{13}O_3N_3,C_6H_3O_7N_3$ requires N, 16·0%).

Oxidation. A solution of the benzoyl compound (1 g.) and potassium permanganate (3·4 g.) in acetone (40 ml.) and water (40 ml.) was heated under reflux for 20 minutes. Excess of oxidising agent was destroyed by addition of ethanol and the manganese dioxide filtered off. The colourless filtrate was evaporated to small bulk and the pH adjusted to 5, whereupon 3-benzamido-6-methylpyridine-2 carboxylic acid, m. p. and mixed m. p. 218° (0·3 g., 32%), separated.

2 : 5-*Dimethyl*-3-*nitro*-1 : 4-*diazaindene*.—(*a*) A mixture of 1-benzoyl-2 : 5-dimethyl-3-nitro-1 : 4-diazaindene (2 g.) in ethyl alcohol (100 ml.) and N-sodium hydroxide (6·8 ml.) was heated under reflux for 10 minutes. N-Hydrochloric acid (6·8 ml.) was then added and the solution evaporated to dryness *in vacuo*. The residue was extracted with water, and the insoluble material filtered off. 2 : 5-*Dimethyl*-3-*nitro*-1 : 4-*diazaindene* separates from ethyl alcohol as pale yellow needles of no definite m. p., darkening at 270° and decomposing up to 285° (1·1 g., 85%) (Found : C, 56·3; H, 4·8; N, 21·9. $C_9H_9O_2N_3$ requires C, 56·3; H, 4·7; N, 22·0%).

(*b*) 2 : 5-Dimethyl-1 : 4-diazaindene nitrate (0·5 g.) was heated with acetic acid (30 ml.) under reflux for 15 minutes and the solution evaporated; the residual deep-red gum was extracted with boiling ethyl acetate. Addition of light petroleum to the extract precipitated a small amount of brown solid which recrystallised from ethanol as yellow needles (0·05 g.). The material, on heating, behaved similarly to the compound prepared as in (*a*) above. The *picrate* separates from glacial acetic acid as greenish-yellow plates, m. p. 235—236° (Found: C, 42·9; H, 3·0; N, 19·9. $C_9H_9O_2N_3,C_6H_3O_7N_3$ requires C, 43·2; H, 2·9; N, 20·0%).

3-*Amino*-2 : 5-*dimethyl*-1 : 4-*diazaindene*.—2 : 5-Dimethyl-3-nitro-1 : 4-diazaindene (1 g.) in acetic acid (20 ml.) was shaken in an atmosphere of hydrogen at room temperature and normal pressure, with 10% palladium–charcoal. After the theoretical quantity of hydrogen had been absorbed, the catalyst was filtered off and the filtrate evaporated under reduced pressure. The residual deep-red oil, which darkened on storage, was converted into the *dihydrochloride* by passage of dry hydrogen chloride into its solution in ethanol. The brown precipitate crystallised from 95% acetic acid as sheaves of tiny needles, m. p. 301—302° (decomp.) (Found: C, 46·5; H, 5·7; N, 17·8; Cl, 29·2. $C_9H_{11}N_3,2HCl$ requires C, 46·1; H, 5·6; N, 17·9; Cl, 30·25%).

The *picrate* of the amino-compound forms orange-yellow lances, m. p. 205—206° (decomp.) (Found: N, 20·35. $C_9H_{11}N_3,2C_6H_3O_7N_3$ requires N, 20·35%).

The amino-compound was converted into 1-*acetyl*-3-*acetamido*-2 : 5-*dimethyl*-1 : 4-*diazaindene*, m. p. 222—223°, by treatment with acetic anhydride (Found: C, 63·4; H, 6·3; N, 17·1. $C_{13}H_{15}O_2N_3$ requires C, 63·7; H, 6·1; N, 17·15%).

3-*Benzeneazo*-2 : 5-*dimethyl*-1 : 4-*diazaindene*.—A cold solution of benzenediazonium chloride [from aniline (0·8 g.)] was added to a cold solution of 2 : 5-dimethyl-1 : 4-diazaindene (2 g.) in 2N-hydrochloric acid. 2N-Sodium hydroxide was added until the solution was just alkaline, whereupon a bright yellow gummy precipitate separated. This hardened on storage and after crystallisation from aqueous alcohol was obtained as bright yellow-orange needles of 3-*benzeneazo*-2 : 5-*dimethyl*-1 : 4-*diazaindene*, m. p. 208° (2·4 g., 70%) (Found: C, 72·0; H, 5·9; N, 22·65. $C_{15}H_{14}N_4$ requires C, 72·0; H, 5·6; N, 22·4%).

The azo-compound (1 g.) was shaken in glacial acetic acid (20 ml.) under hydrogen at normal pressure and temperature in presence of palladised charcoal. 2 Moles of hydrogen were adsorbed very rapidly. The filtered solution was evaporated under reduced pressure and the residue heated under reflux for 15 minutes with acetic anhydride (20 ml.). Excess of anhydride was removed under reduced pressure and the residue triturated with ethyl acetate. The resultant solid separated from aqueous ethanol as needles, m. p. 220—221° (0·6 g., 60%), and showed no depression of m. p. on admixture with the 1-acetyl-3-acetamido-2 : 5-dimethyl-1 : 4-diazaindene prepared as described above. Evaporation of the ethyl acetate liquors left a residue of acetanilide, m. p. 113°.

1-*Benzoyl*-3-*bromo*-2 : 5-*dimethyl*-1 : 4-*diazaindene*.—To a solution of 1-benzoyl-2 : 5-dimethyl-1 : 4-diazaindene hydrate (2·2 g.) in glacial acetic acid (30 ml.), one equivalent of bromine in acetic acid was added dropwise. Next day the solution was evaporated to dryness and the solid residue extracted with hot water. Addition of one equivalent of N-sodium hydroxide (8 ml.) to the extract precipitated a white *bromo*-derivative which separated from ethanol in lances, m. p. 148° (1·6 g., 60%) (Found: C, 58·3; H, 4·0; N, 8·35; Br, 23·55. $C_{16}H_{13}ON_2Br$ requires C, 58·3; H, 3·95; N, 8·5; Br, 24·3%).

The bromo-compound (1 g.), when oxidised in aqueous acetone with potassium permanganate as described above, gave 3-benzamido-6-methylpyridine-2-carboxylic acid (0·3 g., 38%), m. p. and mixed m. p. 216°.

3-*Bromo*-2 : 5-*dimethyl*-1 : 4-*diazaindene*.—(*a*) To 2 : 5-dimethyl-1 : 4-diazaindene (2 g.) in acetic acid (30 ml.), bromine (2·2 g.) in acetic acid (22 ml.) was added dropwise and the mixture was set aside, The needles which separated crystallised from glacial acetic acid and gave 3-*bromo*-2 : 5-*dimethyl*-1 : 4-*diazaindene* by addition of one equivalent of N-sodium hydroxide to their aqueous solution. The precipitated solid separated from aqueous ethanol as prisms, m. p. 238—239° (decomp.) (Found: N, 12·7. $C_9H_9O_2Br$ requires N, 13·0%).

(*b*) 1-Benzoyl-3-bromo-2 : 5-dimethyl-1 : 4-diazaindene (0·5 g.) in ethanol (5 ml.) and N-sodium hydroxide solution (2·5 ml.) were kept at room temperature for 24 hours. Dilution with an equal volume of water yielded 3-bromo-2 : 5-dimethyl-1 : 4-diazaindene (0·3 g., 90%), m. p. and mixed m. p. 239° (decomp.).

3-*Formyl*-2 : 5-*dimethyl*-1 : 4-*diazaindene*.—2 : 5-Dimethyl-1 : 4-diazaindene (2 g.), chloroform (12 ml.), and ethyl alcohol (32 ml.) were heated under reflux with stirring and a solution of potassium hydroxide (20 g.) in water (24 ml.) added during 2 hours. The mixture was heated for a further hour and then cooled. The precipitated potassium chloride was filtered off and the yellow filtrate evaporated to dryness under reduced pressure. The residual red sticky tar was extracted thoroughly with successive portions of boiling water, and the combined extracts were evaporated to small bulk; in the refrigerator, pale yellow needles, m. p. 239—241° (0·85 g., 36%), of 3-*formyl*-2 : 5-*dimethyl*-1 : 4-*diazaindene* separated (Found: C, 69·0; H, 5·6; N, 16·0. $C_{10}H_{10}ON_2$ requires C, 69·0; H, 5·75; N, 16·1%). The *picrate* separates from methyl cyanide as yellow needles, m. p. 234—235° (Found: N, 18·6. $C_{10}H_{10}ON_2,C_6H_3O_7N_3,CH_3{\cdot}CN$ requires N, 18·9%). The solvent of crystallisation was lost at 120° during 2·5 hours *in vacuo*; the resulting picrate had m. p. 250—251° (Found: N, 17·3. $C_{10}H_{10}ON_2,C_6H_3O_7N_3$ requires N, 17·4%).

5-*Methyl*-2-*styryl*-1 : 4-*diazaindene*.—To a solution of 2 : 5-dimethyl-1 : 4-diazaindene (5 g.) in ethanol (60 ml.) benzaldehyde (4 g.) and 2N-sodium hydroxide (7 ml.) were added; after 24 hours the resultant crystalline *styryl* compound was filtered off; it recrystallised from ethanol in needles, m. p. 154—155° (9 g., 80%) (Found: C, 73·5; H, 7·2; N, 8·5; active H, 0·91. $C_{16}H_{14}N_2,2C_2H_5{\cdot}OH$ requires C, 73·6; H, 8·0; N, 8·6; active H, 0·92%).

5-*Methyl*-2-2′-*phenylethyl*-1 : 4-*diazaindene*.—A solution of 5-methyl-2-styryl-1 : 4-diazaindene (1 g.) in glacial acetic acid (20 ml.) was shaken under hydrogen with palladised charcoal (10% of Pd; 0·2 g.), one mole of hydrogen being rapidly absorbed. Evaporation of the filtered solution yielded a gum which on trituration with ethyl acetate changed to minute needles of 5-*methyl*-2-2′-*phenylethyl*-1 : 4-*diazaindene*, m. p. 245—246° (0·75 g., 75%) (Found : C, 81·4; H, 6·6; N, 11·8. $C_{16}H_{16}N_2$ requires C, 81·3; H, 6·8; N, 11·9%).

This compound (1 g.) was heated under reflux in acetone (50 ml.) with potassium permanganate (2·6 g.) for 1 hour, and the filtered solution evaporated to dryness. The residual 4-*oxide* separated from dioxan as tiny needles, m. p. 248—249° (0·5 g.) (Found : C, 76·7; H, 5·8; N, 11·2. $C_{16}H_{14}ON_2$ requires C, 76·8; H, 5·6; N, 11·2%). The *picrate* separates from glacial acetic acid as yellow needles, m. p. 228—229° (decomp.) (Found : C, 55·2; H, 3·8; N, 14·0. $C_{16}H_{14}ON_2,C_6H_3O_7N_3$ requires C, 55·1; H, 3·6; N, 14·6%). The oxide (0·5 g.) was shaken in ethanol (20 ml.) under hydrogen with 10% palladised charcoal (0·2 g.) at normal temperature and pressure until two moles of hydrogen had been absorbed; the filtered solution was evaporated to dryness and the residue induced to crystallise by trituration with ethyl acetate. The resultant needles had m. p. 245° alone or mixed with 5-methyl-2-2′-phenylethyl-1 : 4-diazaindene prepared as above.

3-*Benzyl*-2 : 5-*dimethyl*-1 : 4-*diazaindene*.—To a Grignard reagent prepared from magnesium (0·4 g.) and ethyl bromide (1·5 ml.), 2 : 5-dimethyl-1 : 4-diazaindene (0·8 g.) in dioxan was added and the whole heated under reflux for 3 hours, after which benzyl chloride (1·5 ml.) was added and the mixture heated for a further 6 hours. After addition of water, the ethereal layer was dried and evaporated; the residue after several recrystallisations from ethyl acetate yielded 3-*benzyl*-2 : 5-*dimethyl*-1 : 4-*diazaindene*, needles, m. p. 236° (Found : N, 12·2. $C_{16}H_{16}N_2$ requires N, 11·9%). The *picrate* separates from acetic acid as delicate yellow needles, m. p. 206° (Found : N, 15·4. $C_{16}H_{16}N_2,C_6H_3O_7N_3$ requires N, 15·1%).

3-*Cinnamamido*-2 : 6-*lutidine*.—A solution of 3-amino-2 : 6-lutidine (2·5 g.) and finely-powdered cinnamoyl chloride (3·4 g.) in dry pyridine (30 ml.), after being kept at room temperature for several hours, was poured into a large excess of water and the precipitated oil induced to crystallise by scratching it. 3-*Cinnamamido*-2 : 6-*lutidine* separates from aqueous ethanol as shining needles, m. p. 189—190° (4·0 g., 80%) (Found : C, 76·4; H, 6·6; N, 10·6. $C_{16}H_{16}ON_2$ requires C, 76·6; H, 6·3; N, 11·0%). The *picrate* separates from glacial acetic acid as yellow prisms, m. p. 244° (Found : C, 54·75; H, 4·0. $C_{16}H_{16}ON_2,C_6H_3O_7N_3$ requires C, 54·9; H, 3·95%).

3-β-*Phenylpropionamido*-2 : 6-*lutidine*.—A solution of 3-amino-2 : 6-lutidine (1 g.) and β-phenylpropionyl chloride (1·4 g.) in dry pyridine (20 ml.) was kept at room temperature for 1 hour and then poured into water (300 ml.). The separated oil slowly solidified and separated from benzene–light petroleum in needles, m. p. 134° (0·7 g., 26%) (Found : C, 75·0; H, 6·8. $C_{16}H_{18}ON_2$ requires C, 75·5; H, 7·0%). The *picrate* forms yellow needles, m. p. 159—160° (Found : C, 54·7; H, 4·1. $C_{16}H_{18}ON_2,C_6H_3O_7N_3$ requires C, 54·7; H, 4·35%).

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