58. *The Reaction of* o-*Phenylenediamine with* αβ-*Unsaturated Acids and with* β-*Keto-esters.*

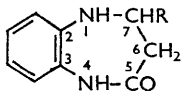
By J. Davoll.

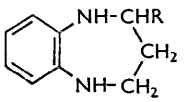
The seven-membered ring structures for the reaction products of acrylic [1] and crotonic [2] acid with *o*-phenylenediamine have been confirmed. The reaction products of *o*-phenylenediamine with ethyl acetoacetate have been shown to have different structures from those previously assigned.[3] Some related reactions have been examined.

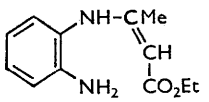
o-*Phenylenediamine and* αβ-*Unsaturated Acids.*—Bachmann and Heisey [1] prepared 4,5,6,7-tetrahydro-5-oxo-1*H*-2,3-benzo-1,4-diazepine (I; R = H) from *o*-phenylenediamine and acrylic acid in hydrochloric acid. We confirmed this structure by reduction with lithium aluminium hydride to the tetrahydro-2,3-benzo-1,4-diazepine (II; R = H),

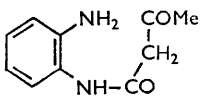
[1] Bachmann and Heisey, *J. Amer. Chem. Soc.*, 1949, **71**, 1985.
[2] Ried and Urlass, *Chem. Ber.*, 1953, **86**, 197.
[3] Sexton, *J.*, 1942, 303.

whose 1,4-di-*p*-toluenesulphonyl derivative was identical with one prepared from *NN'*-di-*p*-toluenesulphonyl-*o*-phenylenediamine and 1,3-dibromopropane.[4] Similarly, *o*-phenylenediamine and crotonic acid yielded the diazepine (I; R = Me) whose structure was proved by analogous reactions. This compound was also obtained from *o*-phenylenediamine and crotonic acid at 165—170°; its preparation by this method has been described elsewhere [2] since this part of our work was completed.

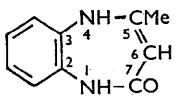

(I)

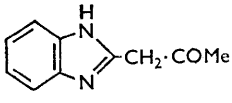

(II)


(III)


(IV)

o-*Phenylenediamine and Ethyl Acetoacetate.*—At room temperature in the presence of traces of acid the product from these reactants is ethyl β-*o*-aminoanilinocrotonate [3,5] (III), though addition of the diamine to the ester in boiling xylene containing pyridine is said to yield *o*-aminoacetoacetanilide [6] (IV). According to Sexton [3] addition of the ester to the diamine in boiling xylene under neutral conditions gives the diazepine (V, or a tautomeric form), m. p. 121°, yet if the ester is previously kept over potassium carbonate or if ethanolic potassium hydroxide is added to the reaction mixture the product is the isomeric 2-acetonylbenzimidazole (VI), m. p. 148°.


(V)


(VI)


(VII)

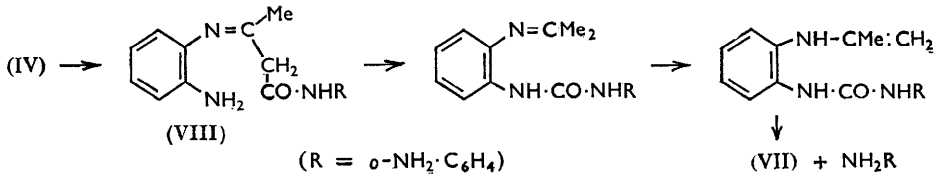
The imidazole was also prepared by reduction of *o*-nitroacetoacetanilide under acidic conditions.

We found that the supposed diazepine (m. p. 121°) with phosphoryl chloride and dimethylaniline gave a chloro-compound in which the chlorine atom could be replaced by an amino-group by treatment with ethanolic ammonia. However, on catalytic reduction and dehalogenation, the chloro-compound absorbed only two mols. of hydrogen instead of the three to be expected for 7-chloro-5-methyl-2,3-benzo-1,4-diazepine, and both Sexton's compounds were therefore re-examined. It was found that the compound of m. p. 148° absorbed one mol. of hydrogen over palladium, the product being the tetrahydrodiazepine (I; R = Me). Hence, the compound of m. p. 148° is the dihydrodiazepine (V), which has recently been prepared [7] from *o*-phenylenediamine and keten, without its identity with Sexton's supposed 2-acetonylbenziminazole having been recognised.

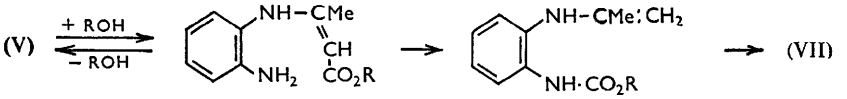
The compound of m. p. 121° also absorbed one mol. of hydrogen to give a product resembling the starting material in its ultraviolet absorption spectrum and solubility in alkali, but differing in not being hydrolysed to 2-oxobenzimidazoline and acetone by dilute acid. It was shown to be 1-isopropyl-2-oxobenziminazoline by synthesis from *o*-isopropylaminoaniline and carbonyl chloride, and the compound of m. p. 121° is thus 1-isopropenyl-2-oxobenzimidazoline (VII), whose eneamine structure is consistent with its ready hydrolysis by acid. The derived chloro-compound is then 2-chloro-1-isopropenylbenzimidazole and its reduction product 1-isopropylbenzimidazole, confirmed by comparison of its picrate with an authentic sample. The 3-alkyl derivatives of compound (VII) were

[4] Stetter, *Chem. Ber.*, 1953, **86**, 197.
[5] Hinsberg and Koller, *Ber.*, 1896, **29**, 1497.
[6] Monti, *Gazzetta*, 1940, **70**, 648.
[7] Ried and Stahlhofen, *Chem. Ber.*, 1957, **90**, 825.

readily prepared, and their hydrolysis by acid to 1-alkyl-2-oxobenzimidazolines affords a convenient preparation of the latter.[8]



The formation of the benzimidazoline (VII) can be explained by the above scheme, which is based on the reactions between aniline and ethyl acetoacetate,[9] and on the formation of 2-oxobenzimidazoline by heating *N*-2-aminophenyl-*N'*-phenylurea.[10] It is assumed that the first product is *o*-aminoacetoacetanilide (IV), which in the presence of traces of acid will condense with more diamine to give the anilide anil (VIII), from which the benzimidazole (VII) can be formed by intramolecular fission followed by cyclisation, as shown. If all traces of acid are removed or potassium hydroxide is added [3] formation of the anil (VIII) is prevented, and the acetoacetanilide (IV) then cyclises to the diazepine (V). [The compound described [6] as *o*-aminoacetoacetanilide resembles



1-isopropenyl-2-oxobenzimidazoline in its hydrolysis by acid, but the melting point is slightly different and the analytical figures do not agree. Only compound (V) or (VII) could be isolated under the conditions described [6].]

Ethyl *o*-aminoanilinocrotonate cannot be postulated as an intermediate in the reaction, since when heated in xylene it gives 2-methylbenzimidazole [3,5] if traces of acid are present, while if a little ethanolic potassium hydroxide was added no reaction occurred. However, we found that treatment of the anilinocrotonate with one equivalent of sodium ethoxide in boiling ethanol gave the diazepine (V) in 84% yield, while with sodium 2-ethoxyethoxide (one equivalent) in boiling 2-ethoxyethanol an 89% yield of 1-isopropenyl-2-oxobenzimidazoline (VII) was obtained, and this could also be prepared in high yield from the dihydrodiazepine (V) in boiling 2-ethoxyethanol containing a catalytic amount of sodium 2-ethoxyethoxide. These are the best routes to both compounds (V) and (VII), since Sexton's procedure [3] gives variable yields, particularly of the former. The conversion of the diazepine (V) into the benzimidazoline (VII) probably occurs as illustrated; alternatively, an anilide anil similar to (VIII), formed by reaction of the ester group of one molecule of aminoanilinocrotonate with the amino-group of another, may be an intermediate.

The diazepine (V) was soluble in acids and alkalis, and on hydrolysis with boiling dilute sulphuric acid gave acetone and a little 2-methylbenzimidazole. With alkaline hypoiodite solution an 80% yield of iodoform was obtained. As described by Sexton [3] the compound reacts with diazotised aniline, the product separating as the hydrochloride. With nitrous acid an unstable compound $C_{10}H_{10}ON_2,N_2O_3$ was obtained. Attempts to prepare a chloro-compound from the diazepine (V) and phosphoryl chloride were unsuccessful. As the compound does not react with methyl iodide in boiling acetone, the structure (V) is preferred to that with a double bond in the 4-position, and a strong amide-carbonyl band in the infrared spectrum (Nujol mull) at 1695 cm.$^{-1}$ indicates the absence of lactim forms.

Ried and Höhne [11] recently described the preparation of two isomeric compounds from

[8] Davoll and Laney, following paper.
[9] Roberts and Edwards, *J. Amer. Chem. Soc.*, 1950, **72**, 5537.
[10] Lellman and Würthner, *Annalen*, 1885, **228**, 199.
[11] Ried and Höhne, *Chem. Ber.*, 1954, **87**, 1801.

1,2-naphthylenediamine and ethyl acetoacetate, to which structures analogous to those given by Sexton [3] were assigned; in view of the above evidence these may require revision.

o-*Phenylenediamine and Ethyl Benzoylacetate.*—As reported [12] the reactants give the phenyl analogue of the methyldiazepine (V). On acid hydrolysis this product yielded acetophenone and 2-phenylbenzimidazole, but unlike the methyl compound it did not react with diazotised aniline and was insoluble in dilute acid and alkali. It did not react with methyl iodide in boiling acetone, or with sodium 2-ethoxyethoxide in boiling 2-ethoxyethanol, and was decomposed by hot phosphoryl chloride. The infrared spectrum in Nujol mull showed a strong amide-carbonyl band at 1680 cm.$^{-1}$.

With *N*-methyl-*o*-phenylenediamine the reaction followed a different course, yielding 21% of 1-methyl-2-phenacylbenzimidazole, whose structure was established by reduction to a hydroxy-compound, followed by treatment with thionyl chloride and reductive dehalogenation of the product to 1-methyl-2-phenethylbenzimidazole, identical with a sample prepared from *N*-methyl-*o*-phenylenediamine and β-phenylpropionic acid.

Experimental

4,5,6,7-*Tetrahydro*-7-*methyl*-5-*oxo*-1H-2,3-*benzo*-1,4-*diazepine.*—*o*-Phenylenediamine (5·4 g.), crotonic acid (6·45 g.), and 5·5N-hydrochloric acid (7·5 c.c.) were heated together at 100° for 4 hr. Basification with concentrated aqueous ammonia then gave the product (4·3 g., 49%); it formed colourless rods (from ethanol), m. p. 184—185° (Ried *et al.*[2] give m. p. 186°) (Found: C, 67·9; H, 6·8; H, 16·2. Calc. for $C_{10}H_{12}ON_2$: C, 68·2; H, 6·9; N, 15·9%), $\lambda_{max.}$ 222, 255, 296 mμ (ε 31,600, 5600, 3000) in EtOH.

4,5,6,7-*Tetrahydro*-1H-2,3-*benzo*-1,4-*diazepine.*—A slurry of 4,5,6,7-tetrahydro-5-oxo-1*H*-2,3-benzo-1,4-diazepine [1] (2 g.) in dry ether was added in 1½ hr. to a refluxing solution of lithium aluminium hydride (0·5 g.) in dry ether (60 c.c.). The mixture was boiled under reflux for 5 hr., cooled, and decomposed with 2N-sodium hydroxide. Evaporation of the dried ethereal layer left a crystalline residue from which boiling light petroleum (60 c.c.; b. p. 60—80°) extracted the diazepine (0·31 g.), m. p. 99—101° (from light petroleum, b. p. 80—100°) (lit.,[13] m. p. 102°) (Found: C, 73·3; H, 8·0; N, 19·0. Calc. for $C_9H_{12}N_2$: C, 72·9; H, 8·2; N, 18·9%). The material (0·54 g.) insoluble in light petroleum was identified as unchanged starting material.

Treatment of tetrahydro-2,3-benzo-1,4-diazepine with toluene-*p*-sulphonyl chloride (2·1 mol.) in pyridine afforded the 1,4-ditoluene-*p*-sulphonyl derivative, m. p. 194—196° alone or in admixture with an authentic sample [4] (Found: N, 6·2. Calc. for $C_{23}H_{24}O_4N_2S_2$: N, 6·1%).

4,5,6,7-*Tetrahydro*-5-*methyl*-1H-2,3-*benzo*-1,4-*diazepine.*—Similarly prepared by lithium aluminium hydride reduction of tetrahydro-7-methyl-5-oxo-2,3-benzo-1,4-diazepine (2 g.), this *compound* (0·6 g.) formed prisms, m. p. 97—98° (Found: C, 74·2; H, 8·7; N, 16·9. $C_{10}H_{14}N_2$ requires C, 74·0; H, 8·7; N, 17·3%). The 1,4-*ditoluene*-p-*sulphonyl derivative*, pale yellow prisms (from acetic acid), had m. p. 202—204° alone or in admixture with material prepared as described below (Found: C, 61·7; H, 5·7; N, 5·9. $C_{24}H_{26}O_4N_2S$ requires C, 61·3; H, 5·6; N, 6·0%).

4,5,6,7-*Tetrahydro*-5-*methyl*-1,4-*ditoluene*-p-*sulphonyl*-1H-2,3-*benzo*-1,4-*diazepine.*—Prepared by Stetter's procedure [4] from 1,3-dibromobutane in 54% yield, this had m. p. 202—204° (Found: C, 61·8; H, 5·8; N, 6·0%).

1-*Isopropenyl*-2-*oxobenzimidazoline.*—(*a*) Prepared from *o*-phenylenediamine and ethyl acetoacetate, this compound, m. p. 121—122°, was described [3] as 6,7-dihydro-5-methyl-7-oxo-1*H*-2,3-benzo-1,4-diazepine, a tautomer of (V) [Found: C, 69·2; H, 6·0; N, 16·3%; *M* (Rast), 176. Calc. for $C_{10}H_{10}ON_2$: C, 69·0; H, 5·8; N, 16·1%; *M*, 174]; it had $\lambda_{max.}$ 206, 282 mμ (ε 47,500, 6800) in EtOH. The compound was rapidly hydrolysed by cold dilute aqueous-ethanolic sulphuric acid to 2-oxobenzimidazoline, and gave a positive iodoform reaction.

(*b*) Ethyl 2-aminoanilinocrotonate (2·2 g.) was boiled under reflux for 2 hr. with a solution of sodium 2-ethoxyethoxide prepared from sodium (0·23 g., 1 atom-equiv.) and 2-ethoxyethanol (10 c.c.). Evaporation under reduced pressure, followed by treatment of a solution of the residue in water (20 c.c.) with glacial acetic acid (0·6 c.c.), gave the isopropenyl compound

[12] Ried and Stahlhofen, *Chem. Ber.*, 1957, **90**, 828.
[13] Hinsberg and Strupler, *Annalen*, 1895, **287**, 220.

(1·54 g., 89%), m. p. 120—121°, unchanged by recrystallisation from aqueous ethanol (Found: N, 16·2%).

(*c*) 4,7-Dihydro-5-methyl-7-oxo-1*H*-2,3-benzo-1,4-diazepine (0·87 g.) was boiled under reflux for 2 hr. with a solution prepared from sodium (*ca.* 10 mg.) and 2-ethoxyethanol (10 c.c.). Evaporation under reduced pressure and addition of water gave the isopropenyl compound (0·69 g., 79%), m. p. 120—121°, unchanged by recrystallisation and undepressed by admixture with the foregoing products.

1-*Isopropyl-2-oxobenzimidazoline.*—(*a*) Hydrogenation of the above compound in ethanol at atmosphetic pressure, with palladium oxide, gave the *isopropyl compound* (85% yield) as rectangular crystals (from aqueous ethanol or benzene–light petroleum), m. p. 127—128° (Found: C, 68·6; H, 6·9; N, 15·5. $C_{10}H_{12}ON_2$ requires C, 68·2; H, 6·9; N, 15·9%), $\lambda_{max.}$ 208, 231, 283 mμ (ε 53,200, 6100, 7000) in EtOH.

(*b*) *o*-Chloronitrobenzene (15·8 g.), isopropylamine (11·8 g.), and ethanol (15 c.c.) were heated together in a sealed tube at 140° for 18 hr. Evaporation and addition of water gave crude *N*-isopropyl-*o*-nitroaniline (18·5 g.), isolated with ether as a red syrup. This (5 g.) was hydrogenated in ethanol with palladised charcoal, and the product, after removal of solvent, was boiled under reflux for 5 hr. with a 12% solution of carbonyl chloride in toluene (35 c.c.). Extraction with 10% sodium hydroxide solution (75 c.c.) and acidification of the aqueous layer afforded the isopropyl compound (1·8 g.), m. p. 127—128° alone or in admixture with material from (*a*) (Found: C, 68·1; H, 6·9; N, 15·7%).

2-*Chloro*-1-*isopropenylbenzimidazole.*—1-Isopropenyl-2-oxobenzimidazoline (9·6 g.), redistilled phosphoryl chloride (48 c.c.), and dimethylaniline (13·3 g.) were boiled together under reflux for 6 hr. Evaporation of the mixture to *ca.* 20 c.c. and addition of ice-water (100 c.c.) followed by extraction with ether gave the *chloro-compound* (5·5 g., 51%) as a nearly colourless liquid, b. p. 95°/0·4 mm., n_D^{20} 1·5853 (Found: C, 61·9; H, 4·9; N, 14·6; Cl, 18·5. $C_{10}H_9N_2Cl$ requires C, 62·3; H, 4·7; N, 14·6; Cl, 18·4%), $\lambda_{max.}$ 205, 247, 275, 282 mμ (ε 33,400, 8100, 6000, 5700) in EtOH. The *picrate* formed pale yellow parallelograms (from ethanol), m. p. 130—131° (Found: C, 45·6; H, 3·2; N, 17·2; Cl, 8·3. $C_{10}H_9N_2Cl,C_6H_3O_7N_3$ requires C, 45·6; H, 2·9; N, 16·6; Cl, 8·4%).

1-*Isopropylbenzimidazole Picrate.*—(*a*) The above chloro-compound (1·93 g.) on hydrogenation in ethanol with palladium oxide (0·3 g.) absorbed 1·93 mols. of hydrogen in 2 hr. with liberation of 1 mol. of acid. The neutralised solution was filtered, evaporated, and treated with water. The product, isolated with ether, gave the *picrate* (3·1 g., 73%) as rods (from ethanol), m. p. 199—200° (Found: C, 49·7; H, 3·7; N, 18·4. $C_{10}H_{12}N_2,C_6H_3O_7N_3$ requires C, 49·4; H, 3·9; N, 18·0).

(*b*) To a solution of benzimidazole (3·5 g.) and potassium hydroxide (1·7 g.) in hot ethanol (25 c.c.) was added isopropyl bromide (3·6 g.). The mixture was boiled under reflux for 4 hr. then evaporated and treated with 10% sodium hydroxide solution. 1-Isopropylbenzimidazole (1·3 g.), isolated with ether, had b. p. 140°/1 mm. (lit.,[14] 98°/0·1 mm.) and gave a picrate (2·53 g.), m. p. 197—199° alone or in admixture with the material from (*a*) (Found: C, 49·0; H, 4·0; N, 17·9%).

2-*Amino*-1-*isopropenylbenzimidazole.*—2-Chloro-1-isopropenylbenzimidazole (6 g.) and ethanolic ammonia (4N, 20 c.c.) were heated together in a sealed tube at 165—170° for 12 hr. The contents of the tube were evaporated to dryness, the residue was extracted with boiling chloroform (3 × 25 c.c.), and the extracted material was converted into the picrate (7·2 g.) in ethanolic solution. A solution of this picrate in hot 75% ethanol (750 c.c.) was percolated through a column of Dowex No. 1 anion-exchange resin (OH^- form), and the filtrate evaporated to give the *amino-compound* (2·18 g., 41%) as needles (from aqueous ethanol), m. p. 148—150° (Found: C, 69·0; H, 6·5; N, 24·5. $C_{10}H_{11}N_3$ requires C, 69·3; H, 6·4; N, 24·3%), $\lambda_{max.}$ 210, 243, 284 mμ (ε 44,300, 9400, 7400). The *picrate* formed leaflets (from ethanol), m. p. 237—238° (Found: N, 20·5. $C_{10}H_{11}N_3,C_6H_3O_7N_3$ requires N, 20·9%).

1-*Methyl*-2-*oxobenzimidazoline.*—A solution of sodium ethoxide prepared from sodium (0·69 g.) and absolute ethanol (15 c.c.) was added to a solution of 1-isopropenyl-2-oxobenzimidazoline (5 g.) in the same solvent (25 c.c.). Methyl iodide (2 c.c.) was added, the mixture was boiled under reflux for 3 hr., then evaporated, and the residue heated to boiling with N-sulphuric acid (50 c.c.). Ethanol was added to give a clear solution, which on cooling afforded 1-methyl-2-oxobenzimidazoline (3·6 g., 84%), m. p. 190—192° (from ethanol) (lit.,

[14] Davies, Mamalis, Petrow, and Sturgeon, *J. Pharm. Pharmacol.*, 1951, **3**, 420.

m. p. 191—192°) (Found: C, 64·5; H, 5·5; N, 19·1. Calc. for $C_8H_8ON_2$: C, 64·9; H, 5·4; N, 18·9%).

4,7-*Dihydro*-5-*methyl*-7-*oxo*-1H-2,3-*benzo*-1,4-*diazepine*.—(*a*) This compound was described by Sexton [3] as 2-acetonylbenzimidazole. Prepared by either of Sexton's methods, it had m. p. 148° (from ethanol) (Found: C, 69·3; H, 6·0; N, 16·1. Calc. for $C_{10}H_{10}ON_2$: C, 69·0; H, 5·8; N, 16·1%), $\lambda_{max.}$ 213, 280, 289 mμ (ε 32,200, 3400, 3400) in EtOH. The reported [7] m. p. for material prepared from *o*-phenylenediamine and diketen is 151°.

(*b*) Ethyl *o*-aminoanilinocrotonate (6·6 g.) was boiled under reflux for 2 hr. with a solution of sodium ethoxide prepared from sodium (0·69 g.) and absolute ethanol (30 c.c.). Evaporation and addition of acetic acid (1·8 c.c.) to a solution of the residue in water (50 c.c.) gave the diazepine (4·37 g., 84%) as needles, m. p. 139—141°. Recrystallisation from ethanol (9 c.c.) gave colourless prisms (2·8 g.), m. p. 147—149° alone or in admixture with the material from (*a*) (Found: C, 68·9; H, 5·8; N, 16·5%).

Reactions of 4,7-*Dihydro*-5-*methyl*-7-*oxo*-1H-2,3-*benzo*-1,4-*diazepine*.—*Hydrogenation.* On hydrogenation in ethanolic solution at room temperature and pressure, with palladium oxide catalyst, the compound absorbed one mol. of hydrogen and gave 80% of tetrahydro-7-methyl-5-oxo-2,3-benzo-1,4-diazepine, m. p. 183—184° alone or in admixture with the material described above (Found: N, 15·6%).

Hydrolysis. The diazepine (1·74 g.) and 2N-sulphuric acid (20 c.c.) were boiled under reflux for 1 hr. Evaporation to 15 c.c. and basification gave 2-methylbenzimidazole (0·15 g.), m. p. and mixed m. p. 174—176°, while the distillate afforded acetone *p*-nitrophenylhydrazone (0·4 g.), m. p. and mixed m. p. 147°.

With benzenediazonium chloride. To a solution of the diazepine (1·74 g.) in 2N-hydrochloric acid (15 c.c.) was added a diazonium solution from aniline (0·93 g.). After 3 days x-*benzeneazo*-4,7-*dihydro*-5-*methyl*-7-*oxo*-1H-2,3-*benzo*-1,4-*diazepine hydrochloride* (2·14 g., 68%) was collected; it formed red needles, m. p. 252° (decomp.) (from 70% acetic acid) (Found: C, 61·3; H, 5·0; H, 17·7. $C_{16}H_{14}ON_4$,HCl requires C, 61·1; H, 4·8; N, 17·8%).

With nitrous acid. To a solution of the diazepine (3·48 g.) in 2N-hydrochloric acid (40 c.c.) at 0° was added dropwise with stirring a solution of sodium nitrite (2·8 g., 2 mol.) in water (25 c.c.). The gum which separated crystallised when rubbed with ethanol, giving the *product* (3·45 g., 69%) as a white powder, m. p. 118—120°, falling to *ca.* 80° on storage. Crystallisation from aqueous ethanol gave colourless prisms, m. p. 104—106° (decomp.) (Found: C, 48·5; H, 4·1; N, 22·6. $C_{10}H_{10}O_4N_4$ requires C, 48·0; H, 4·0; N, 22·4%).

Hydrolysis of 4,7-*Dihydro*-7-*oxo*-5-*phenyl*-1H-2,3-*benzo*-1,4-*diazepine*.—The diazepine [12] (2·36 g.) and 2N-sulphuric acid (20 c.c.) were boiled under reflux for 4 hr. Extraction of the cooled solution with ether gave acetophenone, identified as the semicarbazone (0·95 g.); basification of the aqueous portion yielded 2-phenylbenzimidazole (0·25 g.), m. p. 288—291° (lit., 291°) (Found: C, 79·8; H, 5·2; N, 14·8. Calc. for $C_{13}H_{10}ON_2$: C, 80·4; H, 5·2; N, 14·4%).

1-*Methyl*-2-*phenacylbenzimidazole*.—Ethyl benzoylacetate (11 g.) in xylene (10 c.c.) was added in 30 min. to *N*-methyl-*o*-phenylenediamine (6·1 g.) in boiling xylene (50 c.c.). The mixture was boiled for 1 hr., *ca.* 20 c.c. being distilled off. Cooling gave 1-*methyl*-2-*phenacylbenzimidazole* (2·62 g., 21%) as pale yellow leaflets, m. p. 148—150°, raised to 150—152° by recrystallisation from ethanol (Found: C, 76·5; H, 5·8; N, 10·8. $C_{16}H_{14}ON_2$ requires C, 76·8; H, 5·6; N, 11·2%), $\lambda_{max.}$ 245, 276, 283, 362 mμ (ε 19,000, 6200, 6000, 20,500) in EtOH.

2-β-*Hydroxyphenethyl*-1-*methylbenzimidazole*.—On hydrogenation in ethanolic solution at room temperatures and pressure, with palladium oxide as catalyst, 1-methyl-2-phenacylbenzimidazole (1·25 g.) afforded the *hydroxy-compound* (1 g., 79%) as hexagonal prisms (from ethanol), m. p. 184° (Found: C, 75·9; H, 6·4; N, 11·5. $C_{16}H_{16}ON_2$ requires C, 76·2; H, 6·4; N, 11·1%), $\lambda_{max.}$ 255, 276, 284 mμ (ε 7500, 8100, 8400) in EtOH.

2-β-*Chlorophenethyl*-1-*methylbenzimidazole*.—The above hydroxy-compound (0·8 g.), thionyl chloride (1 c.c.), and dry chloroform (3 c.c.) were boiled together under reflux for 2 hr., then diluted with more chloroform and washed with ice-cold sodium hydrogen carbonate solution. Evaporation of the dried (Na_2SO_4) organic layer yielded the *chloro-compound* (0·56 g., 65%) as rectangular prisms [from benzene–light petroleum (b. p. 40—60°)], which partially melted at 115°, resolidified, and melted completely at 243—245° (Found: C, 72·1; H, 5·7; N, 10·4. $C_{16}H_{15}N_2Cl$ requires C, 71·0; H, 5·6; N, 10·4%).

1-*Methyl*-2-*phenethylbenzimidazole*.—(*a*) On hydrogenation in ethanolic solution at room temperature and pressure, with palladium oxide as catalyst, the above chloro-compound (0·27 g.)

absorbed 31 c.c. of hydrogen. Removal of catalyst and addition of sodium picrate (0·25 g.) in hot aqueous solution afforded *1-methyl-2-phenethylbenzimidazole picrate* (0·36 g., 77%) as leaflets (from aqueous ethanol), m. p. 196—198° (Found: C, 57·0; H, 3·7; N, 14·6. $C_{16}H_{16}N_2,C_6H_3O_7N_3$ requires C, 56·8; H, 4·1; N, 15·1%).

(*b*) *N*-Methyl-*o*-phenylenediamine (3·7 g.) and β-phenylpropionic acid (4·5 g.) were boiled together under reflux for 30 min. A solution of the cooled product in ether was washed with dilute hydroxide solution, dried (Na_2SO_4), and evaporated, giving the *benzimidazole* (2·0 g., 31%), b. p. 218°/2 mm., m. p. 37° (Found: N, 12·4. $C_{16}H_{16}N_2$ requires N, 11·9%). The picrate had m. p. 196—198° alone or in admixture with the material described above (Found: C, 57·4; H, 4·5; N, 15·2%).

The author thanks Dr. R. E. Bowman for many helpful discussions, and Miss Tanner, Dr. J. M. Vandenbelt, and Mr. R. B. Scott for determination of spectra and advice on their interpretation. Thanks are also offered to Mr. F. Oliver for the microanalyses.

Research Department, Parke, Davis & Co.,
Staines Road, Hounslow, Mddx.

[*Received, July 24th,* 1959.]