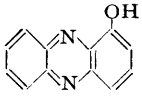
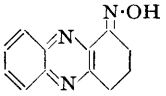
272. 1-*Acetamidophenazine*, 5 : 8 : 13 : 14-*Tetra-azapentaphene*, *and* 5 : 6 : 8 : 13 : 14-*Penta-azapentaphene*.

By Gerald H. Cookson.

Wolff aromatization of 1 : 2 : 3 : 4-tetrahydro-1-hydroxyiminophenazine (II) gives 1-acetamidophenazine, but a similar dehydration of the more nitrogenous analogue (III) was not realized; (II) and (III) react with *o*-phenylenediamine giving products from which the two aza-hydrocarbons (IV) and (VI) mentioned in the title are obtained.

The recent synthesis of the powerful fungicide hemipyocyanine (1-hydroxyphenazine) (I) by Hegedüs (*Helv. Chim. Acta*, 1950, **33**, 766) involved 1-aminophenazine in the penultimate stage and avoided the difficulties of the original method (cf. Surrey, *Org. Synth.*, 1946, **26**, 86). However, although fairly good yields of 1-aminophenazine can be obtained by cyclization of appropriate aminodiphenylamines (Albert and Duewell, *J. Soc. Chem. Ind.*, 1947, **66**, 11; Hegedüs, *loc. cit.*), several steps are required to obtain the starting materials, a disadvantage which does not apply to the method to be described.


(I)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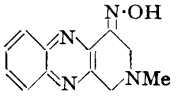
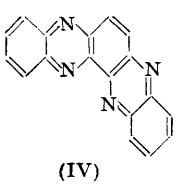
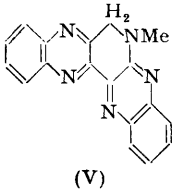
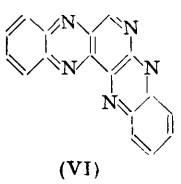

(III)

o-Phenylenediamine condenses rapidly with one molecule of bishydroxyimino*cyclo*hexanone to form 1 : 2 : 3 : 4-tetrahydro-1-hydroxyiminophenazine (II) (Borsche, *Zentr.*, 1909, II, 1549). This is dehydrated and acetylated by boiling acetic anhydride, giving 1-acetamidophenazine in an overall yield of about 30% based on the diamine (for a review of this type of reaction see Horning, *Chem. Reviews*, 1943, **33**, 89). A Beckmann rearrangement, which may take place instead of aromatization (Schroeter, *Ber.*, 1930, **63**, 1308; Horning, Stromberg, and Lloyd, *J. Amer. Chem. Soc.*, 1952, **74**, 5153), was not observed in this case though it may have been responsible for the variable yields. 1-Acetamidophenazine has previously been prepared by removal of the amino-group from 1-acetamido-3-aminophenazine (Kehrmann and Prunier, *Helv. Chim. Acta*, 1924, **7**, 984). It was


(IV)


(V)


(VI)

identified by hydrolysis and comparison with an authentic specimen of the 1-amino-compound. The hydrochloride of (III) was prepared from 3 : 5-bishydroxyimino-1-methylpiperid-4-one hydrochloride in an analogous way to (II) but preliminary experi-

ments with acetic anhydride were not promising. It had been hoped that a quaternary salt of the azaphenazine might have been formed.

When bishydroxyimino*cyclo*hexanone was boiled with two equivalents of *o*-phenylenediamine in acetic acid, the intermediate (II) reacted further to give a pentacyclic compound in high yield. The deeply coloured primary product, which may have been a " phenazhydrin " or a quinonoid dihydro-compound, soon suffered atmospheric oxidation to the pale yellow 5 : 8 : 13 : 14-tetra-azapentaphene (IV). Its absorption spectrum (Fig. 1)

FIG. 1.

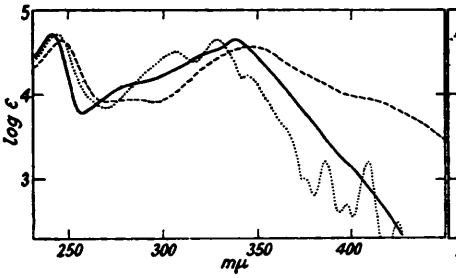


FIG. 2.

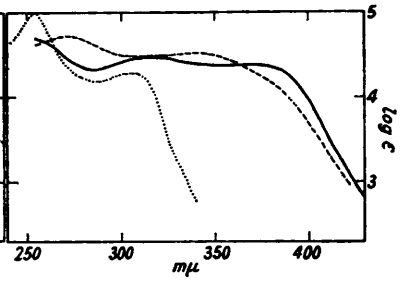


FIG. 1. *Absorption curves of* 5 : 8 : 13 : 14-*tetra-azapentaphene* (IV) *in ethanol* (———) *and in* 3·2N-HCl–EtOH (– – – –), *and of* 5 : 8-*diazapentaphene* (. . . .) (*Badger and Pettit,* J., 1952, 1874).

FIG. 2. *Absorption curves of* 6 : 7-*dihydro*-6-*methyl*-5 : 6 : 8 : 13 : 14-*penta-azapentaphene* (V) *in chloroform* (———) *and in* 0·17N-HCl–$CHCl_3$ (– – – –), *and of* 2 : 2′-*dinaphthyl in ethanol* (. . . .) (*Friedel and Orchin, " U.V. Spectra of Aromatic Compounds," Wiley,* 1951, 309).

closely resembles that of 5 : 8-diazapentaphene although the fine structure has been lost (cf. Badger, Pearce, and Pettit, *J.*, 1951, 3199).

A similar condensation between two molecules of the diamine and one of 3 : 5-bishydroxyimino-1-methylpiperid-4-one hydrochloride took place less readily and gave a very weak base assumed to be 6 : 7-dihydro-6-methyl-5 : 6 : 8 : 13 : 14-penta-azapentaphene (V) but not fully investigated. Elementary analysis gave inconsistent results. The absorption spectrum in neutral and acid chloroform is shown in Fig. 2 together with that

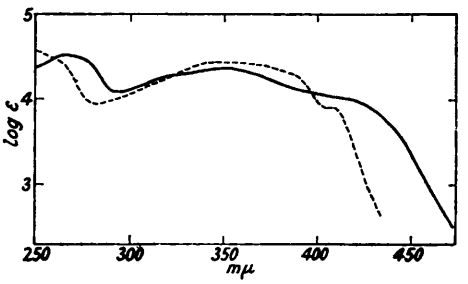


FIG. 3. *Absorption curves of* 5 : 6 : 8 : 13 : 14-*penta-azapentaphene* (VI) *in chloroform* (———) *and in* 0·17N-HCl–$CHCl_3$ (– – – –).

of 2 : 2′-dinaphthyl. The cation of (V) compared with the latter had maxima shifted by 18 mμ and 34 mμ towards longer wave-lengths, a bathochromic effect expected from the addition of the alicyclic bridge (Jones, *J. Amer. Chem. Soc.*, 1941, **63**, 1658) provided $N_{(6)}$ has accepted a proton. Absorption would also be expected to begin at longer wave-lengths owing to the four nitrogen atoms in the quinoxaline rings. The formation of (V) from the starting material involves the loss of water, two molecules of hydroxylamine, and four hydrogen atoms. Ammonium chloride was identified in the reaction mixture, although it is not clear whether this arose from the reduction of hydroxylamine or in some other way.

Vacuum-sublimation of (V) from palladium–charcoal gave a dark green product which was oxidized with hot nitrobenzene to 5 : 6 : 8 : 13 : 14-penta-azapentaphene (VI). This formed bright yellow crystals which appeared unchanged even when heated to 365° in an open capillary. The brilliant turquoise fluorescence shown by neutral but not acid solutions of (VI) may have somewhat flattened the absorption maximum at 348 mμ which was measured without special precautions (Fig. 3).

Experimental

1 : 2 : 3 : 4-Tetrahydro-1-hydroxyiminophenazine (II) separated in 65% yield after equimolecular quantities of *o*-phenylenediamine and bishydroxyimino*cyclo*hexanone had been boiled in water or acetic acid for 15 minutes; it formed platelets (from pyridine), m. p. 213° (efferv.; m. p. higher with quick heating) (Found: C, 67·6; H, 5·2; N, 19·8. Calc. for $C_{12}H_{11}ON_3$: C, 67·6; H, 5·2; N, 19·7%). The 2 : 4-*dinitrophenylhydrazone* crystallized from pyridine in light brown needles which lost solvent of crystallization at 80°/0·2 mm. (20 hours), and had m. p. 249—251° (efferv.) (Found: C, 56·75; H, 4·1; N, 21·9. $C_{18}H_{14}O_4N_6$ requires C, 57·15; H, 3·7; N, 22·2%).

1-*Acetamidophenazine*.—1 : 2 : 3 : 4-Tetrahydro-1-hydroxyiminophenazine (1 g.) was boiled under reflux with acetic anhydride (10 c.c.) for 30 minutes. The dark solution was poured into water (30 c.c.), excess of sodium carbonate added, and the mixture extracted with chloroform. The washed and dried (Na_2SO_4) extract was run through an alumina column from which the product was eluted with dried chloroform; it formed bright yellow crystals, m. p. 170—172°, from methanol or ethyl acetate. The yield in a typical experiment was 0·45 g. (40%), but it varied in different runs between 25% and 75%. The presence of dry hydrogen chloride during the reaction led to tars, and addition of pyridine or fused sodium acetate to the acetic anhydride had little effect.

The acetyl compound was hydrolysed by boiling hydrochloric acid to 1-aminophenazine, deep red prisms (from methanol), m. p. 179—181° undepressed by admixture with an authentic sample kindly supplied by Professor Albert.

3 : 5-*Bishydroxyimino*-1-*methylpiperid*-4-*one hydrochloride* crystallized when excess of ethyl nitrite was passed into a solution of the piperidone (2 g.) in acetic acid (5 c.c.) containing concentrated hydrochloric acid (2·5 c.c.). The product (2·28 g., 75%) was recrystallized from water and dried (P_2O_5) at 20°/0·2 mm. for 24 hours before analysis, but it gave unsatisfactory results. It darkened at 180° and carbonized with gas evolution at *ca.* 195° without melting (Found: C, 32·25; H, 5·2; N, 19·6. $C_6H_{10}O_3N_3Cl,\frac{1}{2}H_2O$ requires C, 33·25; H, 5·1; N, 19·4%).

1 : 2 : 3 : 4-*Tetrahydro*-4-*hydroxyimino*-2-*methyl*-2 : 9 : 10-*triaza*-*anthracene Hydrochloride* (III).—The foregoing hydrochloride (0·8 g.) and *o*-phenylenediamine (1·0 g.) were boiled in ethanol (5 c.c.) for 10 minutes by which time the *product* (0·35 g.) had crystallized in pale brown blades. These, being very soluble in water but almost insoluble in organic solvents, were merely washed with hot alcohol and dried before analysis. They darkened at *ca.* 190° but did not melt (Found: C, 54·45; H, 5·1; N, 20·5. $C_{12}H_{13}ON_4Cl$ requires C, 54·4; H, 4·9; N, 21·2%).

5 : 8 : 13 : 14-*Tetra-azapentaphene* (IV).—*o*-Phenylenediamine (1·0 g.) and bishydroxyimino*cyclo*hexanone (0·55 g.) were boiled with acetic acid (5 c.c.) until the brown solution suddenly became deeply coloured (5—10 min.) and brown needles (0·95 g.) separated. The heat of crystallization made the mixture boil violently. The brown product gave dark blue or green solutions in organic solvents which slowly changed to yellow on atmospheric oxidation. This was accomplished rapidly by chemical means such as recrystallization from nitrobenzene. After a few days in air the brown crystals had become yellow; they had m. p. 300—303°. Traces of impurity were removed by chromatography on alumina in chloroform. The same product was obtained when the tetrahydrohydroxyiminophenazine was boiled in acetic acid with *o*-phenylenediamine. 5 : 8 : 13 : 14-*Tetra-azapentaphene* formed pale yellow needles containing one mol. of chloroform of crystallization, which was rapidly lost under reduced pressure. A solvent-free sample, obtained by sublimation at 270°/0·2 mm., had m. p. 304° [Found: C, 76·4; H, 3·5; N, 19·9%; *M* (Rast), 274 ± 14. $C_{18}H_{10}N_4$ requires C, 76·6; H, 3·55; N, 19·9%; *M*, 282. Loss of $CHCl_3$ on warming at 0·1 mm.: 0·97, 1·0 mol.]. The ultra-violet absorption spectrum in ethanol showed maxima at 242 mμ (log ε 4·71) and 339 mμ (log ε 4·64), which moved to 246 mμ (log ε 4·64) and 348 mμ (log ε 4·56) in 3·2N-ethanolic hydrogen chloride. Diffuse absorption in the blue region gave the acid solution a yellow colour.

The *picrate* crystallized in brown rods from ethylene dibromide. It was easily decomposed by water and melted indistinctly at *ca.* 240—265° (Found: C, 56·0; H, 2·9; N, 18·8. $C_{18}H_{10}N_4,C_6H_3O_7N_3$ requires C, 56·4; H, 2·5; N, 19·2%).

5 : 6 : 8 : 13 : 14-*Penta-azapentaphene* (VI).—A solution of 3 : 5-bishydroxyimino-1-methylpiperid-4-one hydrochloride (0·9 g.) and *o*-phenylenediamine (1·0 g.) in acetic acid (5 c.c.) was boiled for 30 min., and most of the solvent was then removed under reduced pressure and replaced by ethanol. The brown precipitate (0·25 g.) which separated overnight was washed free from ammonium chloride with water. Repeated recrystallization from nitrobenzene

provided pale buff prisms believed to be 6 : 7-*dihydro*-6-*methyl*-5 : 6 : 8 : 13 : 14-*penta-aza-pentaphene* (V) although after washing with alcohol and 24 hours' drying at 100°/0·3 mm. inconsistent analyses were obtained from the same sample (Found : C, 73·2, 72·6; H, 3·6, 3·7; N, 21·8, 22·6. $C_{18}H_{13}N_5$ requires C, 72·3; H, 4·4; N, 23·4%). Sublimation of the pure compound or the crude product at 330°/0·2 mm., best after admixture with acid 10% palladium–charcoal, gave a green product which was oxidized by recrystallization from nitrobenzene to 5 : 6 : 8 : 13 : 14-*penta-azapentaphene*, yellow crystals which did not melt or discolour at 365° (Found : C, 72·1; H, 3·2; N, 24·2. $C_{17}H_9N_5$ requires C, 72·1; H, 3·2; N, 24·7%). A solution in chloroform showed absorption maxima at 265 and 348 mμ (log ε 4·52 and 4·36) and in chloroform containing hydrogen chloride at 351 and 407 mμ (log ε 4·44 and 3·91). The maxima for (V) were at 317 and 368 mμ (log ε 4·48 and 4·39), and in acid chloroform at 272 and 340 mμ (log ε 4·72 and 4·51). The intense turquoise fluorescence of (VI) in neutral solution was quenched by acid; the dihydromethyl compound (V) did not fluoresce. In some experiments (V) was partly converted into (VI) without sublimation and could not be obtained pure.

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