Triazines and Related Products. Part I. 1,3-Di-*o*-cyanophenyltriazene

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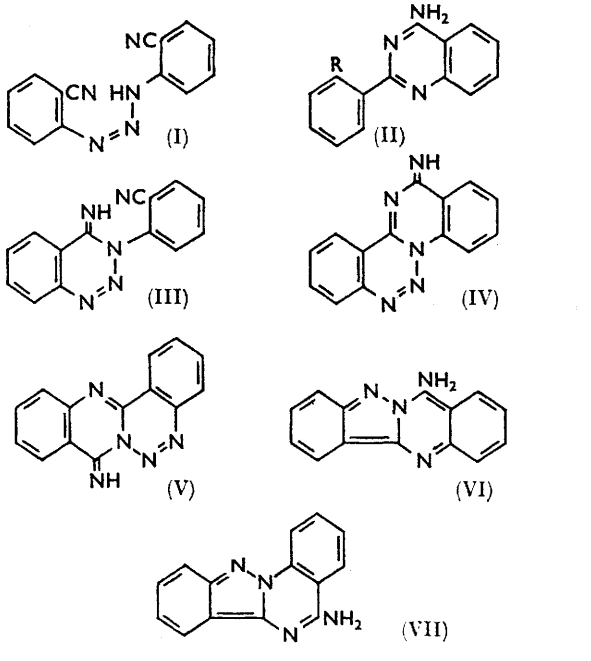
12-Imino-12*H*-[1]benzo-*v*-triazino[3,4-*a*]quinazoline has been prepared by alumina-catalysed cyclisation of 1,3-di-*o*-cyanophenyltriazene and its properties compared with those of the isomeric 7-imino-7*H*-[1]benzo-*v*-triazino[4,3-*b*]quinazoline. The triazino[3,4-*a*]quinazoline is involved as an intermediate in certain reactions of 1,3-di-*o*-cyanophenyltriazene; thus, the triazene affords, on reduction with stannous chloride in ethanol, 11-aminoindazolo[3,2-*b*]quinazoline.

THE decomposition of 1,3-di-*o*-cyanophenyltriazene (I) in aqueous ethanol to yield the aminoquinazoline (II; R = H) is said [1] possibly to involve the intermediate formation of the benzotriazine (III) and the benzotriazinoquinazoline (IV). Diazotisation of the diaminoquinazoline (II; R = NH_2) isolated as its dihydrochloride from the hydrazine and Raney nickel reduction of the triazene (I) was stated to yield the same benzotriazinoquinazoline (IV) or the isomeric compound (V). This Paper describes the chemistry of 1,3-di-*o*-cyanophenyltriazene related to these conversions.

In boiling 75% aqueous ethanol cyclisation and reduction of the triazene (I) to form the aminoquinazoline (II; R = H) was accompanied by the formation of red contaminants.[1] In the present work this reaction was readily studied spectroscopically (u.v.). In 95% ethanol at 20° conversion to the quinazoline (II; R = H) was quantitative in 48 hr.; however, the intermediate triazine (III) and the benzotriazinoquinazoline (IV) could not be isolated.



Attempted chromatographic purification of a sample of the triazene (I) in benzene on alumina furnished an unstable red solid with chemical and spectroscopic properties different from those of typical 4-imino-1,2,3-benzotriazines [1] [cf. (III)]. The red product was assigned structure (IV) on the basis of the evidence summarised below. Investigation of the conditions of the alumina-catalysed cyclisation of the triazene (I) indicated that the amidine synthesis was pH sensitive. The benzotriazinoquinazoline (IV) was readily formed by adsorption on alkaline alumina (pH 9·6); unchanged triazene was quantitatively recovered following similar treatment on acid alumina (pH 4·7). The benzotriazinoquinazoline (IV) underwent reduction in boiling ethanol evolving nitrogen and forming the aminoquinazoline (II; R = H); in ethanolic hydrazine containing Raney nickel the product was the diamine (II; R = NH_2). The benzotriazinoquinazoline (IV) coupled with 2-naphthol in cold ethanol to give an azo-compound (II; R = 1-azo-2-naphthol) which was identical to the product of the coupling reaction between the diazotised diamine (II; R = NH_2) and 2-naphthol.

Additional evidence to confirm that the ethanol decomposition of the triazene (I) involves the intermediate benzotriazinoquinazoline (IV) was obtained by the isolation of the same azo-compound (II; R = 1-azo-2-naphthol) when the benzotriazinoquinazoline was trapped by the incorporation of 2-naphthol in the ethanolic solution.

The previously reported [1] product of equivocal structure from the diazotised diamine (II; R = NH_2) which differed from the benzotriazinoquinazoline (IV) was accordingly assigned structure (V). Evidently the N-3 atom of the quinazoline ring participates in the intramolecular diazonium coupling. This assignment is consistent with the reported [2] cyclisations of 2-*o*-aminophenyl-4-arylaminoquinazolines with triethyl orthoformate to yield triazabenzanthracenes and not the isomeric triazachrysenes. The unstable benzotriazinoquinazoline (V) resembled its isomer (IV) in coupling with 2-naphthol to form the azo-compound (II; R = 1-azo-2-naphthol), and undergoing reduction in ethanol,[1] or ethanolic hydrazine containing Raney nickel, affording the mono- or di-aminoquinazolines (II; R = H or NH_2, respectively). Attempted acid-promoted rearrangement of the benzotriazinoquinazoline (IV) to the isomer (V) was unsuccessful.

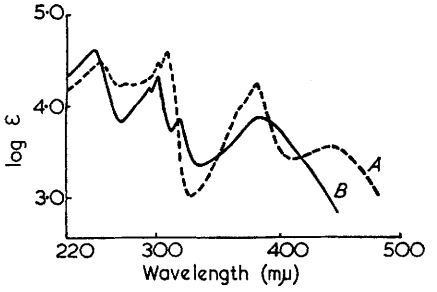
Stannous chloride and hydrochloric acid reduction of the triazene (I) effects cleavage of the diazoamino-group. The formation of *o*-aminobenzonitrile and 3-aminoindazole can be accounted for since *o*-hydrazinobenzonitrile spontaneously cyclises to 3-aminoindazole.[3] Stan-

[1] M. W. Partridge and M. F. G. Stevens, *J. Chem. Soc.*, 1964, 3663.

[2] M. W. Partridge, S. A. Slorach, and H. J. Vipond, *J. Chem. Soc.*, 1964, 3670.

[3] F. C. Cooper, *J. Chem. Soc.*, 1958, 4212; M. A. Aron and J. A. Elvidge, *Chem. and Ind.*, 1958, 1234.

nous chloride in ethanol reduction of the triazene yielded ammonia, *o*-aminobenzonitrile, 3-aminoindazole, and, as the major product, the indazolo[3,2-*b*]quinazoline (VI). The possibility of this indazoloquinazoline (VI) resulting from condensation of *o*-aminobenzonitrile and 3-aminoindazole was precluded on account of their inability to react under the reduction conditions. It is suggested that the indazoloquinazoline (VI) is derived by cyclic deamination of 4-amino-2-*o*-hydrazinophenylquinazoline (II; R = $NHNH_2$) formed *in situ* by reduction of the intermediate benzotriazinoquinazoline (IV). The formation of aminoindazoles by stannous chloride–ethanol reduction of 1,2,3-benzotriazines has been reported [1] probably to involve *ortho*-hydrazinoamidines. Corroboration of the proposed mechanism was obtained by the isolation of the same tetracyclic compound (VI) by pyrolytic decomposition of the hydrazine (II; R = $NHNH_2$) prepared by reduction of the diazotised diamine (II; R = NH_2): the isomeric indazolo[2,3-*a*]quinazoline (VII), which has been synthesised in poor



Absorption spectra of 11-aminoindazolo[3,2-*b*]quinazoline (*A*), and 5-aminoindazolo[2,3-*a*]quinazoline (*B*) in ethanol

yield from nitrobenzene by the von Richter reaction, and as a by-product in the reduction of *o*-nitrobenzonitrile,[4] was not detected.

This isomer (VII) was efficiently prepared by zinc and acetic acid reduction of 2,2′-dicyanoazoxybenzene. Reduction of the azoxy-compound with stannous chloride in ethanol gave 2,2′-dicyanoazobenzene which resembled the azoxybenzene in its ultraviolet absorption properties and also formed the indazoloquinazoline (VII) with zinc in acetic acid. Evidently, the common reduction product, 2,2′-dicyanohydrazobenzene cyclises in acetic acid to form 3-amino-2-*o*-cyanophenylindazole which undergoes a second amine-nitrile addition to yield the aminoindazoloquinazoline (VII). Analogous formation of 3-amino-2-arylindazoles from *o*-cyanoazo-compounds has been reported.[1]

The spectral properties (see Figure) of the isomeric indazoloquinazolines are consistent with the observation [5] that linear polycyclic systems absorb at longer wavelengths than their angular counterparts.

The linear indazoloquinazoline (VI) differed from the angular isomer (VII) in its behaviour on reduction. The indazole ring of (VI) was degraded by hydrazine and Raney nickel to yield the diaminoquinazoline (II; R = NH_2) in contrast with the isomer (VII) which was stable to reduction. Similar reductive cleavage of the N–N bond has been recorded in the Raney nickel hydrogenation of pyrazolo[3,4-*b*]pyridines.[6]

[4] E. Cullen and Ph. L'Écuyer, *Canad. J. Chem.*, 1961, **39**, 155.
[5] W. V. Mayneord and E. M. F. Roe, *Proc. Roy. Soc.*, 1935, *A*, **152**, 299.

EXPERIMENTAL

Ultraviolet absorption spectra were recorded on a Unicam SP 800 spectrophotometer.

12-*Imino*-12H-[1]*benzo*-v-*triazino*[3,4-a]*quinazoline* (IV).—A solution of 1,3-di-*o*-cyanophenyltriazene [7] (0·5 g.) in anhydrous benzene (60 ml.) was stirred (35 min.) with 100—200 mesh alumina (alkaline " Camag " from Hopkins and Williams) (6 g.). The alumina was removed and washed with aliquots of benzene (5 × 10 ml.). The combined benzene solutions afforded the *benzotriazinoquinazoline* (0·3 g.) as crimson rosettes, m. p. 135—136° (efferv.) on being concentrated (Found: C, 67·8; H, 3·7; N, 28·2. $C_{14}H_9N_5$ requires C, 68·0; H, 3·7; N, 28·3%), $\lambda_{max.}$ (in carbon tetrachloride) 270infl, 306, 324, 355 mμ (log ε 3·94, 3·95, 3·95, and 4·09, respectively).

The benzotriazinoquinazoline (0·25 g.) was boiled in 75% aqueous ethanol (4 ml.) for 1 hr. The filtered (charcoal), concentrated solution deposited 4-amino-2-phenylquinazoline (0·18 g.), m. p. and mixed m. p.[8] 147—148° (from aqueous ethanol).

4-*Amino*-2-o-*aminophenylquinazoline* (II; R = NH_2).—The benzotriazinoquinazoline (IV) (0·5 g.) in ethanol (20 ml.) containing hydrazine hydrate (0·8 ml.) and Raney nickel (0·15 g.) was stirred at 60° (1 hr.). A further quantity of Raney nickel (0·15 g.) was added and the temperature maintained at 60° (1 hr.). Nickel was filtered off (Kieselguhr). The residue from the evaporated filtrate was triturated with 4N-hydrochloric acid and afforded the diamine dihydrochloride (0·35 g., 65%), which crystallised from 2N-hydrochloric acid as cream-coloured needles, m. p. and mixed m. p.[1] 288—290°, $\lambda_{max.}$ (in water) 205, 238, 275, 314, 325infl, 370 mμ (log ε 4·52, 4·36, 4·25, 3·90, 3·86, and 3·63 respectively).

7-*Imino*-7H-[1]*benzo*-v-*triazino*[4,3-b]*quinazoline* (V).—4-Amino-2-*o*-aminophenylquinazoline dihydrochloride (0·93 g.) suspended in N-hydrochloric acid (20 ml.) was treated at 0° with sodium nitrite (0·23 g.); the dihydrochloride rapidly dissolved and crystals were deposited. Basification with aqueous ammonia liberated the *triazinoquinazoline* (0·5 g.) which crystallised from benzene–light petroleum as brown prisms, m. p. 148—150° (efferv.) (Found: C, 68·1; H, 4·0; N, 28·5. $C_{14}H_9N_5$ requires C, 68·0; H, 3·7; N, 28·3%), $\lambda_{max.}$ (in hexane) 225, 254infl, 268, 296, 320, 340infl, 350, 364infl mμ (log ε 4·58, 4·32, 4·25, 4·10, 3·88, 3·92, 3·95, 3·90).

Reduction of the triazinoquinazoline in ethanolic hydrazine containing Raney nickel in the manner previously described, afforded 4-amino-2-*o*-aminophenylquinazoline dihydrochloride (80%), m. p. and mixed m. p. 288—290°.

4-*Amino*-2-o-(1-*azo*-2-*naphthol*)*phenylquinazoline* (II; R = 1-azo-2-naphthol).— (*a*) 4-Amino-2-*o*-aminophenylquinazoline dihydrochloride (0·31 g.) in 0·5N-hydrochloric acid (20 ml.) was treated at 0° with sodium nitrite (0·08 g.)

[6] E. C. Taylor and J. W. Barton, *J. Amer. Chem. Soc.*, 1959, **81**, 2448.
[7] J. Pinnow and C. Sämann, *Ber.*, 1896, **29**, 623.
[8] H. Meerwein, P. Laasch, R. Mersch, and J. Nentwig, *Chem. Ber.*, 1956, **89**, 224.

in water (3 ml.). The *azo-compound* (60%) was deposited when a solution of 2-naphthol (0·15 g.) in 2N-sodium hydroxide (10 ml.) was added to the cold diazonium salt, m. p. 276—278° (red needles, from ethanol) (Found: C, 73·5; H, 4·3. $C_{24}H_{17}N_5O$ requires C, 73·6; H, 4·4%).

(*b*) A solution of 1,3-di-*o*-cyanophenyltriazene (0·25 g.) and 2-naphthol (0·15 g.) in boiling ethanol (1½ hr.) rapidly deposited the azo-compound (0·42 g., 86%), m. p. and mixed m. p. 276—278°.

(*c*) Interaction of 12-imino-12*H*-[1]benzo-*v*-triazino[3,4-*a*]quinazoline or 7-imino-7*H*-[1]benzo-*v*-triazino[4,3,*b*]quinazoline and 2-naphthol (1 mol.) in ethanol at 20° (30 min.) furnished the same azo-compound (65 and 55%, respectively), m. p. and mixed m. p. 276—278°.

4-*Amino*-2-o-*hydrazinophenylquinazoline* (II; R = $NHNH_2$).—The suspension formed when 4-amino-2-*o*-aminophenylquinazoline dihydrochloride (1·55 g.) in 2N-hydrochloric acid (20 ml.) was diazotised by a solution of sodium nitrite (0·35 g.) in water (5 ml.) was poured into a stirred solution of stannous chloride dihydrate (2·25 g.) in hydrochloric acid (20 ml.) at 0°. The mixture was kept at 0° (1 hr.) and basified to pH 11 with aqueous sodium hydroxide at 0° to precipitate the *hydrazine* (0·8 g.), m. p. 185—186° (efferv. and resolidification) when crystallised from benzene (Found: C, 67·1; H, 5·5; N, 27·6. $C_{14}H_{13}N_5$ requires C, 66·9; H, 5·5; N, 27·9%), $\lambda_{max.}$ (in ethanol) 238, 268infl, 300, 335infl, 364infl mμ (log ε 4·55, 4·21, 4·02, 3·88, and 3·77). Its *benzylidine-derivative*, formed by interaction of the hydrazine and benzaldehyde (1 mol.) in boiling acetic acid, had m. p. 199—200° (from methanol) (Found: C, 74·1; H, 5·1. $C_{21}H_{17}N_5$ requires C, 74·3; H, 5·05%).

11-*Aminoindazolo*[3,2-b]*quinazoline* (VI).—(*a*) A mixture of 1,3-di-*o*-cyanophenyltriazene (2·5 g.) and stannous chloride dihydrate (4·5 g.) in ethanol (50 ml.) was boiled (1½ hr.) and solvent (30 ml.) removed by distillation. Trituration of the residue with 2N-sodium hydroxide solution (150 ml.) liberated a brown solid. Fractional crystallisation of the ether-soluble products furnished *o*-aminobenzonitrile (0·4 g.), m. p. and mixed m. p.[9] 49—50°, and 3-aminoindazole (0·3 g.), m. p. and mixed m. p.[3] 154—155°. Purification of the brown ether-insoluble solid by sublimation (300°/1 mm.) and crystallisation from ethanol afforded the *indazoloquinazoline* (1·3 g.) as yellow prisms, m. p. 335—340° (Found: C, 71·8; H, 4·6; N, 23·6. $C_{14}H_{10}N_4$ requires C, 71·8; H, 4·3; N, 23·9%).

Reduction of the triazene (1·25 g.) with stannous chloride dihydrate (2·25 g.) in concentrated hydrochloric acid (20 ml.) at 20° (1½ hr.) afforded, after precipitation of the bases with aqueous sodium hydroxide, *o*-aminobenzonitrile (0·5 g.) and 3-aminoindazole (0·55 g.).

(*b*) 4-Amino-2-*o*-hydrazinophenylquinazoline (0·25 g.) rapidly evolved ammonia at 180—190° (30 min.). Purification of the residue by sublimation and crystallisation (ethanol) furnished the indazoloquinazoline (0·2 g.), m. p. and mixed m. p. 345—350°.

Reduction of the indazoloquinazoline (0·3 g.) in ethanol with hydrazine and Raney nickel gave 4-amino-2-*o*-aminophenylquinazoline dihydrochloride (0·07 g.), m. p. and mixed m. p. 288—290° when the evaporated residue was triturated with 4N-hydrochloric acid.

2,2′-*Dicyanoazobenzene*.—A mixture of 2,2′-dicyanoazoxybenzene[10] (2·48 g.) and stannous chloride dihydrate (7·8 g.) was boiled in ethanol for 1 hr. The concentrated solution deposited the *azobenzene* (2·2 g.), m. p. 228—230° unchanged on further crystallisation from ethanol (Found: C, 72·3; H, 3·3; N, 24·2. $C_{14}H_8N_4$ requires C, 72·4; H, 3·5; N, 24·1%), $\lambda_{max.}$ (in ethanol) 240, 246, 253infl, 329, 344infl, 362infl mμ (log ε 4·13, 4·15, 4·02, 4·30, 4·25, and 3·95, respectively).

5-*Aminoindazolo*[2,3-a]*quinazoline* (VII).—(*a*) A stirred solution of 2,2′-dicyanoazobenzene (0·23 g.) in acetic acid (30 ml.) was treated with zinc powder (0·6 g.) at 70—75° (1 hr.). The solution rapidly went colourless and slowly developed a green fluorescence. The indazoloquinazoline (0·17 g.) was precipitated from the filtered, evaporated solution on the addition of water (20 ml.); it crystallised from aqueous ethanol as lime-green rosettes, m. p. and mixed m. p.[4] 223—224°. The hydrochloride (from hot concentrated hydrochloric acid) had m. p. and mixed m. p.[4] 277—279°.

(*b*) Reduction of 2,2′-dicyanoazoxybenzene (1·24 g.) with zinc powder (3 g.) in acetic acid (150 ml.) at 70—75° afforded the indazoloquinazoline (1·1 g.), m. p. and mixed m. p. 223—224°.

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[9] G. R. Bedford and M. W. Partridge, *J. Chem. Soc.*, 1959, 1633.
[10] E. Cullen and Ph. L'Ecuyer, *Canad. J. Chem.*, 1961, **39**, 862.