Triazines and Related Products. Part 18.[1] Decomposition of 1,2,3-Benzotriazines and Related Triazenes with Sodium Azide in Acetic Acid: a Convenient Route to Azidoarenes

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1,2,3-Benzotriazin-4(3*H*)-one and its 3-aryl derivatives decompose in boiling acetic acid containing sodium azide or sodium iodide to afford 2-azido- and 2-iodo-benzamides, respectively, in high yields. Certain azidoarenes with nucleophilic *ortho*-substituents, formed from the decomposition of 1,2,3-benzotriazines and related aryltriazenes, cyclise with elimination of nitrogen under the reaction conditions. 1,2-Bis-*o*-nitrophenyltriazene in acetic acid containing sodium azide yields benzofurazan *N*-oxide and 2-nitroaniline.

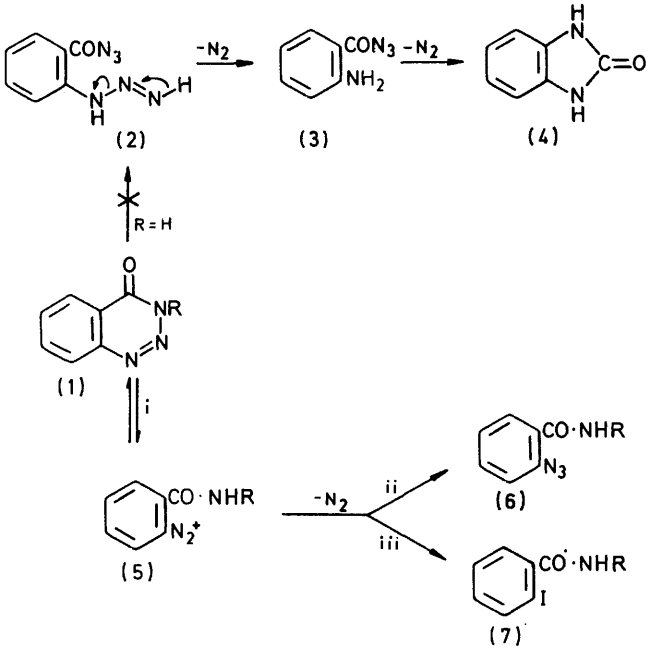
We have previously described the degradation of 1,2,3-benzotriazin-4(3*H*)-ones (1) in the presence of secondary amines [2] and reactive methylene systems.[3] 3-Alkyl-, 3-aryl-, and 3-aralkyl-1,2,3-benzotriazin-4(3*H*)-ones are, in general, unreactive towards amine nucleophiles, whereas the parent triazinone (1a) undergoes nucleophilic attack at C-4 with subsequent ring opening and loss of nitrogen to afford anthranilamide derivatives.[2,4] We anticipated that a similar nucleophilic attack by azide ion could lead to the triazenobenzoyl azide (2), which should undergo successive losses of nitrogen first to give anthraniloyl azide (3) and thence, *via* a Curtius rearrangement,[5] benzimidazolone (4) (Scheme).

The triazinone (1a) however was recovered unchanged from boiling aqueous ethanol, dimethylformamide, or dimethyl sulphoxide containing an excess of sodium azide. Boiling acetic acid, which is known to be an ideal solvent to promote reversible ring-opening of 1,2,3-benzotriazin-4(3*H*)-ones (1) to the diazonium species (5),[6-8] proved an admirable medium for azide-promoted decomposition, and the unsubstituted triazinone (1a) was smoothly converted in near quantitative yield into 2-azidobenzamide (6a) and not the predicted product. Although 3-alkyl- and 3-aralkyl-1,2,3-benzotriazin-4(3*H*)-ones (1b—h) were unchanged under the same conditions, high yields of *N*-aryl-2-azidobenzamides (6i—l) were obtained from the corresponding 3-aryltriazinones (1i—l): the difference in reactivity may be attributed to the electronic influence of the aryl substituents which in these cases encourage initial heterolysis of the triazinone N(2)–N(3) bond.[3] Similar features explain the successful conversion of the 3-pyrimidinyltriazinone (1m) into the appropriate azide (6m). This procedure represents a

[1] Part 17, E. J. Gray, M. F. G. Stevens, G. Tennant, and R. J. S. Vevers, *J.C.S. Perkin I*, 1976, 1496.
[2] M. S. S. Siddiqui and M. F. G. Stevens, *J.C.S. Perkin I*, 1974, 611.
[3] M. S. S. Siddiqui and M. F. G. Stevens, *J.C.S. Perkin I*, 1974, 2482.
[4] A. W. Murray and K. Vaughan, *J. Chem. Soc.* (*C*), 1970, 2070.
[5] M. S. Gibson and M. Green, *Tetrahedron*, 1965, **21**, 2191.
[6] J. G. Erickson, 'The Chemistry of Heterocyclic Compounds,' ed. A. Weissberger, Interscience, New York, vol. 10, p. 1.
[7] J. P. Horwitz, 'Heterocyclic Compounds,' ed. R. C. Elderfield, Wiley, New York, 1961, vol. 7, p. 778.
[8] A. C. Mair and M. F. G. Stevens, *J. Chem. Soc.* (*C*), 1971, 2317.

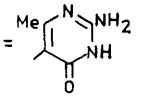
useful new synthesis of *N*-aryl-2-azidobenzamides, which, unlike the *N*-alkyl and *N*-aralkyl analogues, cannot be prepared from appropriately substituted anthranilamides by the usual diazotisation–azidation route because of the dominating competitive intramolecular cyclisation to 3-aryl-1,2,3-benzotriazin-4(3*H*)-ones.[8,9]

The unsubstituted triazinone (1a) and its *N*-aryl derivatives (1i and l) also decomposed in acetic acid containing



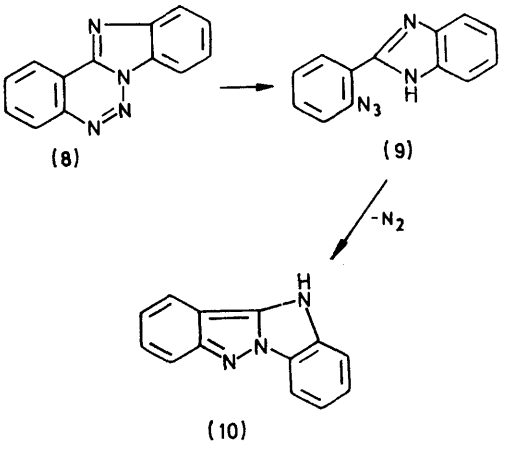
a; R = H
b; R = Me
c; R = Et
d; R = Pr^n
e; R = Pr^i
f; R = $[CH_2]_2$·OH
g; R = $PhCH_2$
h; R = $Ph[CH_2]_2$
i; R = Ph
j; R = *o*-MeC_6H_4
k; R = *o*-NO_2·C_6H_4
l; R = *p*-NO_2·C_6H_4

m; R =



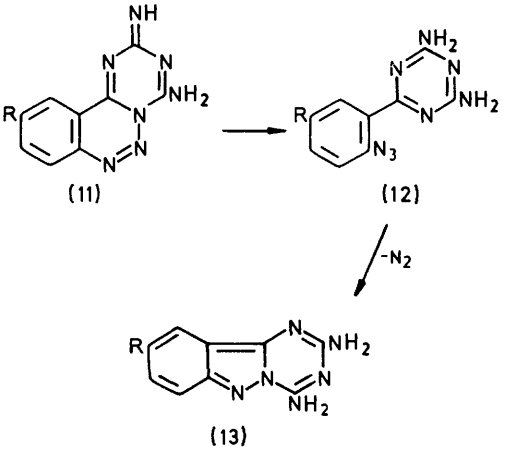
SCHEME Reagents: i, AcOH; ii, NaN_3–AcOH; iii, NaI–AcOH

sodium iodide to afford high yields of the corresponding 2-iodobenzamides (7a, i, and l) respectively, but all the *N*-alkyltriazinones (1b—h) failed to react under the same conditions. The nucleophilicity of the participating anion also limits the synthetic scope of the decomposition: no 2-substituted benzamides were isolated when the triazinone (1a) was boiled in acetic acid



containing sodium bromide, chloride, cyanide, acetate, or sulphite. Conceivably more strongly nucleophilic anions would be as effective as azide and iodide ions.

Decomposition of benzimidazo[1,2-*c*][1,2,3]benzotriazine (8) in acetic acid–sodium azide yielded the known 2-*o*-azidophenylbenzimidazole (9), which was further characterised by thermolytic cyclisation at 200 °C to the indazolo[2,3-*a*]benzimidazole (10).[10] In contrast, the *s*-triazino[1,2-*c*][1,2,3]benzotriazines (11a—c) were transformed into the corresponding diamino-*s*-triazino[1,2-*b*]-indazoles (13a—c) in acetic acid–sodium azide. The intermediates in these reactions [the *o*-azidophenyl-*s*-triazines (12a—c)] were shown independently to cyclise in boiling acetic acid, probably by a facilitated neighbouring-group elimination of nitrogen.[11]



a; R = H
b; R = Me
c; R = Br

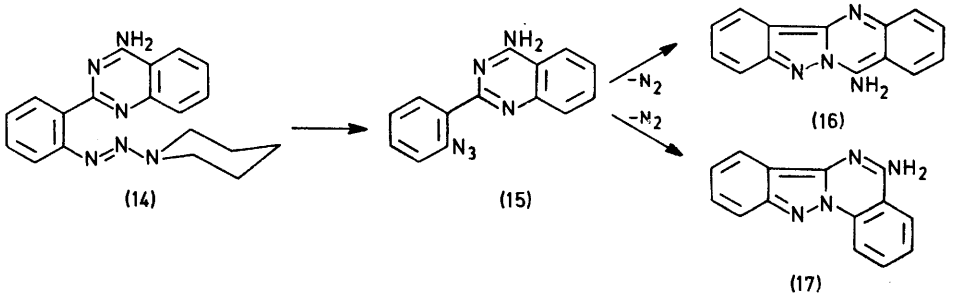
The acyclic *NNN*-systems (triazenes) also decomposed smoothly under the influence of azide ion, particularly with those substrates bearing an *ortho*-substituent suit-

[9] T. B. Brown and M. F. G. Stevens, *J.C.S. Perkin I*, 1975, 1023.

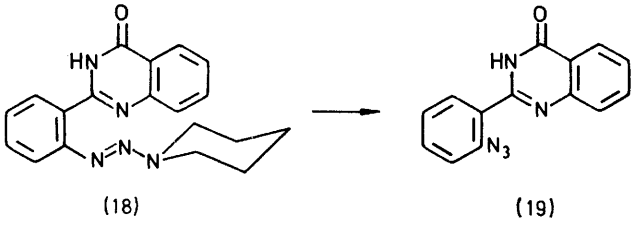
[10] H. N. E. Stevens and M. F. G. Stevens, *J. Chem. Soc.* (*C*), 1970, 2308.

[11] S. M. Mackenzie and M. F. G. Stevens, *J. Chem. Soc.* (*C*), 1970, 2298.

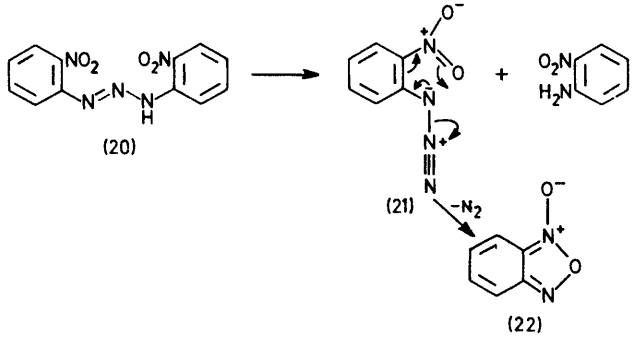
able to interact with the azide group. For example, 4-amino-2-[2-(piperidin-1-ylazo)phenyl]quinazoline (14) yielded the corresponding azide (15) after a short time in boiling acetic acid; prolonged reaction led to the formation of a mixture of the isomeric aminoindazoloquinazolines (16) and (17). The azide (19) formed from the corresponding quinazolone (18) showed no tendency to



cyclise, presumably because the more weakly nucleophilic *N*-atoms of the quinazolone ring cannot initiate



nitrogen loss. Decomposition of the triazene (14) in the presence of acetic acid–sodium iodide afforded a high yield of the hydroiodide salt of 4-amino-2-*o*-iodophenylquinazoline.



Decomposition of 1,3-diaryltriazenes in acetic acid–sodium azide was followed by t.l.c. and in all cases examined the main products of the reactions were the expected azido- and amino-arenes. 1,3-Bis-*p*-chlorophenyltriazene decomposed smoothly at room temperature to afford 4-chlorophenyl azide and 4-chloroaniline. More forcing (boiling) conditions were required with 1,3-bis-*o*-cyanophenyl-1-methyltriazene, which yielded the expected 2-azidobenzonitrile and *N*-methylanthranilonitrile. Less satisfactory was the degradation of 1,3-bis-*p*-nitrophenyltriazene, which gave 4-nitrophenyl azide and 4-nitroaniline and at least five other compounds, presumably formed by secondary decomposition of the nitrophenyl azide in boiling acetic acid. On the other hand, decomposition of the isomeric 1,3-bis-*o*-nitrophenyltriazene (20) on a preparative scale gave only benzofurazan *N*-oxide (22) and 2-nitroaniline. The benzofurazan arises from the intermediate 2-nitrophenyl azide (21), which cyclises with nitrogen loss under the reaction conditions.[12]

EXPERIMENTAL

Light petroleum refers to the fraction of b.p. 60—80°. I.r. spectra were recorded with a Perkin-Elmer 257 spectrometer for KBr discs.

2-Azidobenzamide (6a).—1,2,3-Benzotriazin-4(3*H*)-one (0.6 g) and sodium azide (4 mol. equiv.) were boiled in acetic acid (5 ml) for 1 h and the mixture was diluted with water. A chloroform extract of the mixture furnished a gum when concentrated. Trituration with benzene yielded 2-azidobenzamide (95%), which crystallised from benzene as white needles, m.p. 135—136° (lit.,[8] 135—136°); $\nu_{max.}$ 3 378 and 3 170 (NH), 2 140 and 2 110 (N_3), and 1 653 cm^{-1} (CO).

There was no reaction when the triazinone was boiled with an excess of sodium azide (4 mol. equiv.) in 75% aqueous ethanol, 70% aqueous dimethylformamide, or dimethyl sulphoxide for 3 h.

Similarly prepared from the appropriate 3-substituted 1,2,3-benzotriazin-4(3*H*)-ones and sodium azide in boiling acetic acid were the following *N*-substituted 2-azidobenzamides; N-*phenyl*- (6i) (95%), m.p. 129—130° (efferv.) as buff flakes (from aqueous ethanol) (Found: C, 65.6; H, 4.0; N, 25.4. $C_{13}H_{10}N_4O$ requires C, 65.5; H, 4.2; N, 25.3%), $\nu_{max.}$ 3 290 (NH), 2 135 and 2 100 (N_3), and 1 650 cm^{-1} (CO); N-o-*tolyl*- (6j) (88%), m.p. 100—101°, as grey needles (from ethanol) (Found: C, 66.9; H, 4.6; N, 22.0. $C_{14}H_{12}N_4O$ requires C, 66.7; H, 4.8; N, 22.2%); $\nu_{max.}$ 3 350 (NH), 2 130 and 2 100 (N_3), and 1 668 cm^{-1} (CO); N-o-*nitrophenyl*- (6k) (95%), m.p. 150—152° (efferv.) as bronze needles (from ethanol) (Found: C, 54.9; H, 3.0; N, 24.9. $C_{13}H_9N_5O_3$ requires C, 55.1; H, 3.2; N, 24.7%), $\nu_{max.}$ 3 290 (NH), 2 138 (N_3), and 1 670 cm^{-1} (CO); N-p-*nitrophenyl*- (6l) (93%), m.p. 162—164° (efferv.) as bronze needles (from ethanol) (Found: C, 55.3; H, 3.5; N, 24.7%), $\nu_{max.}$ 3 310 (NH), 2 135 (N_3), and 1 665 cm^{-1} (CO); N-2-*amino*-3,4-*dihydro*-4-*oxo*-6-*methylpyrimidin*-5-*yl*- (6m) (65%) m.p. 188—190° (efferv. and resolid.) as buff micro-rosettes (from ethanol) (Found: C, 50.7; H, 3.6; N, 34.2. $C_{12}H_{11}N_7O_2$ requires C, 50.5; H, 3.9; N, 34.4%), $\nu_{max.}$ 3 500—2 700 (bonded NH, OH), 2 130 (N_3), and 1 650 cm^{-1} (CO).

The 3-alkyltriazinones (1b—f) and 3-aralkyltriazinones (1g and h) were unchanged by boiling acetic acid containing 4 mol. equiv. of sodium azide.

[12] P. A. S. Smith and J. H. Boyer, *Org. Synth.*, 1951, **31**, 14.

2-*Iodobenzamide* (7a).—A solution of 1,2,3-benzotriazin-4(3*H*)-one (1.0 g) in acetic acid (10 ml) containing sodium iodide (2 mol. equiv.) was boiled (1 h) and diluted with water (20 ml). The precipitated iodobenzamide (85%) gave white crystals (from aqueous ethanol), m.p. 182—184° (lit.,[13] 183°), $\nu_{max.}$ 3 350 and 3 190 (NH), and 1 640 cm^{-1} (CO).

Similarly prepared from the appropriate 3-substituted 1,2,3-benzotriazin-4(3*H*)-ones were the following *N*-substituted 2-iodobenzamides; *N*-phenyl- (7i) (85%), m.p. 141—142° (lit.,[14] m.p. 142°), $\nu_{max.}$ 3 230 (NH) and 1 646 cm^{-1} (CO); N-p-*nitrophenyl*- (7l) (90%), m.p. 213—215°, as pale yellow prisms (from ethanol) (Found: C, 42.6; H, 2.7; N, 7.4. $C_{13}H_9IN_2O_3$ requires C, 42.4; H, 2.5; N, 7.6%).

2-o-*Azidophenylbenzimidazole* (9).—A solution of benzimidazo[1,2-*c*][1,2,3]benzotriazine [15] (1.0 g) in acetic acid (10 ml) containing sodium azide (4 mol. equiv.) was boiled (1 h), cooled, and diluted with water (10 ml). The product was extracted into chloroform, and the extract evaporated. The solid residue, crystallised from light petroleum, yielded the azide (85%) as brown prisms, m.p. 165—170° (decrep.), identical (i.r. data and thermal behaviour) with an authentic sample.[10]

2,4-*Diamino*-s-*triazino*[1,2-b]*indazole* (13a).—(i) 4-Amino-2-imino-2*H*-*s*-triazino[1,2-*c*][1,2,3]benzotriazine [11] (1.0 g), acetic acid (10 ml), and sodium azide (4 mol. equiv.) were boiled (1 h) and the mixture was diluted with water (10 ml). The precipitated triazinoindazole (70%) was identical (i.r. and m.p.) with an authentic sample.[11]

(ii) A solution of 2,4-diamino-6-(2-azidophenyl)-*s*-triazine[11] (1.0 g) in acetic acid (10 ml) was boiled (1 h) and diluted with water to yield the same triazinoindazole (85%).

2,4-*Diamino*-9-*methyl*-s-*triazino*[1,2-b]*indazole* (13b).—This triazinoindazole was prepared as above from either 4-amino-2-imino-10-methyl-2*H*-*s*-triazino[1,2-*c*][1,2,3]benzotriazine [11] or 2,4-diamino-6-(2-azido-5-methylphenyl)-*s*-triazine,[11] in 70 or 80% yield, respectively.

2,4-*Diamino*-9-*bromo*-s-*triazino*[1,2-b]*indazole* (13c).—The bromotriazinoindazole was prepared either from 4-amino-10-bromo-2-imino-2*H*-*s*-triazino[1,2-*c*][1,2,3]benzotriazine [11] in acetic acid containing sodium azide (78%), or from 2,4-diamino-6-(2-azido-5-bromophenyl)-*s*-triazine[11] (90%) in acetic acid alone, and was identical (i.r.) with authentic material.[11]

4-*Amino*-2-(2-*azidophenyl*)*quinazoline* (15).—4-Amino-2-[2-(piperidin-1-ylazo)phenyl]quinazoline [16] (1.0 g) was boiled in acetic acid (10 ml) with sodium azide (4 mol. equiv.) for 15 min. The mixture was diluted with water and extracted with chloroform, and the chloroform layer evaporated. The oily residue was dissolved in benzene and fractionated on an alumina column. The first yellow band, eluted with benzene, afforded the *azidophenylquinazoline* (27%), m.p. 143—145° (resolid.) (from ethanol) (Found: C, 64.4; H, 3.9; N, 32.2. $C_{14}H_{10}N_6$ requires C, 64.1; H, 3.8; N, 32.1%), $\nu_{max.}$ 3 340 and 3 180 (NH), and 2 130 and 2 090 cm^{-1} (N_3).

Cyclisation of the azidophenylquinazoline in boiling acetic acid was complete in 1 h. The products, identified as the isomeric indazoloquinazolines (16) and (17), were recognised as intensely fluorescent spots on t.l.c. [on alumina (0.25 mm) with benzene as developing solvent], with R_F identical with those of authentic samples.[17]

2-(2-*Azidophenyl*)*quinazolin*-4(3H)-*one* (19).—A mixture of 2-[2-(piperidin-1-ylazo)phenyl]quinazolin-4(3*H*)-one [2] (1.0 g) and sodium azide (4 mol. equiv.) was boiled in acetic acid (10 ml) for 1 h and diluted with water (10 ml). The precipitated *quinazolinone* (0.5 g) had m.p. >300° (from methanol) (Found: C, 64.1; H, 3.5; N, 26.3. $C_{14}H_9N_5O$ requires C, 63.9; H, 3.4; N, 26.6%), $\nu_{max.}$ 3 200—2 750 (bonded NH, OH), 2 140 and 2 100 (N_3), and 1 680 cm^{-1} (CO).

4-*Amino*-2-(2-*iodophenyl*)*quinazoline*.—4-Amino-2-[2-(piperidin-1-ylazo)phenyl]quinazoline (1.0 g), sodium iodide (2 mol. equiv.), and acetic acid (10 ml) were boiled (2 h), and the mixture was diluted with water. The quinazoline crystallised from ethanol as a *hydroiodide salt*, m.p. 230° (decomp.) (Found: C, 35.5; H, 2.3; N, 8.7. $C_{14}H_{10}IN_3$,HI requires C, 35.4; H, 2.3, N, 8.4%). The *free base*, m.p. 191—193° (from ethanol) was formed by basifying the hydroiodide with aqueous ammonia (Found: C, 48.8; H, 3.05; I, 36.45; N, 12.4. $C_{14}H_{10}IN_3$ requires C, 48.4; H, 2.9; I, 36.6; N, 12.1%).

Decomposition of 1,3-*Bis*-o-*nitrophenyltriazene*.—The triazene (1.44 g) and sodium azide (1.3 g, 4 mol. equiv.) were boiled in acetic acid (15 ml) for 1 h after the initial vigorous effervescence had subsided. Solvent was removed and the residue triturated with benzene (20 ml). Sodium acetate (1.7 g) was filtered off and the filtrate fractionated on an alumina column (benzene as eluant). The rapidly moving pale yellow band afforded benzofurazan *N*-oxide (0.55 g) (81%), identical (i.r.) with an authentic specimen.[12] The deep yellow band similarly yielded 2-nitroaniline (0.5 g, 83%).

The following 1,3-diaryltriazenes were similarly decomposed in acetic acid containing sodium azide (4 mol. equiv.). Products (in parentheses) were identified by comparison with authentic materials on t.l.c. plates [silica gel (0.25 mm); benzene–acetone (7:3)] illuminated at 254 or 366 nm: 1,3-bis-*p*-chlorophenyltriazene (4-chlorophenyl azide and 4-chloroaniline); 1,3-bis-*o*-cyanophenyl-1-methyltriazene (2-azidobenzonitrile and *N*-methylanthranilonitrile); 1,3-bis-*p*-nitrophenyltriazene (4-azidoaniline, 4-nitroaniline, and five unidentified products).

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[13] W. Wachter, *Ber.*, 1893, **26**, 1774.
[14] W. Wachter, *Ber.*, 1893, **26**, 1744.
[15] L. L. Zaika and M. M. Jouillé, *J. Heterocyclic Chem.*, 1966, **3**, 444.
[16] M. F. G. Stevens, *J.C.S. Perkin I*, 1974, 615.
[17] M. F. G. Stevens, *J. Chem. Soc.* (*C*), 1967, 1096.