PERKIN 1

v-Triazolines. Part 37.[1] Rearrangement reactions of 5-amino-1-(2-formyl-, -benzoyl-, -cyano-aryl)-v-triazolines: new synthesis of 2-amino- and 2,4-diamino-quinolines and 2,4-diamino-1,7-naphthyridines

Egle M. Beccalli, Emanuela Erba,* Maria Luisa Gelmi and Donato Pocar

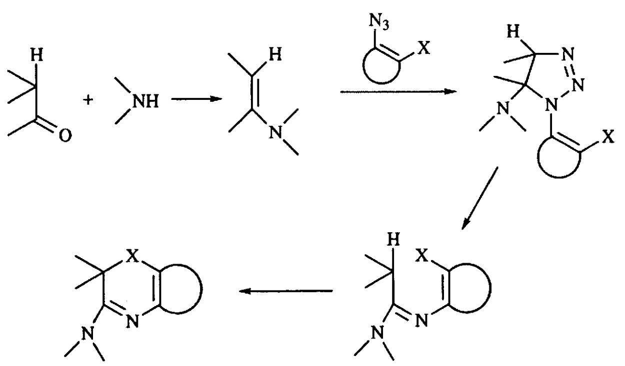
Istituto di Chimica Organica, Facoltà di Farmacia, Università degli Studi di Milano, Via Venezian, 21, I-20133 Milano

2-Aminoquinolines 4 were obtained in an one-pot reaction from arylacetaldehydes 1, secondary amines 2 and aryl azides 3 in refluxing benzene or xylene. 2,4-Diaminoquinolines and 2,4-diamino-1,7-naphthyridines 9 were prepared by heating arylacetaldehydes 1 with secondary amines 2 and aryl or pyridyl azides 8 and reaction with bases. Reaction intermediates were shown in certain cases to be 5-amino-v-triazolines 5 and 10 undergoing thermal rearrangement to amidines 7 and 11 followed by intramolecular base-catalysed cyclocondensation.

Introduction

5-Amino-v-triazolines are a well known class of heterocyclic compounds whose reactivity has been explored by us for several years. Their main use recently has been as starting materials for heterocyclic syntheses. This is justified by the general ease of preparation of 5-amino-v-triazolines which are readily transformed into useful synthetic intermediates or directly into heterocycles through ring transformations. Quinoxalines,[2] quinoxaline N-oxides[3] and benzimidazoles[4] have already been prepared from triazolines.

5-Amino-v-triazolines can be readily obtained by a three-component reaction using aldehydes (or ketones), secondary amines and azides; the latter react in a 1,3-dipolar cycloaddition process with the enamines formed by the former, and are transformed thermally into products according to different reaction paths which are mainly controlled by the substitution pattern of the triazoline. In most cases the main products are tertiary amidines, and their formation occurs by a mechanism ultimately leading to intramolecular migration of the substituent on C-5 toward the adjacent carbon.[5,6] As shown in Scheme 1, in the triazoline and amidine the carbon skeletons of



Scheme 1

the starting carbonyl compound and azide become linked by a nitrogen bridge and this suggests, by proper selection of substituent X in the starting aromatic or heteroaromatic azide, synthetic routes to N-containing heterocycles based on intramolecular condensation of amidine intermediates. This synthetic strategy has already been used to prepare quinoxaline N-oxides.[3]

We now report on straightforward syntheses of 2-amino- and 2,4-diamino-quinolines starting from 5-amino-v-triazolines bearing a 2-formyl-, 2-acetyl-, 2-benzoyl- or a 2-cyano-substituted phenyl group on N-1. An extension of this synthesis to the preparation of 2,4-diamino-1,7-naphthyridines is also described.

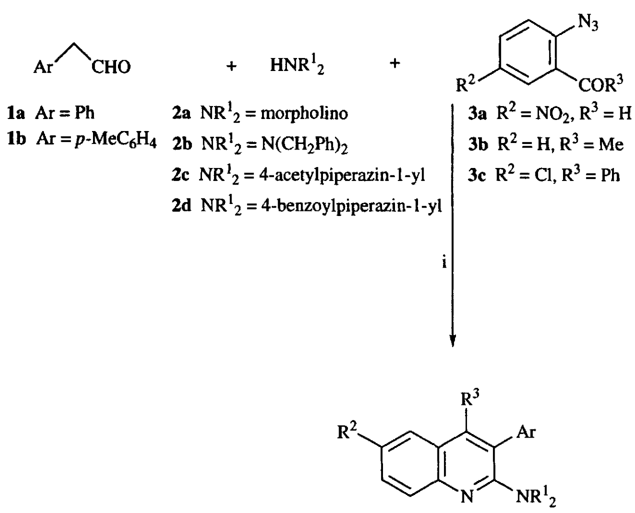
A number of synthetic entries to amino- and diamino-quinolines have been reported based on cyclization which result in the formation of the nitrogen-containing ring.[7,8] Our method is a useful addition to previous ones, being an example of the relatively unexplored ring closure through formation of the C^3–C^4 bond. Moreover, the present procedures represent direct syntheses avoiding the preparation of intermediates which may be troublesome in some instances.

Results and discussion

Refluxing of arylacetaldehydes **1a,b** with equimolar amounts of secondary amines **2a–d** and of aryl azides **3a–c** in an inert solvent resulted in the formation of 2-aminoquinolines **4a–h** (Scheme 2). Satisfactory yields were obtained in most cases with relatively short reaction times. Products **4a–e,h** were formed in boiling p-xylene, whereas refluxing in benzene was sufficient for reactions leading to compounds **4f,g**. Quinolines **4** were easily identified by spectroscopic (mainly ^{1}H NMR) methods.

The formation of compounds **4** is rationalized in view of Scheme 1 as follows: triazolines are formed from the starting materials and undergo spontaneous rearrangement affording the corresponding amidines of arylacetic acids. Ring-closure follows through condensation of the benzylic methylene group with an aldehyde or ketone group on the phenyl ring. This condensation is catalysed by bases, such as traces of secondary amine, and should produce an aldol product, *i.e.* a 4-hydroxy-3,4-dihydroquinoline such as compound **6** in Scheme 3, from which elimination of water is favoured by aromatization to give the quinoline ring.

Confirmation of the above reaction mechanism was obtained by performing the reactions under different conditions and the concomitant isolation in some cases of single intermediates (triazolines, amidines and hydroxydihydroquinolines). Usually, isolation of triazolines derived from azides having strong electron-withdrawing groups, such as compound **3a**, is difficult because their rearrangement to amidines occurs spontaneously even at room temperature.[3,9] The isolation of the unstable dibenzylaminotriazoline **5a** (Scheme 3) was made possible by its



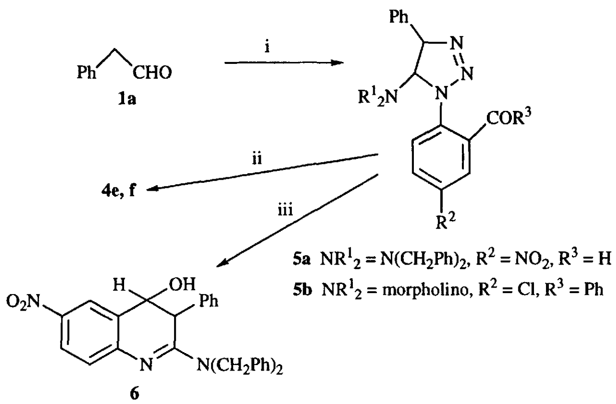
1a Ar = Ph
1b Ar = p-MeC_6H_4

2a NR^1_2 = morpholino
2b NR^1_2 = $N(CH_2Ph)_2$
2c NR^1_2 = 4-acetylpiperazin-1-yl
2d NR^1_2 = 4-benzoylpiperazin-1-yl

3a $R^2 = NO_2$, R^3 = H
3b R^2 = H, R^3 = Me
3c R^2 = Cl, R^3 = Ph

4a NR^1_2 = morpholino, $R^2 = NO_2$, R^3 = H, Ar = Ph
4b NR^1_2 = 4-acetylpiperazin-1-yl, $R^2 = NO_2$, R^3 = H, Ar = Ph
4c NR^1_2 = 4-benzolylpiperazin-1-yl, $R^2 = NO_2$, R^3 = H, Ar = Ph
4d NR^1_2 = morpholino, $R^2 = NO_2$, R^3 = H, Ar = p-MeC_6H_4
4e NR^1_2 = $N(CH_2Ph)_2$, $R^2 = NO_2$, R^3 = H, Ar = Ph
4f NR^1_2 = morpholino, R^2 = Cl, R^3 = Ar = Ph
4g NR^1_2 = 4-acetylpiperazin-1-yl, R^2 = Cl, R^3 = Ar = Ph
4h NR^1_2 = morpholino, R^2 = H, R^3 = Me, Ar = Ph

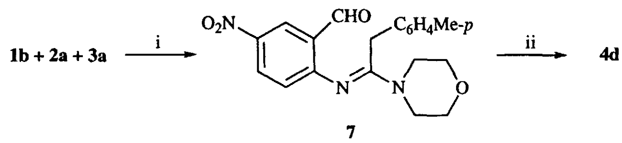
Scheme 2 *Reagents and conditions:* i, p-xylene, room temp., 1 h; then reflux, 4 h (**4a–e,h**); PhH, room temp., 1 h; then reflux, 4 h (**4f,g**)



5a NR^1_2 = $N(CH_2Ph)_2$, $R^2 = NO_2$, R^3 = H
5b NR^1_2 = morpholino, R^2 = Cl, R^3 = Ph

Scheme 3 *Reagents and conditions:* i, **2b** + **3a**, p-xylene, room temp. (**5a**); **2a** + **3c**, toluene, room temp. (**5b**); ii, p-xylene (**5a**) or toluene (**5b**), reflux, 3 h; iii, p-xylene, reflux, 1 h

insolubility, which caused immediate precipitation from the reaction medium. On the other hand, the cycloaddition product from substrates **1a**, **2a** and azide **3c**, *i.e.* triazoline **5b**, was obtained easily at room temperature because in this case the weaker electron-withdrawing effect of the substituent on the aryl group gives this compound sufficient stability at ambient temperature. Prolonged heating of triazolines **5a,b** in boiling p-xylene afforded quinolines **4e,f**. The intermediate amidine was evidenced by TLC in the former case, but was not observed when starting from substrate **5b** and this shows that in the case of compound **5a** the cyclization occurs at a lower rate than does the triazoline rearrangement, whereas in the second case the rate of formation of the quinoline product is at least of the same order of magnitude as the triazoline rearrangement. The intermediacy of amidines was also demonstrated in both cases by performing the reaction of the starting reactants at room temperature. However, most amidines from azide **3a** were obtained only in impure form and could not be purified by chromatography owing to their high tendency to be hydrolysed, which is an effect of the strong electron-withdrawing substituent. Only amidine **7** (Scheme 4) was isolated by



Scheme 4 *Reagents and conditions:* i, PhH, room temp.; ii, EtONa, EtOH, room temp.; or Et_3N, PhH, room temp.; or p-xylene, reflux

crystallization and was found to undergo cyclization to the quinoline **4d** at room temperature in the presence of bases such as triethylamine or a catalytic amount of sodium ethoxide in ethanol. The same result was obtained by simple refluxing in boiling p-xylene. Heating of triazoline **5b** at a relatively low temperature, *i.e.* in boiling benzene instead of p-xylene, in the presence of a catalytic amount of triethylamine or in the absence of added catalyst, resulted in an excellent yield of the quinoline **4f** (Scheme 3). This fits in well with the fact that, also in the one-pot reaction, the quinoline **4f** could be produced at a lower temperature than could its analogues **4a–d**. We suggest that the ease of formation of quinolines **4f,g** depends on their precursors' greater trend toward aromatization because a tertiary benzylic hydroxy group is present in the 4-hydroxydihydroquinoline precursors. In agreement with this, short-time heating of triazoline **5a** afforded a mixture of final product **4e** and its immediate precursor, *i.e.* the 4-hydroxy-3,4-dihydroquinoline **6** (Scheme 3).

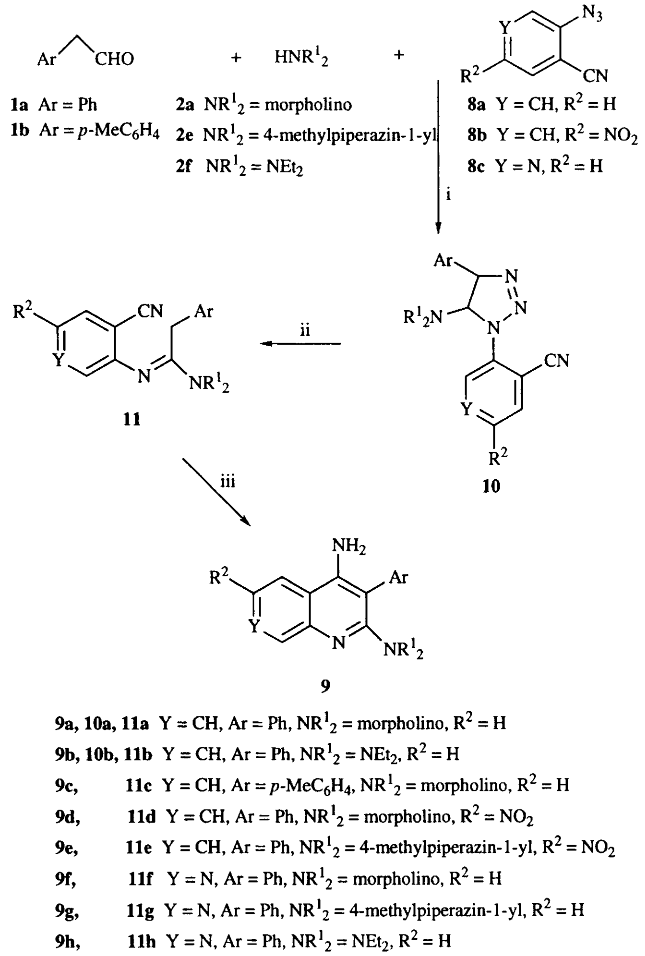
The 2,4-diaminoquinolines **9a–e** and 2,4-diamino-1,7-naphthyridines **9f–h** were prepared by refluxing of arylacetaldehydes **1a,b** with the appropriate secondary amines **2a**, **2e**, **2f** and azides **8a–c** in benzene solution at room or slightly higher temperature, then addition of a strong base, typically sodium butoxide or lithium diisopropylamide, and refluxing until cyclization was complete (Scheme 5, in which all isolated intermediates are also shown). All structures of compound **9** were easily confirmed by ^{1}H and ^{13}C NMR data. As shown in Scheme 5, rearrangement of triazolines **10**, which may or may not be isolable for the reasons set forth above, leads to the corresponding arylacetamidines **11**. Triazolines **10a,b** were readily obtained by performing the reaction at low temperatures and could be transformed into the corresponding amidines **11a,b** by further heating, whereas compounds **11c–h** were obtained directly. These intermediates readily underwent base-catalysed ring closure to afford compounds **9**.

A single case of quinoline synthesis starting from an α-branched arylacetaldehyde was tried (Scheme 6). Reaction of enamine **12** with azide **8b** in benzene solution afforded amidine **13**. Cyclocondensation of this with sodium *tert*-butoxide produced, in moderate yield, the 4-imino-3,4-dihydroquinoline **14**.

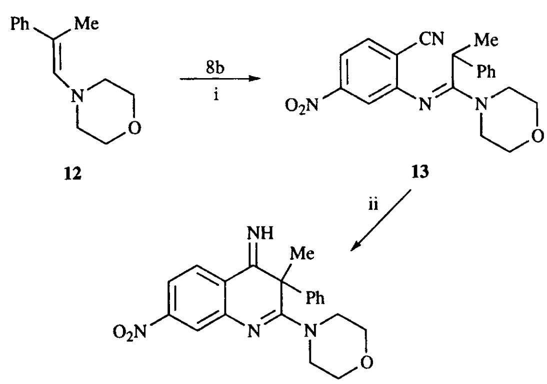
In conclusion, reaction of readily available starting materials such as arylacetaldehydes, secondary amines and phenyl or pyridyl azides bearing *ortho*-COH, -COR or -CN functionalities coupled with base-catalysed cyclization in a one-pot procedure represents a practical entry to 2-aminoquinolines, 2,4-diaminoquinolines and 2,4-diamino-1,7-naphthyridines which are classes of heterocycles whose relevance in the field of medicinal and agricultural chemistry is well documented.[8,10]

Experimental

Mps were determined using a Büchi 510 (capillary) apparatus. IR spectra were measured using a JASCO IR Report 100 instrument. NMR spectra were obtained with Bruker AC 200 and EM-390 Varian instruments at 200 MHz. *J* Values are given in Hz for solutions in $CDCl_3$. Column chromatography was performed on silica gel with Kieselgel 60–70, 230 ASTM



Scheme 5 *Reagents and conditions:* i, PhH or BuOH, room temp.; ii, *p*-xylene or BuOH, reflux; iii, BuONa, BuOH, reflux



Scheme 6 *Reagents and conditions:* i, $CHCl_3$, room temp., 24 h; ii, Bu^{t}ONa, Bu^{t}OH, 50 °C

(Merck). 4-Tolylacetaldehyde **1b**[11] and aryl azides **3a**,[12] **3b**,[13] **3c**,[14] **8a**,[15] **8b**[16] and **8c**[17] are known compounds.

General procedure for the preparation of 2-aminoquinolines 4 from arylacetaldehydes 1, amines 2 and azides 3

To a solution of azide **3** (0.005 mol) and arylacetaldehyde **1** (0.005 mol) in *p*-xylene (20 cm^3) was added dropwise the amine **2** (0.005 mol). The solution was stirred at room temperature for 1 h, refluxed for 4 h, and monitored by TLC in ethyl acetate–cyclohexane (2:3). The crude reaction mixture was dried over sodium sulfate and concentrated under reduced pressure. The residue was crystallized from the solvent indicated in Table 1 to afford pure quinoline **4**. Analytical and spectral data are listed in Table 1.

2-(5-Dibenzylamino-4-phenyl-4,5-dihydro-1*H*-1,2,3-triazol-1-yl)-5-nitrobenzaldehyde 5a

Compound **3a** (1 g, 0.0052 mol) and aldehyde **1a** (0.62 g, 0.0052 mol) were dissolved in *p*-xylene (20 cm^3). Dibenzylamine **2a** (1 g, 0.0052 mol) was added to the cold solution. After 30 min the precipitate (2.1 g) was separated by filtration (87%); mp 122–123 °C (Found: C, 70.85; H, 5.3; N, 14.05. $C_{29}H_{25}N_5O_3$ requires C, 70.9; H, 5.1; N, 14.25%); δ_H 3.46–3.68 (4 H, m, CH_2), 5.14 (1 H, d, *J* 4.4, 5-H), 5.79 (1 H, d, *J* 4.4, 4-H), 6.96–8.74 (18 H, m, ArH) and 10.12 (1 H, s, CHO).

5-Chloro-2-(5-morpholino-4-phenyl-4,5-dihydro-1*H*-1,2,3-triazol-1-yl)benzophenone 5b

Azide **3c** (2.0 g, 0.0078 mol) and phenylacetaldehyde **1a** (0.94 g, 0.0078 mol) were dissolved in benzene (30 cm^3). Morpholine **2a** (0.68 g, 0.0078 mol) was added dropwise to the stirred solution. After 4 h the reaction was complete [TLC, ethyl acetate–cyclohexane (3:7)]. The reaction mixture was dried with sodium sulfate, evaporated under reduced pressure, and crystallized from CH_2Cl_2/Pr$^i_2$O to afford pure compound **5b** (76%); mp 131 °C (Found: C, 66.85; H, 5.4; N, 12.3. $C_{25}H_{23}ClN_4O_2$ requires C, 67.1; H, 5.1; N, 12.5%); ν_{max}(Nujol)/cm^{-1} 1670 (C=O); δ_H 2.15–2.36 (4 H, m, CH_2NCH_2), 3.28–3.49 (4 H, m, CH_2OCH_2), 4.58 (1 H, d, *J* 3.3, 5-H), 5.41 (1 H, d, *J* 3.3, 4-H) and 6.77–7.89 (13 H, m, ArH).

2-Dibenzylamino-6-nitro-3-phenyl-3,4-dihydroquinolin-4-ol 6

Azide **3a** (1.0 g, 0.0052 mol) and aldehyde **1a** (0.62 g, 0.0052 mol) were dissolved in *p*-xylene (20 cm^3) and dibenzylamine **2b** (1 g, 0.0052 mol) was added to the solution. The solution was stirred at room temperature for 1 h and then was refluxed for 1 h. Pure title compound **6** was separated by filtration (21%); mp 153–154 °C (Found: C, 75.0; H, 5.7; N, 8.9. $C_{29}H_{25}N_3O_3$ requires C, 75.2; H, 5.4, N, 9.1%); δ_H 4.20–4.35, 4.55–4.75, 5.75–5.90 (4 H, 3 m, CH_2), 4.32 (1 H, d, *J* 1.8, 3-H), 4.68 (1 H, d, *J* 1.8, 4-H), 6.97–7.46 (16 H, m, 8-H and Ph), 7.95 (1 H, d, J_{5-7} 2.6, 5-H) and 8.61 (1 H, dd, J_{5-7} 2.6, J_{7-8} 8.8, 7-H); δ_C 47.60 (d), 49.59–50.02 (2 t), 72.94 (d), 142.1 (d), 152.6 (d) and 163.5 (s); *m*/*z* 463 (M^+, 4%), 372 (75), 354 (25), 307 (10), 106 (50) and 91 (100).

2-Dibenzylamino-6-nitro-3-phenylquinoline 4e from compound 5a

A *p*-xylene solution of the triazoline **5a** (1.0 g, 0.002 mmol) was refluxed for 3 h until disappearance of the starting material and of the intermediate **6** [TLC, ethyl acetate–cyclohexane (2:3)]. The solution was cooled and compound **4e** (0.86 g, 90%) was filtered off.

6-Chloro-2-morpholino-3,4-diphenylquinoline 4f from compound 5b

A solution of the triazoline **5b** (1 g, 0.002 mol) in toluene was refluxed for 3 h until disappearance of the starting compound [TLC, ethyl acetate–cyclohexane (2:3)]. The solution was evaporated under reduced pressure and the residue was crystallized from propan-2-ol to afford compound **4f** (0.4 g, 46%).

2-[1-Morpholino-2-(4-tolyl)ethylidenamino]-5-nitrobenzaldehyde 7

Azide **3a** (0.96 g, 0.005 mol) and aldehyde **1b** (0.67 g, 0.005 mol) were dissolved in $CHCl_3$ (10 cm^3). To the solution was added morpholine **2a** (0.435 g, 0.005 mol) dropwise. The mixture was stirred at room temperature for 3 h, dried over sodium sulfate, and evaporated under reduced pressure. The residue was crystallized from ethanol and gave pure compound **7** (0.85 g, 45%); mp 136 °C (Found: C, 65.05; H, 5.9; N, 11.3. $C_{20}H_{21}N_3O_4$ requires C, 65.25; H, 5.7; N, 11.4%); ν_{max} (Nujol)/cm^{-1} 1670 (C=O) and 1595 (C=N); δ_H 2.31 (3 H, s, Me), 3.60–3.69 (8 H, m, morpholine), 3.71 (2 H, s, CH_2), 6.78 (1 H, d,

Table 1 Analytical and spectral data of compounds **4**

Compound (formula)	Yield (%)	Mp (T/°C) (solvent)	δ_H(J/Hz)	Found (%) (requires) C	H	N
4a ($C_{19}H_{17}N_3O_3$)	52	177 (Pr^{i}OH)	3.31–3.37 (4 H, m, CH_2NCH_2), 3.64–3.68 (4 H, m, CH_2OCH_2), 7.27–7.62 (5 H, m, Ph), 7.85 (1 H, d, J_{7-8} 9.2, 8-H), 7.92 (1 H, s, 4-H), 8.35 (1 H, dd, J_{7-8} 9.2, J_{5-7} 2.5, 7-H), 8.62 (1 H, d, J_{5-7} 2.5, 5-H)	67.9 (68.0)	5.3 (5.1)	12.0 (12.3)
4b ($C_{21}H_{20}N_4O_3$)	37	174 (EtOH)	2.05 (3 H, s, CH_3), 3.26–3.59 (8 H, m, piperazine), 7.39–7.64 (5 H, m, Ph), 7.86 (1 H, d, J_{7-8} 9.2, 8-H), 7.96 (1 H, s, 4-H), 8.37 (1 H, dd, J_{7-8} 9.20, J_{5-7} 2.5, 7-H), 8.64 (1 H, d, J_{5-7} 2.5, 5-H)	67.2 (67.0)	5.7 (5.4)	14.6 (14.9)
4c ($C_{26}H_{22}N_4O_3$)	32	204 (EtOH)	3.38–3.81 (8 H, m, piperazine), 7.26–7.63 (10 H, m, Ph and PhCO), 7.86 (1 H, d, J_{7-8} 9.1, 8-H), 7.96 (1 H, s, 4-H), 8.37 (1 H, dd, J_{7-8} 9.1, J_{5-7} 2.5, 7-H), 8.64 (1 H, d, J_{5-7} 2.5, 5-H)	70.95 (71.2)	5.35 (5.1)	12.6 (12.9)
4d ($C_{20}H_{19}N_3O_3$)	60	290 (EtOH)	2.43 (3 H, s, CH_3), 3.33–3.38 (4 H, m, CH_2NCH_2), 3.64–3.69 (4 H, m, CH_2OCH_2), 7.27–7.53 (4 H, m, ArH), 7.84 (1 H, d, J_{7-8} 9.2, 8-H), 7.90 (1 H, s, 4-H), 8.35 (1 H, dd, J_{7-8} 9.2, J_{5-7} 2.5, 7-H), 8.62 (1 H, d, J_{5-7} 2.5, 5-H)	68.5 (68.7)	5.65 (5.4)	12.0 (12.0)
4e ($C_{29}H_{23}N_3O_2$)	64	171 (MeCN)	4.45 (4 H, s, 2 × CH_2), 7.06–7.54 (15 H, m, 3 × Ph), 7.82 (1 H, d, J_{7-8} 9.40, 8-H), 7.92 (1 H, s, 4-H), 8.35 (1 H, dd, J_{7-8} 9.4, J_{5-7} 2.6, 7-H), 8.63 (1 H, d, J_{5-7} 2.6, 5-H)	75.3 (75.5)	5.2 (5.0)	8.8 (9.1)
4f ($C_{25}H_{21}ClN_2O$)	52	224 (Pr^{i}OH)	3.14–3.20 (4 H, m, CH_2NCH_2), 3.52–3.56 (4 H, m, CH_2OCH_2), 6.99–7.28 (10 H, m, 2 × Ph), 7.31 (1 H, d, J_{5-7} 2.3, 5-H), 7.53 (1 H, dd, J_{5-7} 2.3, J_{7-8} 8.9, 7-H), 7.84 (1 H, d, J_{7-8} 8.9, 8-H)	74.7 (74.9)	5.3 (5.28)	7.0 (7.0)
4g ($C_{27}H_{24}ClN_3O$)	48	225 CH_2Cl_2/Pr$^i_2$O)	2.05 (3 H, s, CH_3), 3.01–3.44 (8 H, m, piperazine), 6.99–7.30 (10 H, m, 2 × Ph), 7.32 (1 H, d, J_{5-7} 2.1, 5-H), 7.5 (1 H, dd, J_{5-7} 2.1, J_{7-8} 8.8, 7-H), 7.83 (1 H, d, J_{7-8} 8.8, 8-H)	73.0 (73.3)	5.65 (5.4)	9.3 (9.5)
4h ($C_{20}H_{20}N_2O$)	51	130 (MeCN)	2.42 (3 H, s, CH_3), 3.08–3.13 (4 H, m, CH_2NCH_2), 3.47–3.51 (4 H, m, CH_2OCH_2), 7.34–7.93 (9 H, m, Ph and quinoline-H)	78.85 (78.9)	6.4 (6.6)	8.9 (9.2)

$J_{5'-6'}$ 8.87, 6'-H), 6.94–7.14 (4 H, m, ArH), 8.18 (1 H, dd, $J_{5'-6'}$ 8.87, $J_{5'-3'}$ 2.77, 5'-H), 8.61 (1 H, d, $J_{3'-5'}$ 2.77, 3'-H) and 10.28 (1 H, s, CHO).

2-Morpholino-6-nitro-3-(4-tolyl)quinoline 4d from compound 7

(a) Sodium (0.04 g, 0.0019 mol) was dissolved in anhydrous butan-1-ol (10 cm^3). Compound **7** (0.7 g, 0.0019 mol) was added to the cold solution. After 4 h the yellow precipitate compound **4d** (0.6 g, 90%) was removed by filtration.

(b) A p-xylene solution of compound **7** (0.5 g, 0.0013 mol) was refluxed for 4 h and evaporated under reduced pressure. The crude residue was crystallized from ethanol to afford compound **4d** (0.3 g, 60%).

(c) A solution of compound **7** (0.5 g, 0.0013 mol) in benzene (10 cm^3) containing a catalytic amount of triethylamine was refluxed for 3 h and evaporated under reduced pressure. The crude residue was crystallized from propan-2-ol to afford compound **4d** (0.27 g, 58%).

General procedures for the preparation of 2,4-diaminoquinolines 9a–e and 2,4-diaminonaphthyridines 9f–h

Method a. From arylacetaldehydes 1, amines 2 and azides 8. Azide **8** (0.02 mol) and arylacetaldehyde **1** (0.02 mol) were dissolved in butan-1-ol (20 cm^3). Amine **2** (0.02 mol) was added to the solution and the mixture was refluxed for 2 h. Then a solution of sodium butoxide [sodium (0.92 g, 0.04 mol) in butan-1-ol (5 cm^3)] was added and heating was continued for 2 h. After complete evaporation of the mixture the crude reaction product was dissolved in dichloromethane and the insoluble salt was separated by filtration. The solution was evaporated to dryness and the residue was crystallized from the solvent indicated in Table 2 to afford pure products **9**. Analytical and spectroscopic data are listed in Table 2.

Method b. From dihydro-v-triazoles 10. Compound **10** (0.01 mol) was dissolved in butan-1-ol (10 cm^3) and the solution was refluxed for 1 h. Then a solution of sodium butoxide [sodium (0.01 mol) in butan-1-ol (5 cm^3)] was added and heating was continued for 2 h. The mixture was evaporated under reduced pressure and the residue was taken up with dichloromethane. The insoluble residue was filtered off and the crude reaction mixture was chromatographed on a silica gel column with ethyl acetate–cyclohexane (3:2) as the eluent. The main fraction was crystallized from the solvent indicated in Table 2. Analytical and spectroscopic data are listed in Table 2.

Method c. From amidines 11. Sodium (0.7 g, 0.03 mol) was dissolved in butan-1-ol (20 cm^3) and to the solution was added an amidine **11** (0.03 mol). The reaction mixture was refluxed for 2.5 h and evaporated to dryness. The residue was taken up with dichloromethane, filtered and evaporated again. The crude residue was crystallized from the solvent indicated in Table 2 to yield pure product **9**. Analytical and spectral data are listed in Table 2.

2-(5-Amino-4-phenyl-4,5-dihydro-1H-1,2,3-triazol-1-yl)-benzonitriles 10a,b. Azide **8a** (10.0 g, 0.07 mol) and phenylacetaldehyde **1a** (8.1 g, 0.07 mol) were dissolved in benzene (50 cm^3) and an amine **2** (0.07 mol) was added dropwise. The mixture was stirred at room temperature for 2 h. A precipitate was formed, which was filtered off, and recrystallized from benzene–pentane to afford a pure benzonitrile **10**. Analytical and spectal data are listed in Table 3.

2-(1-Amino-2-phenylethylideneamino)benzonitriles 11a,b. A triazoline **10** (0.009 mol) was dissolved in p-xylene (10 cm^3) and the solution was refluxed for 1 h and evaporated under reduced pressure. The residue was purified by crystallization from the solvent indicated in Table 3, which also lists the analytical and spectral data, to give pure product **11**.

(1-Amino-2-arylethylideneamino)-benzonitriles 11c–e and -isonicotinonitriles 11f–h. An azide **8** (0.01 mol) and an arylacetaldehyde **1** (0.01 mol) were dissolved in benzene (30 cm^3). To the cold solution was added an amine **2** (0.01 mol). The mixture was stirred for 2 h, dried over sodium sulfate, and evaporated under reduced pressure. The crude residue was crystallized from the solvent indicated in Table 3, which also lists analytical and spectral data, to obtain pure products **11**.

2-(1-Morpholino-2-phenylpropylideneamino)-4-nitrobenzonitrile 13

Azide **8b** (2.0 g, 0.01 mol) and 4-(2-phenylprop-1-yl)morpholine **12**[18] (2.75 g, 0.012 mol) were dissolved in benzene (20 cm^3). The reaction mixture was stirred for 24 h at room temperature and evaporated to dryness. The residue was chromatographed on a silica gel column with ethyl acetate–cyclohexane (3:7) as

Table 2 Analytical and spectral data of compounds **9a–h** and **14**

Compound (formula)	Method/ Yield	Mp (T/°C) (solvent)	$\nu(NH_2)$ (Nujol)	δ_H(J/Hz)	Found (%) (requires)		
					C	H	N
9a[a] ($C_{19}H_{19}N_3O$)	A/47 B/54 C/50	200 (PhH/pentane)	3330 3430	3.05–3.23 (4 H, m, CH_2NCH_2), 3.42–3.67 (4 H, m, CH_2OCH_2), 4.51 (2 H, br s, NH_2), 7.20–7.91 (9 H, m, ArH)	74.6 (74.75)	6.4 (6.2)	13.7 (13.7)
9b ($C_{19}H_{21}N_3$)	A/41 B/34 C/32	136 ($Pr^i{}_2O$)	3400 3510	0.79 (6 H, t, J 7.0, 2 × Me, 3.05 (4 H, q, J 7.0, 2 × CH_2), 4.47 (2 H, br s, NH_2), 7.13–7.68 (9 H, m, ArH)	78.05 (78.35)	6.9 (7.2)	14.1 (14.4)
9c ($C_{20}H_{21}N_3O$)	A/60 C/68	157 ($Pr^i{}_2O$)	3340 3440	2.42 (3 H, s, CH_3), 3.11–3.19 (4 H, m, CH_2NCH_2), 3.49–3.65 (4 H, m, CH_2OCH_2), 4.54 (2 H, br s, NH_2), 7.28–7.81 (8 H, m, ArH)	74.9 (75.2)	6.3 (6.6)	12.9 (13.2)
9d ($C_{19}H_{18}N_4O_3$)	A/65 C/72	259 ($Pr^i{}_2O$)	3340 3445	3.20–3.40 (4 H, m, CH_2NCH_2), 3.52–3.65 (4 H, m, CH_2OCH_2), 4.74 (2 H, br s, NH_2), 7.39–7.59 (5 H, m, Ph), 7.74 (1 H, d, J_{7-8} 9.2, 8-H), 8.32 (1 H, dd, J_{7-8} 9.2, J_{5-7} 2.4, 7-H), 8.66 (1 H, d, J_{5-7} 2.4, 5-H)	64.8 (65.1)	5.35 (5.1)	15.8 (16.0)
9e ($C_{20}H_{21}N_5O_2$)	A/47 C/50	217 ($Pr^i{}_2O$)	3330 3420	2.20–2.25 [7 H, m, $CH_3N(CH_2)_2$], 3.25–3.30 (4 H, m, CH_2NCH_2), 4.70 (2 H, br s, NH_2), 7.40–7.59 (5 H, m, Ph), 7.72 (1 H, d, J_{7-8} 9.20, 8-H), 8.31 (1 H, dd, J_{7-8} 9.20, J_{7-5} 2.46, 7-H), 8.64 (1 H, d, J_{5-7} 2.46, 5-H)	65.8 (66.1)	5.7 (5.7)	19.0 (19.2)
9f[b] ($C_{18}H_{18}N_4O$)	A/52 C/60	243 ($Pr^i{}_2O$)	3340 3440	3.11–3.16 (4 H, m, CH_2NCH_2), 3.48–3.53 (4 H, m, CH_2OCH_2), 4.62 (2 H, br s, NH_2), 7.25–7.58 (6 H, m, Ph and 5-H), 8.38 (1 H, d, J_{5-6} 5.6, 6-H), 9.13 (1 H, s, 8-H)	70.3 (70.6)	6.0 (5.9)	18.1 (18.3)
9g ($C_{19}H_{21}N_5$)	A/48 C/57	167 ($Pr^i{}_2O$)	3320 3450	2.18–2.35 (4 H, m, 2 × CH_2), 2.21 (3 H, s, CH_3), 3.16–3.28 (4 H, m, 2 × CH_2), 4.82 (2 H, br s, NH_2), 7.39–7.57 (6 H, m, Ph and 5-H), 8.36 (1 H, d, 6-H), 9.13 (1 H, s, 8-H)	71.7 (71.5)	6.8 (6.6)	21.7 (21.9)
9h ($C_{18}H_{20}N_4$)	A/48 C/60	134 (Et_2O)	3320 3450	0.88 (6 H, t, J 7.0 2 × CH_3, 3.16 (4 H, q, J 7.0 2 × CH_2), 4.44 (2 H, br s, NH_2), 7.32–7.55 (6 H, m, Ph and 5-H), 8.32 (1 H, d, J_{5-6} 5.6, 6-H), 9.09 (1 H, s, 8-H)	73.7 (74.0)	6.8 (6.8)	18.9 (19.2)
14 ($C_{20}H_{20}N_4O_3$	C/38	218 (MeOH)	3100	1.74 (3 H, br s, CH_3), 3.29–3.69 (8 H, m, morpholine), 7.21–7.48 (6 H, m, ArH), 8.23 (1 H, dd, J_{7-8} 9.1, J_{7-5} 2.7, 7-H), 8.88 (1 H, br s, 5-H), 8.98 (1 H, br s, NH)	65.7 (65.9)	5.5 (5.5)	15.1 (15.4)

[a] δ_O NMR ($CDCl_3$) 50.1 (t), 67.3 (t), 109.3 (s), 117.2 (s), 120.7 (d), 123.3 (d), 128.0 (d), 128.7 (d), 129.7 (d), 129.83 (d), 113.0 (d), 187.0 (s), 147.3 (s), 147.6 (s), 160.2 (s). [b] δ_C NMR ($CDCl_3$) 49.8 (t), 67.1 (t), 111.7 (s), 113.8 (d), 120.9 (s), 128.5 (d), 130.1 (d), 130.5 (d), 136.2 (s), 141.2 (d), 142.5 (s), 146.6 (s), 152.7 (d), 161.2 (s).

Table 3 Analytical and spectral data of compounds **10** and **11**

Compound (formula)	Yield	Mp (T/°C) (solvent)	ν(CN) (Nujol)	δ_H(J/Hz)	Found (%) (requires)		
					C	H	N
10a ($C_{19}H_{19}N_5O$)	90	112 (PhH/Pentane)	2220	2.32–2.58 (4 H, m, CH_2NCH_2), 3.44–3.66 (4 H, m, CH_2OCH_2), 5.44 (1 H, d, J_{4-5} 2.8, 5-H), 5.59 (1 H, d, J_{4-5} 2.8, 4-H), 7.14–8.02 (9 H, m, ArH)	68.25 (68.5)	5.8 (5.7)	20.8 (21.0)
10b ($C_{19}H_{21}N_5$)	58	67–68 ($Pr^i{}_2O$/pentane)	2200	0.86 (6 H, t, J 7.1, 2 × CH_3 ArH), 2.32–2.66 (4 H, m, 2 × CH_2), 5.45 (1 H, d, J_{4-5} 3.2, 5-H) 5.52 (1 H, d, J_{4-5} 3.2, 4-H), 7.16–7.86 (9 H, m, ArH)	71.25 (71.5)	6.7 (6.6)	21.7 (21.9)
11a ($C_{19}H_{19}N_3O$)	44	94 (Et_2O)	2200	3.49–3.58 (8 H, m, morpholine), 3.73 (2 H, s, CH_2Ph), 6.78–7.54 (9 H, m, ArH)	74.5 (74.7)	6.5 (6.2)	13.5 (13.8)
11b ($C_{19}H_{21}N_3$)	42	95–96	2210	1.12–1.58 (6 H, m, 2 × CH_3), 3.39–3.72 (4 H, m, 2 × CH_2), 3.72 (2 H, s, CH_2Ph), 6.74–7.51 (9 H, m, ArH)	78.2 (78.35)	7.5 (7.2)	14.3 (14.4)
11c ($C_{20}H_{21}N_3O$)	67	oil	2210	2.32 (3 H, s, CH_3), 2.48–3.65 (8 H, m, morpholine), 3.68 (2 H, s, CH_2Ph), 6.77–7.55 (8 H, m, ArH)	75.0 (75.2)	6.9 (6.6)	13.0 (13.2)
11d ($C_{19}H_{18}N_4O_3$	55	116 ($Pr^i{}_2O$)	2220	3.45–3.89 (8 H, m, morpholine), 3.91 (2 H, s, CH_2Ph), 6.83 (1 H, d, J_{3-4} 8.9, 3-H), 7.13–7.39 (5 H, m, Ph), 8.19 (1 H, dd, J_{3-4} 8.9, J_{4-6} 2.5, 4-H), 8.42 (1 H, d, J_{4-6} 2.5, 6-H)	64.9 (65.1)	5.85 (6.1)	15.8 (16.0)
11e ($C_{20}H_{21}N_5O_2$	77	136 ($Pr^i{}_2O$)	2210	2.28 (3 H, s, CH_3), 2.28–2.34 (4 H, m, 2 × CH_2), 3.61–3.64 (4 H, m, 2 × CH_2), 3.78 (2 H, s, CH_2Ph), 6.80 (1 H, d, J_{3-4} 9.0, 3-H), 7.13–7.38 (5 H, m, Ph), 8.16 (1 H, dd, J_{3-4} 9.0, J_{4-6} 2.7, 4-H), 8.41 (1 H, d, J_{4-6} 2.7, 6-H)	66.0 (66.1)	5.9 (5.8)	19.05 (19.3)
11f ($C_{18}H_{18}N_4O$)	40	110 ($Pr^i{}_2O$)	2220	3.52–3.70 (8 H, m, morpholine), 3.75 (2 H, s, CH_2Ph), 7.13–7.38 (6 H, m, ArH), 8.21–8.24 (2 H, m, H-6 and 5-H)	70.3 (70.6)	6.1 (5.9)	18.1 (18.3)
11g ($C_{19}H_{21}N_5$)	35	oil	2210	2.17 (3 H, s, CH_3), 2.18–2.33 (4 H, m, 2 × CH_2), 3.53–3.70 (4 H, m, 2 × CH_2), 3.70 (2 H, s, CH_2Ph), 7.14–7.40 (6 H, m, Ph and 3-H), 8.17–8.20 (2 H, m, 4- and 5-H)	71.3 (71.5)	6.7 (6.6)	21.7 (21.9)
11h ($C_{18}H_{20}N_4$)	40	92–93 ($Pr^i{}_2O$)	2200	0.88 (6 H, t, J 7.1, 2 × CH_3), 2.32–2.70 (4 H, m, 2 × CH_2), 5.40 (1 H, d, $J_{4'-5'}$ 3.27 5'-H) 5.52 (1 H, d, $J_{4'-5'}$ 3.27, 4'-H), 7.10–7.47 (5 H, m, Ph), 7.50 (1 H, d, J_{5-6} 5.0, 6-H), 8.47 (1 H, d, J_{5-6} 5.0, 5-H), 9.22 (1 H, s, 3-H)	67.4 (67.5)	6.4 (6.25)	26.0 (26.25)

the eluent, and the main fraction was crystallized from diethyl ether to afford pure compound **13**. Analytical data are found in Table 3.

4-Imino-3-methyl-2-morpholino-7-nitro-3-phenyl-3,4-dihydroquinoline 14

Amidine **13** (0.3 g, 0.8 mmol) was added to a solution of sodium *tert*-butoxide [sodium (0.018 g, 0.8 mmol) in *tert*-butyl alcohol (5 cm^3)]. The solution was stirred for 8 h at 50 °C, then the solvent was evaporated off. The residue was taken up in dichloromethane, and the solution was filtered and evaporated. The crude residue was crystallized to yield pure compound **14**. Analytical and spectral data are listed in Table 2.

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