Antitumour polycyclic acridines. Part 3.[1] A two-step conversion of 9-azidoacridine to 7*H*-pyrido[4,3,2-*kl*]acridines by Graebe–Ullmann thermolysis of substituted 9-(1,2,3-triazol-1-yl)acridines

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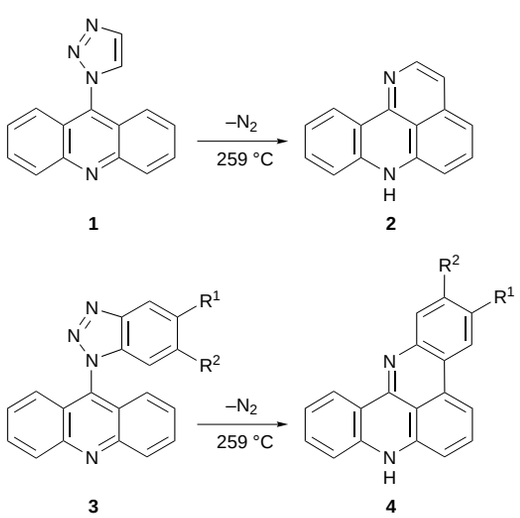
9-Azidoacridine 5 reacted with a series of alkynes to form mixtures of regioisomeric 9-(4- and 5-substituted-1,2,3-triazol-1-yl)acridines 6, except for the reaction with trimethylsilylacetylene which gave a single regioisomer. Structural assignments have been confirmed by ^{1}H NMR and NOE experiments and the X-ray structure of 9-(4-butyl-1,2,3-triazol-1-yl)acridine 6a corroborates the positioning of the butyl group and shows that the plane of the triazole ring intersects that of the acridine moiety by 65.97(5)° in the crystal structure. Graebe–Ullmann fragmentation of the triazolylacridines was monitored by differential scanning calorimetry and preparative thermolytic conversion to 2- or 3-substituted 7*H*-pyrido[4,3,2-*kl*]acridines 8 was performed in hot diphenyl ether. Whereas 9-[4-(3-chloropropyl)-1,2,3-triazol-1-yl]acridine 11 cyclised to 3-(3-chloropropyl)-7*H*-pyrido[4,3,2-*kl*]acridine 13, the isomeric triazole 12 afforded the pentacyclic salt 1*H*,8*H*-2,3-dihydroindolizino[7,6,5-*kl*]acridinium chloride 15.

Introduction

In an earlier paper[2] we showed that the venerable Graebe–Ullmann degradation of 1-aryl-1,2,3-triazoles[3] could be adapted for the thermolytic conversion of 9-(1,2,3-triazol-1-yl)-acridine **1** to 7*H*-pyrido[4,3,2-*kl*]acridine **2** (Scheme 1). Annelation of additional benzene rings to the triazole moiety, as in the substituted 9-(benzotriazol-1-yl)acridines **3a**–**d** and the corresponding naphthotriazole **3e**, also afforded an efficient entry to related pentacyclic and hexacyclic acridines **4a**–**e**. The pentacyclic compounds, which are structurally related to recently isolated polycyclic acridine marine natural products,[4] have intriguing physical and biological properties. They are weakly basic, highly fluorescent and, because of their near planarity,[2] bind to DNA in an intercalative mode at high [DNA] : [ligand] ratios as evidenced by circular and linear dichroism studies.[1] Additionally, they stabilise DNA triple helices and are potent inducers of apoptosis (programmed cell death) in human lung and breast tumour cell lines.[5]



	R^1	R^2
a	H	H
b	Cl	H
c	Me	H
d	H	NO_2
e	CH=CH–CH=CH	

Scheme 1

In order to investigate the structure–antitumour activity relationships in this new series of compounds we required synthetic access to more structural variety in the pyridine ring of the tetracyclic framework **2**. In this paper we describe our efforts to synthesise a range of acridine derivatives with 4- and 5-substituted-1,2,3-triazolyl groups attached in the 9-position. We have also shown by differential scanning calorimetry and thermolytic methods that these substrates can be cyclised efficiently to 2- and 3-substituted pyrido[4,3,2-*kl*]acridines (see structure **8** for numbering scheme).

Results and discussion

Synthesis of 9-(1,2,3-triazol-1-yl)acridines from 9-azidoacridine and alkynes

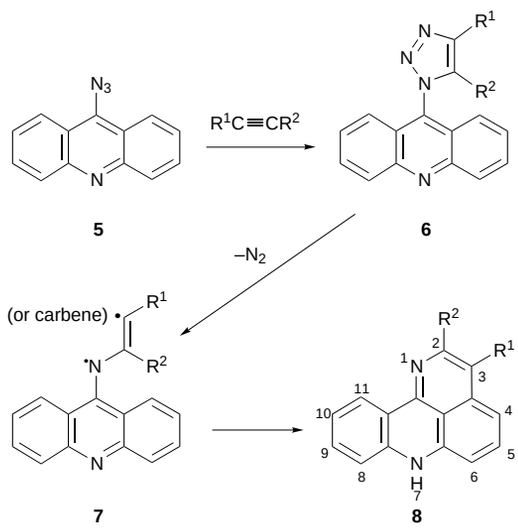
The route chosen for the synthesis of 9-(1,2,3-triazol-1-yl)-acridines involved 1,3-dipolar cycloadditions between 9-azido-acridine **5** and substituted alkynes (Scheme 2). A precedent for this approach is the synthesis of the benzotriazole counterpart from 9-azidoacridine and benzyne.[6,7] The azide–alkyne route has the advantage that two series of regioisomeric triazoles **6** should be formed which might be converted independently to 2- or 3-substituted (or 2,3-disubstituted) pyridoacridines. A potential limitation was the known propensity of 9-azido-acridine to undergo thermal decomposition to the azo-compound *N*,*N*′-di(acridin-9-yl)diazene[8] which might limit the temperature range employed to effect cycloaddition.

To determine the optimum conditions for cycloaddition, azide **5** was reacted with hex-1-yne in DMF or toluene in the temperature range 25–75 °C in the dark. At 25 °C no reaction

Table 1 Effect of solvent, temperature and alkyne stoichiometry on the yield of triazoles from the cycloaddition of 9-azidoacridine **5** and hex-1-yne

Solvent	*T*/°C	*t*/h	Mol equiv. of hex-1-yne	Yield (**6a** + **6b**) (%)	Ratio (**6a**/**6b**)
DMF	25	168	2	*a*	—
Toluene	25	168	2	*a*	—
DMF	50	96	2	39	1.08
Toluene	50	96	2	40	1.04
DMF	60	24	3	45	1.13
Toluene	60	24	3	61	1.34
DMF	75	24	2	42	1.22
Toluene	75	24	2	38	1.17

[a] Only starting materials present.

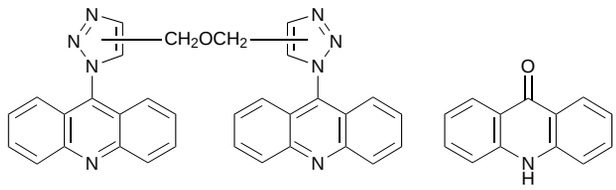


	R^1	R^2
a	C_4H_9	H
b	H	C_4H_9
c	C_3H_7	H
d	H	C_3H_7
e	C_3H_6CN	H
f	H	C_3H_6CN
g	$CH_2OCH_2C{\equiv}CH$	H
h	H	$CH_2OCH_2C{\equiv}CH$
i	Bn	H
j	H	Bn
k	Ph	H
l	H	Ph
m	CO_2Me	H
n	H	CO_2Me
o	CO_2Me	CO_2Me
p	CO_2H	CO_2H
q	CH_2OH	H
r	$SiMe_3$	H

Scheme 2

took place and the optimum conditions utilised the alkyne (3 mol equiv.) in toluene at 60 °C for 24 h (Table 1). Above this temperature considerable decomposition of the azide was noted. Both regioisomers **6a** and **6b** were isolated by flash chromatography of the crude reaction mixture and the conditions providing the highest overall yield of mixed butyltriazoles (61%) were also the most regioselective with the least sterically-hindered 9-(4-butyl-1,2,3-triazol-1-yl)acridine **6a** preferred to the 5-butyltriazolyl isomer **6b** in the ratio 1.34:1 (see later for assignment of structures).

Similar mixtures of regioisomers **6** were obtained from the reactions between 9-azidoacridine and a range of alkynes (Scheme 2). Only one of the alkyne functions of diprop-2-ynyl ether participated in cycloaddition giving a mixture of **6g** and



6h in 31% overall yield with no bis-acridines **9**—note: three isomers are possible—being detected. Yields of mixed triazoles, in general, were >50% and in all cases the 9-(4-substituted-triazolyl)acridine series were the major products; reaction with phenylacetylene (**6k**:**6l** = 2.7:1) and methyl propiolate (**6m**:**6n** = 3.79:1) gave notable regioselectivity.

Dimethylacetylene dicarboxylate and 9-azidoacridine gave the expected diester **6o** (46%) which was saponified in methanolic sodium hydroxide to give the diacid **6p**. In the case of prop-2-ynyl alcohol only one isomer **6q** was isolated (22%) together with acridone **10** (59%), the latter probably formed by hydrolysis of 9-azidoacridine by traces of water in the prop-2-ynyl alcohol. 9-Azidoacridine reacted with trimethylsilyl (TMS) acetylene in toluene at 60 °C with complete regioselectively to give the 9-(4-trimethylsilyl-1,2,3-triazol-1-yl)acridine **6r** in 49% yield. The behaviour of sterically-challenged TMS acetylenes in [3 + 2] cycloadditions is known to be a special case and normally affords only one regioisomer.[9] Efforts to effect decarboxylation of diacid **6p** to 9-(1,2,3-triazol-1-yl)acridine **1** under a range of standard conditions were not successful. In an alternative approach to **1**, the labile TMS group of **6r** was removed by stirring the TMS-triazole in ethanol with silica gel to afford the unsubstituted triazole (60%). Also we have shown previously that triazole **1** can be prepared (49%), together with the 9-(1,2,3-triazol-2-yl)acridine isomer (26%), by reacting 9-chloroacridine with the anion of 1,2,3-triazole.[2]

The structures of the isomeric triazoles were distinguished by ^{1}H NMR studies. The 2D COSY spectrum of 9-(4-butyl-1,2,3-triazol-1-yl)acridine **6a** confirms the location of the 4-spin proton system of the acridine nucleus at δ 8.3–7.4, the triazole 5′-proton at δ 8.6 together with resonances for the butyl group between δ 2.9–1.0. Irradiation of the triazole 5′ proton caused a 7% NOE enhancement of the acridine doublet at δ 7.4 assigned to the equivalent 1-(or 8-)proton. Similarly, irradiation of this acridine proton gave an 8% enhancement of the triazole 5′ proton signal. The low enhancements are probably explained by free rotation about the pivotal acridine–triazole bond. In practice, the proportions of **6a** and **6b** in the crude cycloaddition mixture from **5** and hex-1-yne could be monitored simply by integrating signals for the α-methylene triplets of the butyl groups (Fig. 1); the triplet for the major isomer **6a** appeared 0.65 ppm downfield of the corresponding triplet in the minor isomer **6b** and this differential was diagnostic in other alkylated triazoles in the series which bear an α-methylene group on the substituent in the 4′-(or 5′-)position.

The 9-(triazolyl)acridines showed electronic absorption spectra typical of simple 9-substituted acridines with three main bands at (approx.) 210, 250 and 360 mm in ethanol.

Crystal structure of 9-(4-butyl-1,2,3-triazol-1-yl)acridine 6a

The structure of **6a** is shown with the crystallographic numbering scheme in Fig. 2, which confirms the 4′-position of the butyl substituent in the triazole ring. The acridine ring is planar within +/−0.03 Å. Because of twisting about the C9–N11 bond, the triazole ring, itself planar within +/−0.002 Å, intersects the acridine ring plane at an angle of 65.97(5)°. The butyl chain has an extended conformation and therefore is reasonably planar (to +/−0.05 Å). Rotation about the exit bond from the triazole ring creates an angle of 71.4(1)° between butyl and triazole planes but makes the butyl chain nearly parallel to the acridine ring [13.2(2)°]. Molecules in the crystal are packed so as to

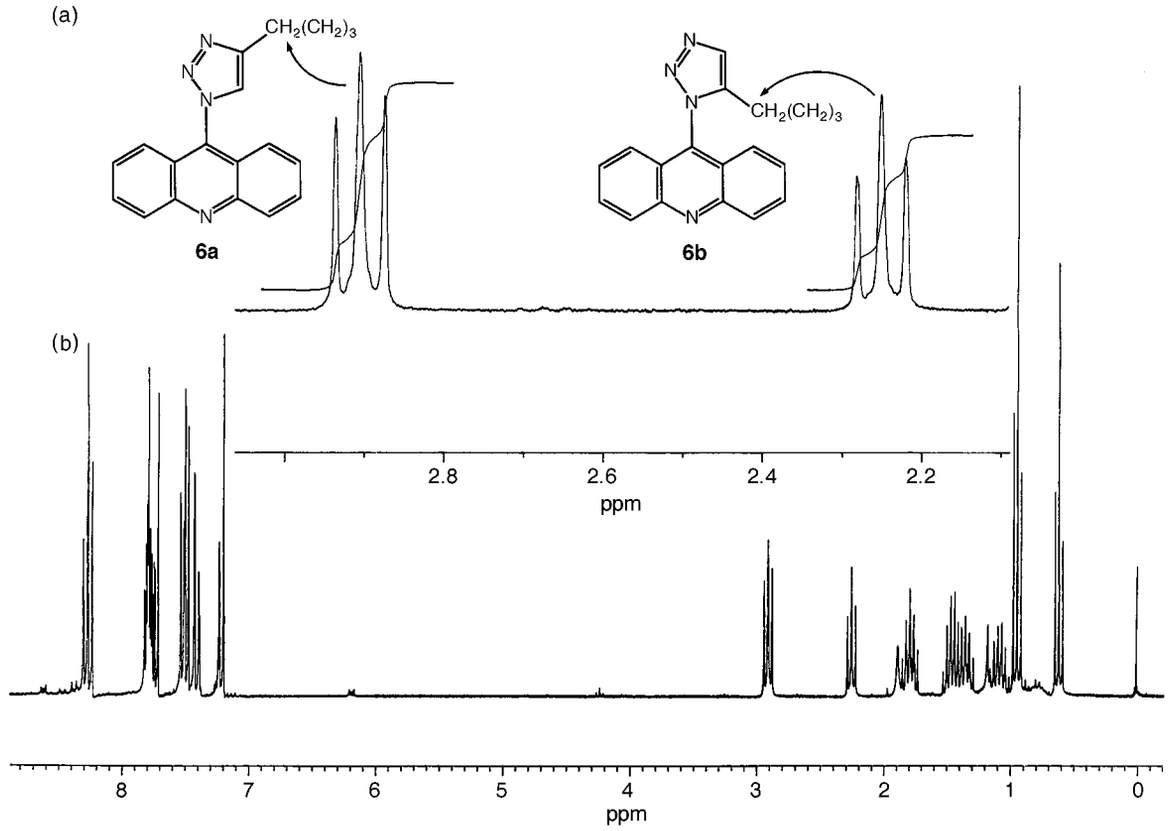


Fig. 1 ^{1}H NMR spectrum of a mixture of 9-(4-butyl-1,2,3-triazol-1-yl)acridine **6a** and 9-(5-butyl-1,2,3-triazol-1-yl)acridine **6b** in $CDCl_3$: (a) α-methylene absorptions; (b) full spectrum

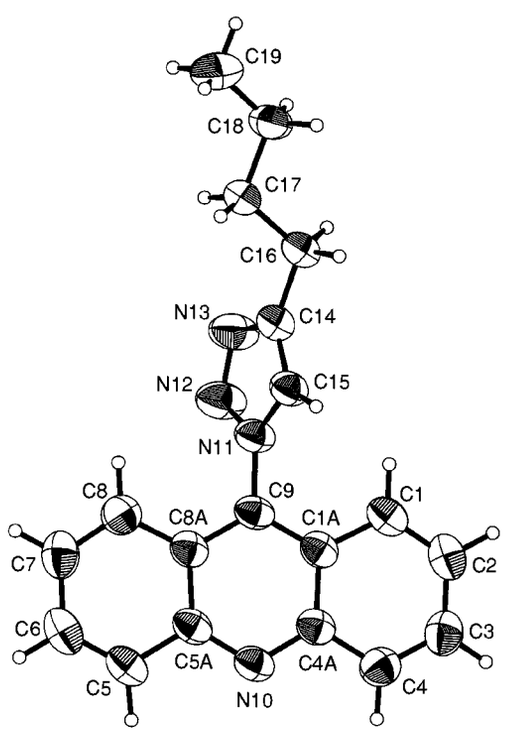


Fig. 2 ORTEP[14] drawing of the molecular structure of 9-(4-butyl-1,2,3-triazol-1-yl)acridine **6a**. Displacement ellipsoids are drawn at the 50% probability level.

position two H atoms of inversion-related molecules at somewhat less than van der Waals contact distances from N10. From a molecule related by $(1 - x, 1 - y, 2 - z)$ the H15···N10 intermolecular contact is 2.56(2) Å, C15···N10 is 3.452(2) Å, and the angle C15–H15···N10 is 153(1)°. Corresponding values for a molecule at $(1 - x, 2 - y, 2 - z)$ are H5···N10 2.64(2) Å, C5···N10 3.577(2) Å, C5–H5···N10 154(1)°. The approach of these H atoms to N10 is roughly symmetrical, with H15 1.79(2) Å above the acridine ring plane and H5 1.21(2) below. The ^{1}H NMR chemical shifts of 8.66 and 8.34 for the two protons (*vide infra*) show that the inductive effects of nearby N atoms have rendered these H atoms electron-deficient, making them plausible candidates for weak C–H···N hydrogen bonding.

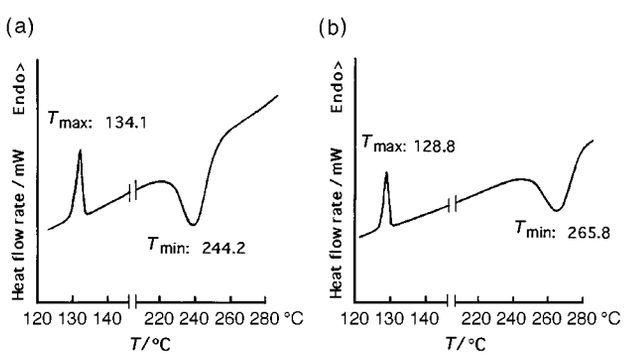


Fig. 3 Thermograms monitoring melting and decomposition of: (a) 9-(4-butyl-1,2,3-triazol-1-yl)acridine **6a**; (b) 9-(5-butyl-1,2,3-triazol-1-yl)acridine **6b**

Thermolysis of 9-(1,2,3-triazol-1-yl)acridines

Analysis of the thermolysis of the isomeric butyltriazoloacridines **6a** and **6b** by differential scanning calorimetry (DSC) [Fig. 3(a) and (b), and Table 2] showed sharp endothermic peaks at 134.1 and 128.8 °C, respectively, corresponding to melting, followed by broad decomposition exotherms with minima at 244.2 and 265.8 °C, respectively. Thus, unlike the corresponding thermograms of 9-(benzotriazol-1-yl)acridines where melting and thermolysis to 8*H*-quino[4,3,2-*kl*]acridines were coincident,[2] in the monocyclic triazoles there was a broad temper-

Table 2 Thermal analysis of 9-(1,2,3-triazol-1-yl)acridines

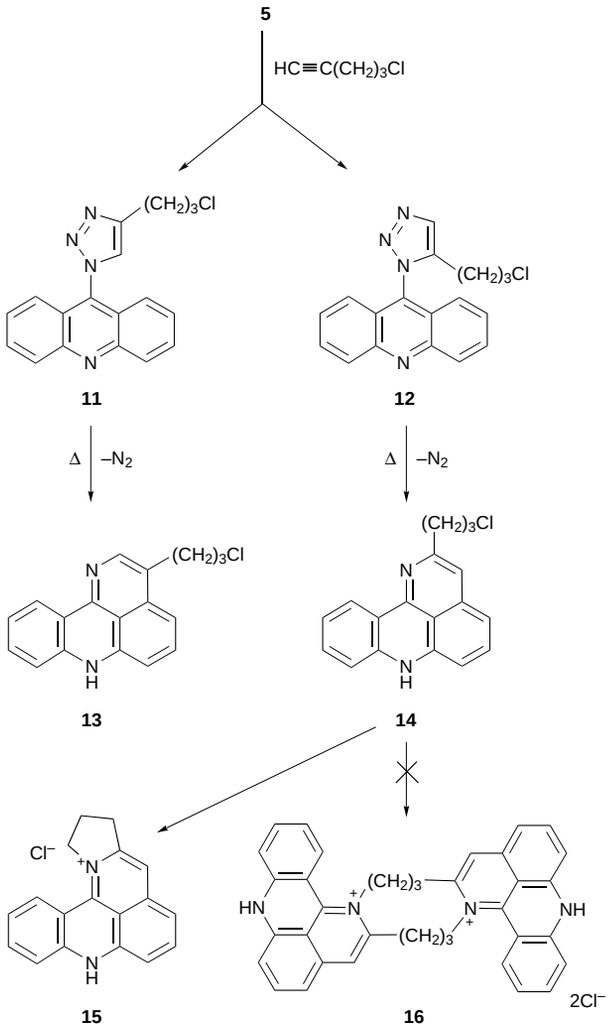
Comp.	Mp/°C [a]	Decomp. temp./°C [b]	Energy release/ J g^{-1} [c]
1 [d]	212.1	249.9	−2414.2
6a	134.1	244.2	−1707.8
6b	128.8	265.8	−1278.9
6c	175.5	254.4	−3813.2
6d	139.6	261.2	−3869.7
6e	167.2	252.2	−1111.7
6f	163.0	260.6	−1434.0
6g	144.6	233.2	−4879.4
6h	153.3	249.8	−4701.1
6i	181.2	248.7	−2340.7
6j	200.8	261.7	−1366.9
6k	239.0	272.3	−1529.5
6l	249.7	263.1	−4987.3
6m	208.9	244.7	−3849.8
6n	241.3	241.3	—
6q	208.4	208.4	—
6r	207.9	244.1	−3401.7
11	169.6	225.8	−3833.7
12	162.8	236.4	−3192.9

[a] Maximum point on the melting endotherm (T_{max}). [b] Minimum point on the decomposition exotherm (T_{min}). [c] During cyclisation. [d] For details of synthesis see ref. 2.

ature range where both compounds were stable in the molten phase. Exceptions to this pattern were the decompositions of the triazoles **6n** and **6q** where melting and thermolysis temperatures were close or coincident. A significant observation was the lower decomposition temperature of the 9-(4-butyltriazolyl)-acridine **6a** compared with the 5-substituted-triazolyl isomer **6b**. This feature was common for the other isomeric alkylated triazoles **6c**–**j** but was reversed in the phenyl-substituted triazoles **6k**,**l** (Table 2).

The triazolylacridines **6a**–**n** which were selected for preparative thermolysis to produce pyridoacridines had decomposition exotherms in the range 233–272 °C measured by DSC. Boiling diphenyl ether (259 °C) has been employed to effect Graebe–Ullmann reactions in related 9-(benzotriazolyl)acridines.[2] However, a variation of these conditions was required to secure optimum yields of the more thermally-unstable tetracyclic systems **8**. Thus, solutions of the triazoles in diphenyl ether were heated until effervescence of nitrogen commenced (generally at 210–230 °C) and were maintained at that temperature until all starting material had been consumed (TLC). Rewardingly, the triazoles **6a**–**n** gave the corresponding tetracycles **8a**–**n**, respectively, uncomplicated by scrambling of substituents R^1 and R^2 by 1,2-shifts. Thus, the 9-(4-substituted-1,2,3-triazol-1-yl)-acridine series **6** gave exclusively 3-substituted pyridoacridines **8** and the 5-substituted triazoles exclusively the isomeric 2-substituted pyridoacridines, possibly *via* discrete, non-interconvertible, diradical species, *e.g.* **7a**–**n** (Scheme 2). In essence, these results parallel similar photolytic conversions of 1-(2-methyl-1-naphthyl)-1,2,3-triazoles to 1*H*-benzo[*de*]quinolines reported by Mitchell and Rees where a carbene has been proposed as the reactive intermediate.[10] Unoptimised yields of novel tetracyclic acridines ranged from 33–88% (Table 3). The triazole diester **6o** was also thermolysed to the pyridoacridine diester **8o** in diphenyl ether (67%) and was subsequently hydrolysed to afford the diacid **8p**. Attempts to thermolyse the triazole diacid **6p** in boiling diphenyl ether were unsuccessful.

One series of alkyltriazoles behaved anomalously on thermolysis. Interaction of 9-azidoacridine and 5-chloropent-1-yne in toluene at 60 °C gave the expected mixture of the 9-[4-(3-chloropropyl)-1,2,3-triazol-1-yl]acridine **11** (35%) and the isomeric 5-substituted triazole **12** (23%) after chromatographic separation (Scheme 3). Whereas thermolysis of **11** in boiling diphenyl ether progressed normally to the 3-substituted pyridoacridine **13** (61%), thermolysis of the isomeric triazole **12** gave a quantitative yield of an unexpected maroon product



Scheme 3

identified as 1*H*,8*H*-2,3-dihydroindolizino[7,6,5-*kl*]acridinium chloride **15**. The intermediate 2-(3-chloropropyl)pyridoacridine **14** undergoes an internal S_N2 reaction rather than an alternative intermolecular dimerisation to give the macrocycle **16** as evidenced by the observation of the required ion at *m*/*z* 259 in the mass spectrum of the salt. In practice the novel pentacyclic acridinium salt **15** can be prepared in a 'one-pot' reaction without separation of the triazoles **11** and **12**: the crude mixture of triazoles is thermolysed and the non-polar tetracycle **13** and water-soluble pentacyclic acridinium salt **15** are readily separable by solvent partitioning.

The series of tetracycles **8** are highly coloured compounds and the isomers **8a** and **8b** give near identical electronic absorption spectra for the free bases with four main absorption bands at (approx.) 230, 250–260, 320 and 420–440 nm. The salt **15** has a qualitatively different electronic absorption spectrum with a long wavelength absorption at 482 nm. The pyridoacridines **8** are assigned the 7*H*-tautomeric structures (rather than 1*H*) by analogy with the structure of the related pentacyclic system 8*H*-quino[4,3,2-*kl*]acridine **4a** which was confirmed by ^{1}H NMR and X-ray crystallographic analysis.[2] The spectroscopic data on the tetracyclic acridines are assembled in Table 4.

In summary we report a convenient two-step synthesis of 7*H*-pyrido[4,3,2-*kl*]acridines **8** from 9-azidoacridine and show that a broad range of substituents can be incorporated onto the tetracyclic nucleus. The planar framework of these compounds implies that they should have the potential to make productive non-covalent interactions with duplex, triplex and quadruplex DNA and therefore to exhibit a range of inhibitory effects against DNA-processing enzymes such as topoisomerases and

Table 3 Physical and analytical data for substituted 7*H*-pyrido[4,3,2-*kl*]acridines **8**

Starting material	Product	Yield (%)	Mp/°C	Molecular formula	M_r	Found (required)		
						C	H	N
6a	**8a**	83[a]	200–202	$C_{19}H_{18}N_2$	274	79.9 (80.3)	6.8 (7.0)	9.45 (9.85)[d]
6b	**8b**	63[a]	106–108	$C_{19}H_{18}N_2$	274	80.2 (80.3)	6.7 (7.0)	9.5 (9.85)[d]
6c	**8c**	49[b]	234–235	$C_{18}H_{16}N_2$	260	82.7 (83.0)	6.3 (6.2)	10.6 (10.7)
6d	**8d**	47[b]	94–96	$C_{18}H_{16}N_2$	260	82.55 (83.0)	6.2 (6.2)	10.3 (10.7)
6e	**8e**	63[a]	192–193	$C_{19}H_{15}N_3$	285	77.8 (77.6)	5.4 (5.4)	13.9 (14.3)[d]
6f	**8f**	61[a]	138–140	$C_{19}H_{15}N_3$	285	75.3 (75.25)	5.25 (5.6)	13.5 (13.9)[e]
6g	**8g**	41[c]	168–170	$C_{19}H_{14}N_2O$	286	75.2 (75.0)	4.8 (5.2)	9.55 (9.2)[e]
6h	**8h**	33[b]	240 (decomp.)	$C_{19}H_{14}N_2O$	286	*f*	*f*	*f*
6i	**8i**	66[a]	240–241	$C_{22}H_{16}N_2$	308	80.9 (81.0)	5.1 (5.5)	8.7 (8.6)[e]
6j	**8j**	88[b]	141–143	$C_{22}H_{16}N_2$	308	85.3 (85.7)	5.0 (5.2)	8.8 (9.1)
6k	**8k**	71[a]	249–251	$C_{21}H_{14}N_2$	294	85.55 (85.7)	4.8 (5.2)	
6l	**8l**	63[a]	192–193	$C_{21}H_{14}N_2$	294	84.0 (84.4)	4.6 (4.9)	9.3 (9.4)[d]
6m	**8m**	62[b]	259–261	$C_{17}H_{12}N_2O_2$	276	71.2 (71.5)	4.5 (4.9)	9.5 (9.8)[e]
6n	**8n**	58[c]	235–237	$C_{17}H_{12}N_2O_2$	276	71.4 (71.6)	4.2 (4.4)	9.7 (9.8)[d]
6o	**8o**	67[a]	110–112	$C_{19}H_{14}N_2O_4$	334	64.4 (64.8)	4.3 (4.5)	7.6 (7.95)[e]

[a] Recrystallised from aq. ethanol. [b] Recrystallised from chloroform. [c] Recrystallised from aq. DMF. [d] With 0.5 H_2O. [e] With 1 H_2O. [f] Insufficient material for microanalysis.

telomerase. The non-planar pentacyclic acridinium salt **15** is potently inhibitory across a wide spectrum of human tumour cells *in vitro* and has the desirable properties of being easily synthesised, having robust stability and appreciable water solubility.[11] The biological properties of these new structures will be published separately.

Experimental

Melting points were obtained on a Gallenkamp melting point apparatus and are uncorrected. IR spectra were measured in KBr on a Mattson 2020 Galaxy Series FT-IR spectrometer. UV spectra were measured in 95% ethanol on a Cecil 1020S scanning spectrometer. ^{1}H and ^{13}C NMR spectra were recorded on a Bruker ARX250 spectrometer operating at 250.13 and 62.9 MHz, respectively. *J* Values are given in Hz. ^{13}C assignments (C = quaternary carbon) were based on DEPT135 and DEPT90 experiments. Mass spectra were recorded on an AEI MS-902, a VG Micromass 7070E or a VG Platform spectrometer. Differential scanning calorimetry was performed with a Perkin-Elmer DSC-4 instrument using the Thermal Analysis Data Station (TADS) for data collection, handling and presentation. Silica gel C60H (40–60 mm) was used for flash chromatography.

General method for the synthesis of regioisomeric 9-[(4- or 5-substituted)-1,2,3-triazol-1-yl]acridines 6

9-Azidoacridine[8] (5 mM) and the appropriate alkyne (15 mM) were heated in toluene (10 cm^3) at 60 °C under nitrogen until reaction was complete (generally 24–48 h). Solvent was removed under vacuum and the products were purified by flash chromatography using hexane–ethyl acetate (1.5:1) as eluting solvent. The following triazolylacridines were prepared.

9-(4-Butyl-1,2,3-triazol-1-yl)acridine 6a. From hex-1-yne, recrystallised from ethyl acetate as amber crystals (35%), mp 134–135 °C, ν_{max}(KBr)/cm^{-1} 2954, 1560, 1516, 1486, 1449, 1037, 753, 639; λ_{max}(EtOH)/nm 211, 249, 359; δ_H([$^2H_6$]DMSO) 8.66 (1 H, s, H-5′), 8.34 (2 H, d, *J* 7.2, H-4,5), 7.99 (2 H, dt, *J* 1.5, 6.8, H-3,6), 7.73 (2 H, dt, *J* 1.0, 6.6, H-2,7), 7.39 (2 H, d, *J* 8.0, H-1,8), 2.89 (2 H, t, *J* 7.5, CH_2), 1.78 (2 H, quintet, *J* 7.5, CH_2), 1.46 (2 H, sextet, *J* 7.0, CH_2), 1.01 (3 H, t, *J* 7.2, CH_3); δ_C([$^2H_6$]DMSO) 149.5 (C), 148.6 (C), 138.7 (C), 132.1 (CH), 130.2 (CH), 129.2 (CH), 127.2 (CH), 123.2 (CH), 31.9 (CH_2), 25.5 (CH_2), 22.6 (CH_2), 14.6 (CH_3) (Found: C, 75.5; H, 6.0; N, 18.6; M$^+$ [EI], 302. $C_{19}H_{18}N_4$ requires C, 75.5; H, 6.0; N, 18.5%; *M*, 302).

9-(5-Butyl-1,2,3-triazol-1-yl)acridine 6b. From hex-1-yne, recrystallised from ethyl acetate as cream crystals (26%), mp 128–129 °C, ν_{max}(KBr)/cm^{-1} 2956, 1535, 1514, 1487, 1427, 1236, 755, 649; λ_{max}(EtOH)/nm 211, 249, 359; δ_H([$^2H_6$]DMSO) 8.37 (2 H, d, *J* 9.0, H-4,5), 8.11 (1 H, s, H-4′), 8.00 (2 H, dt, *J* 1.2, 6.8, H-3,6), 7.74 (2 H, dt, *J* 1.2, 7.2, H-2,7), 7.34 (2 H, d, *J* 8.2, H-1,8), 2.33 (2 H, t, *J* 7.5, CH_2), 1.33 (2 H, quintet, *J* 7.2, CH_2), 1.11 (2 H, sextet, *J* 7.5, CH_2), 0.59 (3 H, t, *J* 7.2, CH_3); δ_C([$^2H_6$]DMSO) 149.6 (C), 142.0 (C), 133.7 (CH), 132.2 (CH), 130.4 (CH), 128.6 (CH), 123.0 (CH), 122.9 (C), 30.8 (CH_2), 22.8 (CH_2), 22.0 (CH_2), 14.1 (CH_3) (Found: C, 75.5; H, 5.9; N, 18.6; MH$^+$ [CI], 303. $C_{19}H_{18}N_4$ requires C, 75.5; H, 6.0; N, 18.5%; *M*H, 303).

9-(4-Propyl-1,2,3-triazol-1-yl)acridine 6c. From pent-1-yne in a sealed tube, recrystallised from ethyl acetate as amber crystals (41%), mp 175–176 °C, ν_{max}(KBr)/cm^{-1} 2959, 1553, 1488, 1451, 1384, 1024, 755, 641; λ_{max}(EtOH)/nm 211, 249, 359; δ_H([$^2H_6$]-DMSO) 8.66 (1 H, s, H-5′), 8.34 (2 H, d, *J* 8.8, H-4,5), 7.99 (2 H, dt, *J* 1.6, 7.2, H-3,6), 7.74 (2 H, dt, *J* 1.1, 8.2, H-2,7), 7.39 (2 H, d, *J* 8.7, H-1,8), 2.86 (2 H, t, *J* 7.5, CH_2), 1.82 (2 H, sextet, *J* 7.4, CH_2), 1.04 (3 H, t, *J* 7.4, CH_3); δ_C([$^2H_6$]DMSO) 149.5 (C), 148.3 (C), 138.8 (C), 132.0 (CH), 130.3 (CH), 129.3 (CH), 127.3 (CH), 123.2 (CH), 122.5 (C), 27.8 (CH_2), 23.0 (CH_2), 14.5 (CH_3) (Found: C, 75.2; H, 5.5; N, 19.4; MH$^+$ [CI], 289. $C_{18}H_{16}N_4$ requires C, 75.5; H, 5.6; N, 19.4%; *M*H, 289).

9-(5-Propyl-1,2,3-triazol-1-yl)acridine 6d. From pent-1-yne in a sealed tube, recrystallised from ethyl acetate as amber crystals (26%), mp 139–140 °C, ν_{max}(KBr)/cm^{-1} 2960, 1560, 1516, 1448, 1384, 1042, 755, 649; λ_{max}(EtOH)/nm 211, 249, 360; δ_H([$^2H_6$]-DMSO) 8.34 (2 H, d, *J* 8.9, H-4,5), 8.11 (1 H, s, H-4′), 8.00 (2 H, dt, *J* 1.2, 7.5, H-3,6), 7.74 (2 H, dt, *J* 1.4, 7.4, H-2,7), 7.25 (2 H, d, *J* 7.5, H-1,8), 2.31 (2 H, t, *J* 7.5, CH_2), 1.39 (2 H, sextet, *J* 7.2, CH_2), 0.69 (3 H, t, *J* 7.4, CH_3); δ_C([$^2H_6$]DMSO) 149.6 (C), 131.2 (CH), 129.9 (CH), 129.0 (CH), 129.3 (CH), 126.0 (C), 123.2 (CH), 122.8 (C), 121.5 (CH), 24.2 (CH_2), 20.4 (CH_2), 13.6 (CH_3) (Found: C, 75.2; H, 5.5; N, 19.4; MH$^+$ [CI], 289. $C_{18}H_{16}N_4$ requires C, 75.0; H, 5.6; N, 19.4%; *M*H, 289).

9-[4-(3-Cyanopropyl)-1,2,3-triazol-1-yl]acridine 6e. From 5-cyanohex-1-yne, recrystallised from ethyl acetate as cream crystals (51%), mp 167–168 °C, ν_{max}(KBr)/cm^{-1} 3080, 2254 (CN), 1553, 1487, 1450, 1035, 775, 750; λ_{max}(EtOH)/nm 213, 250, 360; δ_H([$^2H_6$]DMSO) 8.60 (1 H, s, H-5′), 8.33 (2 H, d, *J* 8.8, H-4,5), 7.97 (2 H, t, *J* 7.2, H-3,6), 7.71 (2 H, t, *J* 8.5, H-2,7), 7.45 (2 H, d, *J* 8.6, H-1,8), 3.01 (2 H, t, *J* 7.2, CH_2), 2.70 (2 H, t, *J* 7.0, CH_2), 2.12 (2 H, quintet, *J* 7.0, CH_2); δ_C([$^2H_6$]DMSO) 147.8 (C), 145.3 (C), 135.2 (C), 130.4 (CH), 128.7 (CH), 128.0 (CH), 121.3 (CH), 121.2 (CH), 118.9 (C), 22.4 (CH_2), 20.7 (CH_2), 14.6 (CH_2) (Found: C, 72.7; H, 4.8; N, 22.1; MH$^+$ [CI], 314. $C_{19}H_{15}N_5$ requires C, 72.8; H, 4.8; N, 22.4%; *M*H, 314).

9-[5-(3-Cyanopropyl)-1,2,3-triazol-1-yl]acridine 6f. From 5-cyanohex-1-yne, recrystallised from ethyl acetate as cream

Table 4 ^{1}H NMR spectra and electronic absorption spectra of 7*H*-pyrido[4,3,2-*kl*]acridines **8**

		^{1}H NMR chemical shifts (δ)										
Compound	Solvent[a]	H-2	H-3	H-4	H-5	H-6	H-8	H-9	H-10	H-11	Others[b]	λ_{max}/nm[c]
8a	A	8.07	Bu^n	7.02	7.52	6.82	7.11	7.37	7.04	8.32	2.73 (t, *J* 7.7, CH_2), 1.61 (m, *J* 7.4, CH_2), 1.40 (m, *J* 7.1, CH_2), 0.94 (t, *J* 7.1, CH_3)	229.4, 248.7, 265, 310*, 320.9, 423. 460*
8b	A	Bu^n	6.98	6.95	7.44	6.75	7.14	7.44	7.06	8.37	2.72 (t, *J* 7.6, CH_2), 1.73 (m, *J* 7.1, CH_2), 1.39 (m, *J* 7.1, CH_2), 0.94 (t, *J* 7.3, CH_3)	230.7, 248.1, 265. 310*, 318.2, 423, 460*
8c	A	8.05	Pr^n	7.01	7.50	6.82	7.01	7.40	7.01	8.34	2.71 (t, *J* 7.8, CH_2), 1.65 (m, *J* 7.4, CH_2), 0.96 (t, *J* 7.4, CH_3)	228, 267.5, 320, 425.5, 450*
8d	A	Pr^n	6.95	6.88	7.40	6.69	7.09	7.40	7.05	8.33	2.67 (t, *J* 7.2, CH_2), 1.80 (m, *J* 7.3, CH_2), 0.95 (t, *J* 7.4, CH_3)	228, 266.5, 318, 460*
8e	B	8.18	$(CH_2)_3CN$	7.12	7.54	6.75	6.97	7.38	7.12	8.51	2.84 (t, *J* 7.2, CH_2), 2.60 (t, *J* 7.2, CH_2), 1.91 (m, *J* 7.2, CH_2)	230.2, 267.7, 323, 425.3, 450*
8f	B	$(CH_2)_3CN$	7.05	6.99	7.40	6.64	6.93	7.40	7.13	8.55	3.00 (t, *J* 7.0, CH_2), 2.51 (t, *J* 7.0, CH_2), 2.30 (m, *J* 7.0, CH_2)	230.2, 265, 318.4, 422.7, 450*
8g	B	8.29	$CH_2OCH_2C{\equiv}CH$	7.33	7.56	6.78	6.98	7.42	7.17	8.54	4.86 (s, CH_2), 4.24 (d, *J* 2.5, CH_2), 2.55 (t, *J* 2.5, CH)	230, 249.5, 317, 460*
8h	A	$CH_2OCH_2C{\equiv}CH$	7.17	*d*	*d*	*d*	*d*	*d*	*d*	*d*	4.77 (s, CH_2), 4.24 (d, *J* 2.5, CH_2), 2.55 (t, *J* 2.5, CH)	227, 250*, 265*, 317.5, 423, 450*
8i	A	8.15	CH_2Ph	6.97	7.43	6.82	7.27	7.43	7.27	8.36	7.27 (m, Ph), 4.10 (s, CH_2)	228.5, 267.5, 319, 429, 455*
8j	A	CH_2Ph	7.10	6.99	7.48	6.82	7.21	7.48	7.15	8.44	7.48 (m, Ph), 4.16 (s, CH_2)	228, 266, 318.5, 455*
8k	A	7.8	Ph	7.07	7.47	6.80	7.17	7.47	7.07	8.54	8.27 (m, Ph), 7.47 (m, Ph)	232.7, 260.1, 318, 329.6, 421.1, 450
8l	A	Ph	8.17	7.06	7.59	6.98	7.27	7.59	7.16	8.47	7.59 (m, Ph)	230, 265*, 321, 437, 460*
8m	A	8.79	CO_2Me	8.17	7.66	7.00	7.25	7.54	7.13	8.42	3.86 (s, CH_3)	232.5, 272, 316.5, 374, 470, 500*
8n	B	CO_2Me	8.04	7.13	7.48	6.81	6.93	7.38	7.07	8.57	4.03 (s, CH_3)	228.5, 327.5, 423, 455*
8o	A	CO_2Me	CO_2Me	7.21	7.69	7.07	7.26	7.56	7.16	8.37	3.87 (s, CH_3), 3.40 (s, CH_3)	230.7, 249.4, 362, 391.7, 460*
8p	A	CO_2H	CO_2H	7.17	7.81	7.07	7.39	7.56	7.20	8.51		231.1, 249.8, 320, 392.4, 440*

[a] Solvents: A, [$^2H_6$]DMSO; B, $CDCl_3$. [b] Excluding NH and OH absorptions; coupling constants in Hz. [c] Measured in 95% ethanol (shoulders denoted by *). [d] Absorptions between δ 6.74–8.50 unassigned.

crystals (27%), mp 163–165 °C, ν_{max}(KBr)/cm^{-1} 2924, 2252 (CN), 1628, 1552, 1450, 1384, 1088, 760; λ_{max}(EtOH)/nm 209, 250, 360; δ_H([$^2H_6$]DMSO) 8.37 (2 H, d, *J* 8.8, H-4,5), 8.19 (1 H, s, H-4′), 8.01 (2 H, dt, *J* 1.1, 7.9, H-3,6), 7.73 (2 H, dt, *J* 1.0, 6.8, H-2,7), 7.27 (2 H, d, *J* 8.7, H-1,8), 2.40 (m, 4 H, 2 × CH_2), 1.74 (2 H, quintet, *J* 7.4, CH_2); δ_C([$^2H_6$]DMSO) 147.9 (C), 139.0 (C), 135.1 (C), 131.5 (CH), 130.5 (CH), 128.7 (CH), 128.0 (CH), 121.3 (CH), 121.2 (CH), 118.9 (C), 22.4 (CH_2), 20.7 (CH_2), 14.6 (CH_2) (Found: C, 72.9; H, 4.6; N, 22.2; MH^+ [CI], 314. $C_{19}H_{15}N_5$ requires C, 72.8; H, 4.8; N, 22.4%; *M*H, 314).

9-[4-(Prop-2-ynyloxymethyl)-1,2,3-triazol-1-yl]acridine 6g. From diprop-2-ynyl ether, recrystallised from ethyl acetate as amber crystals (18%), mp 144–145 °C, ν_{max}(KBr)/cm^{-1} 3324, 2108, 1553, 1439, 1227, 1074, 1042, 756; λ_{max}(EtOH)/nm 210, 249, 361; δ_H([$^2H_6$]DMSO) 8.95 (1 H, s, H-5′), 8.35 (2 H, d, *J* 8.8, H-4,5), 8.00 (2 H, dt, *J* 1.2, 8.0, H-3,6), 7.74 (2 H, dt, *J* 1.2, 7.8, H-2,7), 7.40 (2 H, d, *J* 8.5, H-1,8), 4.85 (2 H, s, CH_2), 4.36 (2 H, d, *J* 2.5, CH_2), 3.58 (1 H, t, *J* 2.5, CH); δ_C([$^2H_6$]DMSO) 149.5 (C), 144.9 (C), 138.3 (C), 132.1 (CH), 130.2 (CH), 129.5 (CH), 123.2 (CH), 122.5 (C), 80.9 (C), 78.6 (CH), 62.9 (CH_2), 57.9 (CH_2) (Found: C, 72.55; H, 4.4; MH^+ [CI], 315. $C_{19}H_{14}N_4O$ requires C, 72.6; H, 4.5%; *M*H, 315).

9-[5-(Prop-2-ynyloxymethyl)-1,2,3-triazol-1-yl]acridine 6h. From diprop-2-ynyl ether, recrystallised from aqueous ethanol as amber crystals (13%), mp 153–154 °C, ν_{max}(KBr)/cm^{-1} 3296, 2100, 1551, 1441, 1233, 1090, 770, 750; λ_{max}(EtOH)/nm 209.5, 248.5, 361.5; δ_H([$^2H_6$]DMSO) 8.35 (2 H, d, *J* 8.8, H-4,5), 8.28 (1 H, s, H-4′), 7.98 (2 H, dt, *J* 1.5, 8.1, H-3,6), 7.71 (2 H, dt, *J* 0.9, 7.2, H-2,7), 7.21 (2 H, d, *J* 8.5, H-1,8), 4.37 (2 H, s, CH_2), 3.78 (2 H, s, *J* 2.4, CH_2), 3.08 (1 H, t, *J* 2.5, CH); δ_C([$^2H_6$]DMSO) 149.5 (C), 138.2 (C), 136.9 (C), 135.0 (CH), 132.1 (CH), 130.2 (CH), 129.5 (CH), 123.0 (CH), 79.6 (C), 78.4 (CH), 59.6 (CH_2), 57.8 (CH_2) (Found: C, 68.3; H, 4.4; N, 17.2; MH^+ [CI], 315. $C_{19}H_{14}N_4O{\cdot}1H_2O$ requires C, 68.7; H, 4.8; N, 16.9%; *M*H, 315).

9-(4-Benzyl-1,2,3-triazol-1-yl)acridine 6i. From 3-phenylprop-1-yne (10 mol equiv.) with no solvent, recrystallised from ethyl acetate as yellow crystals (41%), mp 181–183 °C (decomp.), ν_{max}(KBr)/cm^{-1} 3025, 1555, 1487, 1431, 1221, 1007, 752, 706; λ_{max}(EtOH)/nm 207, 248.5, 361; δ_H([$^2H_6$]DMSO) 8.69 (1 H, s, H-5′), 8.34 (2 H, d, *J* 8.7, H-4,5), 7.98 (2 H, dt, *J* 1.3, 8.1, H-3,6), 7.74 (2 H, dt, *J* 1.1, 8.2, H-2,7), 7.38 (7 H, m, H-1,8 and Ph), 4.28 (2 H, s, CH_2); δ_C([$^2H_6$]DMSO) 149.5 (C), 147.6 (C), 140.0 (C), 138.1 (C), 132.1 (CH), 130.2 (CH), 129.5 (CH), 129.4 (CH), 127.9 (CH), 123.2 (CH), 122.5 (C), 32.5 (CH_2) (Found: C, 78.3; H, 4.7; N, 16.7; MH^+ [CI], 337. $C_{22}H_{16}N_4$ requires C, 78.5; H, 4.8; N, 16.7%; *M*H, 337).

9-(5-Benzyl-1,2,3-triazol-1-yl)acridine 6j. From 3-phenylprop-1-yne with no solvent, recrystallised from ethyl acetate as cream crystals (29%), mp 200–202 °C, ν_{max}(KBr)/cm^{-1} 3067, 1555, 1514, 1435, 1238, 1069, 980, 760; λ_{max}(EtOH)/nm 202.5, 249, 362; δ_H([$^2H_6$]DMSO) 8.32 (2 H, d, *J* 8.8, H-4,5), 8.09 (1 H, s, H-4′), 7.95 (2 H, dt, *J* 1.3, 7.5, H-3,6), 7.62 (2 H, dt, *J* 1.1, 7.7, H-2,7), 7.12 (2 H, d, *J* 8.2, H-1,8), 6.92 (3 H, m, Ph), 6.61 (2 H, m, Ph), 3.8 (2 H, s, CH_2); δ_C([$^2H_6$]DMSO) 149.4 (C), 141.3 (C), 136.9 (C), 136.6 (C), 133.9 (CH), 131.9 (CH), 130.2 (CH), 129.3 (CH), 129.0 (CH), 128.9 (CH), 127.3 (CH), 123.0 (CH), 122.9 (C), 29.4 (CH_2) (Found: C, 78.8; H, 4.8; N, 16.95; MH^+ [CI], 337. $C_{22}H_{16}N_4$ requires C, 78.5; H, 4.8; N, 16.7%; *M*H, 337).

9-(4-Phenyl-1,2,3-triazol-1-yl)acridine 6k. From phenylacetylene (10 mol equiv.) with no solvent, this acridine recrystallised from chloroform as yellow crystals (36%), mp 239 °C (decomp.), ν_{max}(KBr)/cm^{-1} 3080, 1551, 1483, 1433, 1384, 1021, 784, 693; λ_{max}(EtOH)/nm 210, 250, 360; δ_H($CDCl_3$) 8.58 (1 H, s, H-5′), 8.38 (2 H, d, *J* 8.4, H-4,5), 7.97 (2 H, dt, *J* 1.0, 7.8, H-3,6), 7.69 (2 H, dt, *J* 1.1, 7.8, H-2,7), 7.38 (2 H, d, *J* 9.2, H-1,8), 7.15 (5 H, m, Ph); δ_C($CDCl_3$) 149.7 (C), 142.1 (C), 132.9 (CH), 131.2 (CH), 130.2 (CH), 129.9 (CH), 129.3 (CH), 128.6 (CH), 127.6 (CH), 126.0 (C), 123.3 (C), 122.8 (C) (Found: C, 78.1; H, 4.2; N, 17.4; MH^+ [CI], 323. $C_{21}H_{14}N_4$ requires C, 78.2; H, 4.4; N, 17.4%; *M*H, 323).

9-(5-Phenyl-1,2,3-triazol-1-yl)acridine 6l. From phenylacetylene (10 mol equiv.) with no solvent, recrystallised from chloroform as yellow crystals (13%), mp 249–250 °C (decomp.), ν_{max}(KBr)/cm^{-1} 3055, 1553, 1478, 1439, 1074, 1022, 754, 694; λ_{max}(EtOH)/nm 249, 361.5; δ_H($CDCl_3$) 9.40 (1 H, s, H-4′), 8.37 (2 H, d, *J* 8.7, H-4,5), 8.01 (4 H, m, Ph), 7.76 (2 H, dt, *J* 0.8, 8.0, H-2,7), 7.57 (5 H, m, H-1,8 and Ph); δ_C($CDCl_3$) 149.8 (C), 148.0 (C), 137.8 (C), 131.2 (CH), 130.3 (CH), 129.5 (CH), 129.2 (CH), 128.6 (CH), 126.4 (CH), 123.9 (CH), 122.8 (CH), 122.6 (C) (Found: C, 78.1; H, 4.3; N, 17.5; MH^+ [CI], 323. $C_{21}H_{14}N_4$ requires C, 8.2; H, 4.4; N, 17.4%; *M*H, 323).

Methyl 1-(acridin-9-yl)-1,2,3-triazole-4-carboxylate 6m. From methyl propiolate, recrystallised from ethyl acetate as orange crystals (53%), mp 208–210 °C, ν_{max}(KBr)/cm^{-1} 3092, 1740 (C=O), 1516, 1441, 1317, 1248, 1070, 752; λ_{max}(EtOH)/nm 213, 247.5, 361.5; δ_H([$^2H_6$]DMSO) 8.69 (1 H, s, H-5′), 8.15 (2 H, dd, *J* 1.1, 7.8, H-4,5), 7.77 (2 H, dt, *J* 2.0, 7.6, H-3,6), 7.48 (2 H, dt, *J* 1.1, 7.8, H-2,7), 7.05 (2 H, dt, *J* 0.7, 8.7, H-1,8), 3.41 (3 H, s, CH_3); δ_C([$^2H_6$]DMSO) 158.0 (C), 149.4 (C), 138.6 (CH), 137.9 (C), 132.6 (C), 132.1 (CH), 130.2 (CH), 129.6 (CH), 122.9 (CH), 122.8 (C), 53.6 (CH_3) (Found: C, 67.4; H, 3.9; N, 18.4; MH^+ [CI], 305. $C_{17}H_{12}N_4O_2$ requires C, 67.1; H, 3.95; N, 18.4%; *M*H, 305).

Methyl 1-(acridin-9-yl)-1,2,3-triazole-5-carboxylate 6n. From methyl propiolate, recrystallised from ethyl acetate as orange crystals (14%), mp 241 °C (decomp.), ν_{max}(KBr)/cm^{-1} 3042, 1740 (C=O), 1516, 1441, 1317, 1213, 1032, 752; λ_{max}(EtOH)/nm 210, 249, 361.5; δ_H([$^2H_6$]DMSO) 9.63 (1 H, s, H-4′), 8.37 (2 H, d, *J* 8.8, H-4,5), 8.02 (2 H, t, *J* 8.7, H-3,6), 7.74 (2 H, t, *J* 6.7, H-2,7), 7.44 (2 H, d, *J* 8.6, H-1,8), 3.96 (3 H, s, CH_3); δ_C([$^2H_6$]DMSO) 161.3 (C), 149.6 (C), 140.4 (C), 137.4 (C), 133.9 (CH), 132.0 (CH), 130.3 (CH), 129.6 (CH), 123.0 (CH), 122.4 (C), 52.8 (CH_3) (Found: C, 67.3; H, 3.9; N, 18.2; MH^+ [CI], 305. $C_{17}H_{12}N_4O_2$ requires C, 67.1; H, 3.95; N, 18.4%; *M*H, 305).

Dimethyl 1-(acridin-9-yl)-1,2,3-triazole-4,5-dicarboxylate 6o. From dimethyl acetylenedicarboxylate (46%), crystallised from aqueous ethanol as orange needles, mp 138 °C, ν_{max}(KBr)/cm^{-1} 2954, 1735 (C=O), 1456, 1384, 1249, 1226, 1068, 755; λ_{max}(EtOH)/nm 207, 250, 361; δ_H([$^2H_6$]DMSO) 8.37 (2 H, d, *J* 8.8, H-4,5), 8.01 (2 H, dt, *J* 1.2, 6.6, H-3,6), 7.74 (2 H, dt, *J* 1.0, 7.3, H-2,7), 7.44 (2 H, d, *J* 9.2, H-1,8), 4.01 (3 H, s, CH_3), 3.54 (3 H, s, CH_3); δ_C([$^2H_6$]DMSO) 161.0 (C), 158.5 (C), 149.4 (C), 136.5 (C), 135.0 (C), 132.3 (CH), 130.3 (CH), 130.0 (CH), 122.6 (CH), 122.5 (C), 54.6 (CH_3), 53.8 (CH_3) (Found: M^+ [EI], 362. $C_{19}H_{14}N_4O_4$ requires *M*, 362).

1-(Acridin-9-yl)-1,2,3-triazole-4,5-dicarboxylic acid 6p. The aforementioned dicarboxylate **6o** (0.5 g) was hydrolysed in a mixture of methanol (10 cm^3) and water (0.5 cm^3) containing sodium (0.5 g) for 0.5 h. The resulting suspension was diluted with water (25 cm^3), acidified with 1 M hydrochloric acid, and the precipitated *dicarboxylic acid* **6p** was collected (71%) as a yellow solid, mp 184 °C (decomp.); ν_{max}(KBr)/cm^{-1} 3449, 2546, 1646 (C=O), 1583, 1533, 1459, 1009, 809; λ_{max}(EtOH)/nm 213, 250, 359; δ_H([$^2H_6$]DMSO) 12.70 (2 H, br s, 2 × CO_2H), 8.56 (2 H, d, *J* 8.6, H-4,5), 8.45 (2 H, t, *J* 7.3, H-3,6), 7.92 (2 H, t, *J* 8.4, H-2,7), 7.60 (2 H, d, *J* 8.7, H-1,8); δ_C([$^2H_6$]DMSO) 161.6 (C), 158.1 (C), 148.0 (C), 141.0 (C), 137.2 (C), 133.1 (CH), 129.5 (CH), 128.6 (CH), 123.6 (CH), 123.1 (C) (Found: C, 61.1; H, 3.0; N, 16.5; MH^+ [CI], 335. $C_{17}H_{10}N_4O_4$ requires C, 61.1; H, 3.0; N, 16.8%; *M*H, 335).

9-[(4-Hydroxymethyl)-1,2,3-triazol-1-yl]acridine 6q. From prop-2-ynyl alcohol and 9-azidoacridine (22%), this acridine was crystallised from aqueous ethanol as orange needles, mp 208 °C; ν_{max}(KBr)/cm^{-1} 3108 (OH), 1561, 1518, 1439, 1117, 1053, 1036, 756; λ_{max}(EtOH)/nm 210.5, 248.5, 361; δ_H([$^2H_6$]-DMSO) 8.78 (1 H, s, H-5′), 8.35 (2 H, d, *J* 8.8, H-4,5), 7.99 (2 H, dt, *J* 1.3, 8.0, H-3,6), 7.74 (2 H, dt, *J* 1.1, 8.0, H-2,7), 7.41 (2 H, d, *J* 8.7, H-1,8), 5.49 (1 H, t, *J* 5.1, OH), 4.79 (2 H, d, *J* 5.1, CH_2); δ_C([$^2H_6$]DMSO) 149.6 (C), 138.0 (C), 132.1 (CH), 130.2 (CH), 129.3 (CH), 128.1 (CH), 123.2 (CH), 122.7 (C),

55.9 (CH_2) (Found: C, 61.4; H, 4.6; N, 18.3; MH^+ [CI], 277. $C_{16}H_{12}N_4O{\cdot}2H_2O$ requires C, 61.5; H, 5.2; N, 17.9%; *M*H, 277). The other product of the reaction was acridone **10** identical[8] to an authentic sample.

9-(4-Trimethylsilyl-1,2,3-triazol-1-yl)acridine 6r. Prepared from (trimethylsilyl)acetylene (1.47 g) and 9-azidoacridine (1.1 g) in dry toluene (10 cm^3) at 60 °C under nitrogen for 48 h. Solvent was removed under vacuum and the residue was purified by flash chromatography (EtOH) and recrystallisation (EtOH–ethyl acetate) to give the acridine as brown crystals (0.78 g, 49%), mp 208 °C; ν_{max}(KBr)/cm^{-1} 3094, 1561, 1449, 1250, 1096, 1032, 845, 756; λ_{max}(EtOH)/nm 209.5, 248, 361; δ_H([$^2H_6$]DMSO) 8.94 (1 H, s, H-5′), 8.30 (2 H, d, *J* 7.8, H-4,5), 7.97 (2 H, dt, *J* 1.1, 7.8, H-3,6), 7.71 (2 H, dt, *J* 1.0, 8.0, H-2,7), 7.32 (2 H, t, *J* 8.5, H-1,8), 0.41 (9 H, s, TMS); δ_C([$^2H_6$]DMSO) 149.6 (C), 146.6 (C), 138.6 (CH), 132.1 (CH), 130.3 (CH), 129.4 (CH), 123.3 (CH), 122.0 (C), 0 (CH_3) (Found: C, 68.5; H, 5.6; N, 17.5; MH^+ [CI], 319. $C_{18}H_{18}N_4Si$ requires C, 67.9; H, 5.7; N, 17.5%; *M*H, 319).

A solution of the trimethylsilyltriazolylacridine **6r** (0.2 g) in ethanol (25 cm^3) was stirred with silica gel (2.0 g) for 24 h. Evaporation of solvent afforded 9-(1,2,3-triazol-1-yl)acridine **1** (65%), identical (IR, ^{1}H NMR) to an authentic sample prepared from 9-chloroacridine and the anion of 1,2,3-triazole.[2]

9-[4-(3-Chloropropyl)-1,2,3-triazol-1-yl]acridine 11. Prepared from 9-azidoacridine and 5-chlorohex-1-yne in toluene at 60 °C according to the general method (above), this triazole recrystallised from ethyl acetate as cream crystals (35%), mp 169–170 °C, ν_{max}(KBr)/cm^{-1} 3075, 1553, 1516, 1439, 1354, 1040, 775, 752; λ_{max}(EtOH)/nm 211.5, 247, 361.5; δ_H([$^2H_6$]DMSO) 8.72 (1 H, s, H-5′), 8.34 (2 H, dt, *J* 0.8, 8.3, H-4,5), 7.99 (2 H, dt, *J* 1.2, 7.4, H-3,6), 7.73 (2 H, dt, *J* 1.2, 7.4, H-2,7), 7.45 (2 H, dt, *J* 0.6, 8.1, H-1,8), 3.83 (2 H, t, *J* 6.3, CH_2), 3.03 (2 H, t, *J* 7.3, CH_2), 2.26 (2 H, quintet, *J* 6.8, CH_2); δ_C([$^2H_6$]DMSO) 149.5 (C), 147.2 (C), 138.6 (C), 132.1 (CH), 130.1 (CH), 129.3 (CH), 127.5 (CH), 123.3 (CH), 122.5 (C), 45.7 (CH_2), 32.5 (CH_2), 23.2 (CH_2) (Found: C, 67.1; H, 4.6; N, 17.5; MH^+ [CI], 323, 325. $C_{18}H_{15}N_4Cl$ requires C, 67.1; H, 4.6; N, 17.4%; *M*H, 323, 325).

9-[5-(3-Chloropropyl)-1,2,3-triazol-1-yl]acridine 12. Recrystallised from ethyl acetate as cream crystals (23%), mp 163–164 °C, ν_{max}(KBr)/cm^{-1} 3049, 1551, 1514, 1489, 1456, 1385, 1236, 754; λ_{max}(EtOH)/nm 211, 249.5, 361.5; δ_H([$^2H_6$]DMSO) 8.38 (2 H, d, *J* 8.8, H-4,5), 8.18 (1 H, d, *J* 0.4, H-5′), 8.01 (2 H, dt, *J* 1.3, 7.8, H-3,6), 7.75 (2 H, dt, *J* 0.9, 7.8, H-2,7), 7.27 (2 H, dd, *J* 0.6, 8.2, H-1,8), 3.48 (2 H, t, *J* 6.3, CH_2), 2.49 (2 H, t, *J* 8.0, CH_2), 1.87 (2 H, quintet, *J* 6.6, CH_2); δ_C([$^2H_6$]DMSO) 149.6 (C), 141.0 (C), 136.9 (C), 133.2 (CH), 132.2 (CH), 130.4 (CH), 129.8 (CH), 123.1 (C), 122.9 (CH), 44.8 (CH_2), 31.1 (CH_2), 20.7 (CH_2) (Found: C, 66.8; H, 4.6; N, 17.6; Cl, 10.8; MH^+ [CI], 323, 325. $C_{18}H_{15}N_4Cl$ requires C, 67.1; H, 4.6; N, 17.4%; Cl, 10.9; *M*H, 323, 325).

General method for the thermolytic conversion of 9-[(4- or 5-substituted)-1,2,3-triazol-1-yl]acridines to 7*H*-pyrido[4,3,2-*kl*]-acridines

The triazolylacridine **6** (0.25 g) was mixed with diphenyl ether (10 g) and the mixture was heated to 210–230 °C until effervescence of nitrogen gas ceased (0.5 h) and TLC analysis showed that all starting material had been consumed. The cooled mixture was added to the top of a silica gel column and the column eluted with hexane to remove diphenyl ether. The product was then eluted with EtOH–ethyl acetate (1 : 1), solvent was evaporated and the residue crystallised from aqueous ethanol, chloroform or aqueous DMF to give red crystals of the pyridoacridines **8**. The physical and analytical properties of the pyridoacridines are recorded in Table 3 and the ^{1}H NMR and electronic absorption data in Table 4.

3-(3-Chloropropyl)-7*H*-pyrido[4,3,2-*kl*]acridine 13. 9-[4-(3-Chloropropyl)-1,2,3-triazol-1-yl]acridine **11** (0.16 g) was thermolysed according to the general method and the pyridoacridine **13** was crystallised from ethyl acetate as yellow crystals (0.09 g, 61%), mp 204–205 °C; ν_{max}(KBr)/cm^{-1} 2939, 1638, 1549, 1479, 1333, 1265, 1157, 784; λ_{max}(EtOH)/nm 230, 267.5, 319.5, 426; δ_H($CDCl_3$) 8.52 (1 H, dd, *J* 1.2, 8.0, H-11), 8.21 (1 H, s, H-2), 7.53 (2 H, m, H-5, NH), 7.39 (1 H, dt, *J* 1.5, 7.5, H-9), 7.13 (2 H, m, H-4, 10), 6.95 (1 H, d, *J* 8.2, H-8), 6.73 (1 H, d, *J* 7.0, H-6), 3.65 (2 H, t, *J* 6.5, CH_2), 3.02 (2 H, t, *J* 7.8, CH_2), 2.04 (2 H, quintet, *J* 7.2, CH_2); δ_C($CDCl_3$) 150.8 (C), 144.3 (CH), 140.3 (C), 139.4 (C), 137.3 (C), 131.9 (CH), 131.5 (CH), 126.1 (C), 125.3 (CH), 122.2 (CH), 122.0 (C), 115.2 (CH), 110.9 (CH), 105.6 (CH), 45.0 (CH_2), 32.1 (CH_2), 27.8 (CH_2) (Found: C, 73.0; H, 5.0; N, 9.2; MH^+ [CI], 295, 297. $C_{18}H_{15}N_2Cl$ requires C, 73.3; H, 5.1; N, 9.5%; *M*H, 295, 297).

1*H*,8*H*-2,3-Dihydroindolizino[7,6,5-*kl*]acridinium chloride 15. 9-[5-(3-Chloropropyl)-1,2,3-triazol-1-yl]acridine **12** (0.16 g) was thermolysed (as above) and the product was filtered directly from the cooled, diluted (ethyl acetate) melt and washed with ethyl acetate. The acridinium salt **15** formed red micro-crystals from aqueous ethanol (0.114 g, 77%), mp >300 °C (decomp.); ν_{max}(KBr)/cm^{-1} 3443 (NH), 1737, 1661, 1624, 1566, 1483, 1341, 870; λ_{max}(EtOH)/nm 237, 278.5, 316.5, 346.5, 374, 482; δ_H(D_2O) 7.72 (1 H, d, *J* 9.0, H-11), 7.44 (1 H, t, *J* 8.0, H-9), 7.24 (1 H, t, *J* 7.8, H-6), 7.05 (1 H, t, *J* 7.5, H-10), 6.64 (3 H, m, H-4,5,8), 6.18 (1 H, d, *J* 8.2, H-7), 4.08 (2 H, t, *J* 7.0, CH_2), 2.78 (2 H, t, *J* 7.2, CH_2), 2.08 (2 H, quintet, *J* 7.2, CH_2); δ_C(D_2O) 148.5 (C), 147.2 (C), 140.9 (C), 138.1 (C), 135.9 (C), 135.6 (CH), 135.2 (CH), 127.0 (CH), 123.2 (CH), 117.5 (CH), 116.5 (C), 114.4 (CH), 113.0 (CH), 111.8 (C), 108.8 (CH), 58.7 (CH_2), 29.5 (CH_2), 22.7 (CH_2) (Found: C, 72.3; H, 5.0; N, 9.25; MH^+ [CI], 259. $C_{18}H_{15}N_2Cl{\cdot}0.25H_2O$ requires C, 72.2; H, 5.2; N, 9.4%; *M*H − HCl, 259).

Crystal data for 6a

$C_{19}H_{18}N_4$, M = 302.37, triclinic, space group $P\bar{1}$, a = 7.7379(14), b = 8.704(2), c = 12.686(3) Å, α = 92.33(2), β = 91.14(2), γ = 112.784(14)°, V = 786.5(3)°, Z = 2, D_c = 1.277 g cm^{-3}, μ = 0.078 mm^{-1}. Of the 3421 reflections collected on an Enraf-Nonius CAD4 diffractometer with MoKα radiation between $2.5 < \theta < 25°$, 2750 were independent (R_{int} = 1.5%) and 2088 were considered observed [$F > 4\sigma(F)$]. The structure was solved by direct methods.[12] Full-matrix least-squares refinement[13] on all F^2 data included positional parameters for all atoms, displacement parameters that were anisotropic for non-hydrogen atoms and isotropic for H atoms, and an extinction correction. The final discrepancy indices were R = 3.9% for observed reflections and $wR(F^2)$ = 11.9% for all data. No feature on an electron density map exceeded +0.17 or −0.18 e $Å^{-3}$. Full crystallographic details, excluding structure factor tables, have been deposited at the Cambridge Crystallographic Data Centre (CCDC). For details of the deposition scheme, see 'Instructions for Authors', *J. Chem. Soc.*, *Perkin Trans. 1*, available *via* the RSC Web pages (http://www.rsc.org/authors). Any request to the CCDC for this material should quote the full literature citation and the reference number 207/184.

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