Synthesis of Bridged Benzodiazepines by Reaction of Amines and Hydrazine Derivatives with 4,6-Dibromomethyl-5,2,8-ethanylylidene-5*H*-1,9-benzodiazacycloundecine

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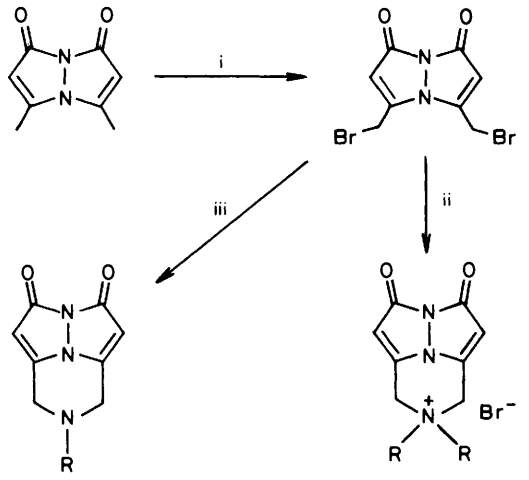
Bromination of 4,6-dimethyl-5,2,8-ethanylylidene-5*H*-1,9-benzodiazacycloundecine with *N*-bromosuccinimide gives a number of brominated products. Reaction of the dibromo and tribromo derivatives with amines and hydrazine derivatives are described. Amines give dihydro derivatives of bridged 14π annulenes, while the hydrazine derivatives give tetrahydro analogues of bridged 14π annulenes. Oxidation studies with the dihydro- and tetrahydro-annulenes are reported.

The group of Kosower[1] has reported the bromination of bimanes and the successful elaboration of the bromo derivatives by reaction with amines to give tricyclic amines having interesting photophysical properties (Scheme 1). Earlier, we have reported[2] the preparation of bridged benzodiazepines [*e.g.* (**1**)] by reaction of *o*-phenylenediamines with the readily available diketone (**2**). The functionalisation of (**1**) and elaboration, as reported by the Kosower group,[1] might lead to polycyclic amines [*e.g.* (**3**)], by reaction of the dibromide (**4**) with methylamine. Amines such as (**3**) are dihydro derivatives of the 14π-annulene system (**5**). Similarly, the reaction of compound (**4**) with hydrazine derivatives might lead, *via* cyclisation, to polycyclic hydrazines [*e.g.* (**6**) by reaction with hydrazine]. The hydrazine (**6**) is a tetrahydro derivative of a further 14π-annulene system (**7**). Bridged heterocyclic annulenes have been the recent subject[3] of extensive synthetic studies. We report in this paper the successful preparation of compound (**4**) and elaboration to give (**3**) and analogues by reaction with amines, and to give derivatives of (**6**) by reaction with hydrazine derivatives. We also describe attempted oxidations to give the 14π-annulene systems (**5**) and (**7**) and, in the following paper,[4] the reactions of compound (**4**) with carbon nucleophiles leading to the successful synthesis of 14π-annulenes.

The reaction of the bridged benzodiazepine (**1**) with *N*-bromosuccinimide in refluxing carbon tetrachloride afforded a mixture of the dibromide (**4**) and the tribromide (**8**). The dibromide (**4**) could be isolated from the reaction mixture by direct crystallisation; a chromatographic separation gave both (**4**) (66%) and (**8**) (25%).

The reaction of the dibromide (**4**) with simple primary amines gave the expected products of cyclisation. Thus, methylamine gave compound (**3**) in 52% yield, and the amines (**9**)—(**14**) were similarly obtained by reaction with ethylamine, t-butylamine, aniline, *p*-anisidine, benzylamine, and glycine methyl ester. In contrast, the reaction of compound (**4**) with ammonia, although rapid, afforded only polymeric products. In the bimane series,[1] cyclic products were successfully obtained by the use of acetamide as a nucleophile. However, the fact that we were not able to obtain cyclic products in the attempted reaction of (**4**) with either acetamide or *p*-nitroaniline suggests that successful cyclisation is only possible with the more nucleophilic amines. The reaction of secondary amines with (**4**) gave quaternary ammonium salts [*e.g.* (**15**) by reaction with piperidine (75% yield)].

With the intention of synthesising compound (**7**) by oxidation of (**6**) or a derivative of (**6**), the reaction of the dibromide (**4**) with hydrazine derivatives was studied. The reaction of (**4**) with hydrazine was unsatisfactory since only polymeric products were isolated. In contrast, its reaction with dimethyl, di-t-butyl, and dibenzyl hydrazodicarboxylate afforded smoothly the products of cyclisation (**16**)—(**18**). Similarly, 1,2-dimethylhydrazine afforded the expected product of cyclisation (**19**).

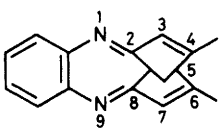


Scheme 1. Reagents: i, Br_2; ii, R_2NH; iii, RNH_2

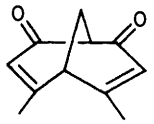
Although the products (**16**)—(**19**) are well characterised by microanalytical data and by other spectroscopic evidence, they have very complex ^1H n.m.r. spectra. In the case of (**16**)—(**18**), such complexity may arise not only from processes associated with the flipping of the ring but also from the variety of isomeric possibilities offered by the two amide groups. However, study of the variable temperature ^1H n.m.r. spectra of compound (**19**) clarifies the conformational characteristics associated with its skeleton (see Scheme 2 and Figure). At 20 °C in chlorobenzene as solvent two methyl signals are observed in the spectrum of (**19**). At 40 °C the two signals are broader and less separated relative to the spectrum at 20 °C. At 85 °C the signals have coalesced and at 110 °C a single sharp signal is observed. At intermediate temperatures, the ratio of the integrated areas of the two signals is unity. These results imply that in this temperature range a single conformational process is being observed in which the two possible sites for the methyl groups are equally populated. In chlorobenzene the observed activation energy is $\Delta G_c^{\ddagger} = 17$ kcal/mol† as determined using the relation:

$$\tau_C = \frac{2^{\frac{1}{2}}}{\pi(\nu_A - \nu_B)}$$

† 1 kcal = 4.184 kJ.



(1)



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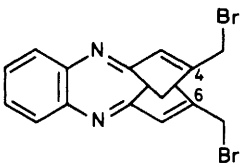

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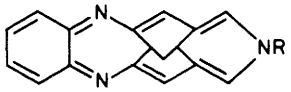
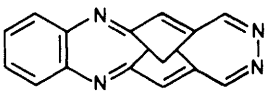
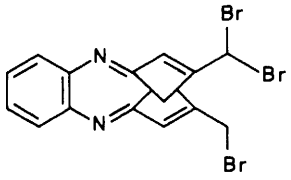


(5)



(7)



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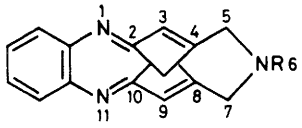
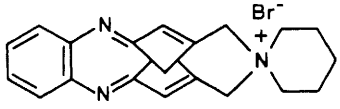


(3) R = Me
(9) R = Et
(10) R = Bu^t
(11) R = Ph
(12) R = *p*-MeOC$_6$H$_4$
(13) R = CH$_2$Ph
(14) R = CH$_2$CO$_2$Me



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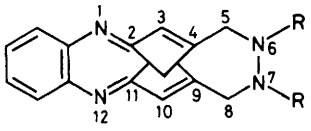
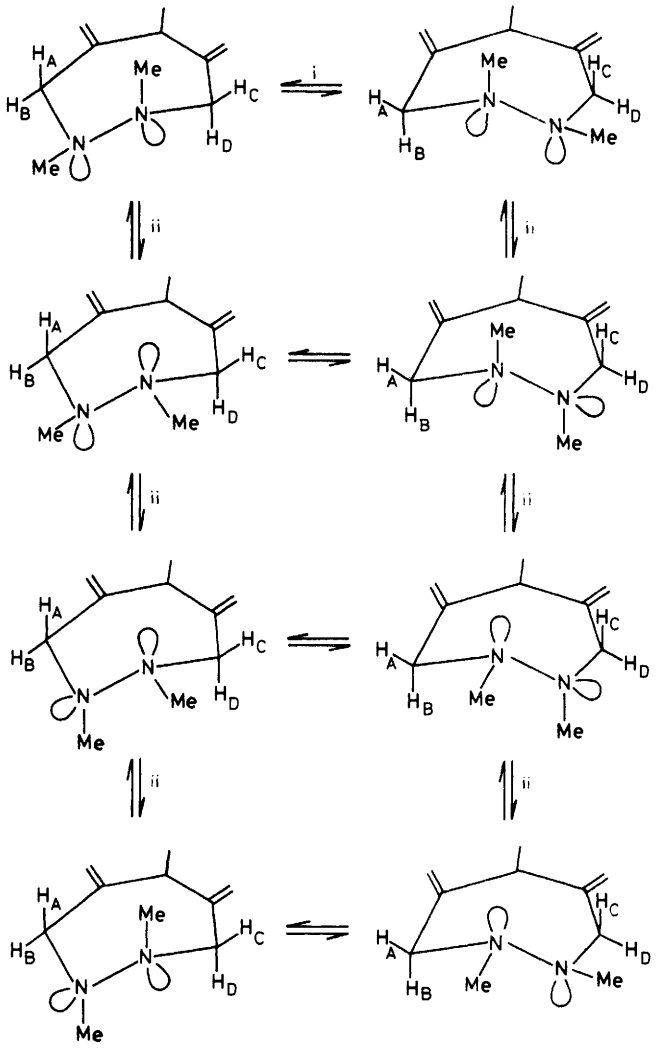


(6) R = H
(16) R = CO$_2$Me
(17) R = CO$_2$Bu^t
(18) R = CO$_2$CH$_2$Ph
(19) R = Me
(21) R = COPh

and the Eyring equation assuming that the transmission coefficient is 1. In CD_2Cl_2 no significant changes were observed in the spectrum between 20 °C and −53 °C.

The observed activation energy $\Delta G_c^{\ddagger} = 17$ kcal/mol might be associated with either a process of ring flipping or ring inversion, or a process of inversion at a single nitrogen. The ring inversion in compound (**19**) has no analogues in the literature of a seven-membered ring with a well defined activation energy. However, in *N,N'*-dimethylhexahydropyridazine (**20**), the energy barrier to nitrogen inversion is of a similar magnitude to the barrier for ring inversion.[5] For the pyridazine (**20**),



Scheme 2. i, Ring flipping; ii, N inversion

parameters have been determined[6] for some of the different possible ring inversion processes and for the possible nitrogen inversion processes. As shown in Scheme 2, the conformational analysis of (**19**) might be of equivalent complexity to the case of the hexahydropyridazine (**20**). However, the observation of a single conformational process, with the collapse of the two methyl resonances to a single sharp signal, affords a probable explanation of the conformational equilibria in (**19**).

Four possible analyses must be considered: (i) the dynamic process associated with $\Delta G_c^{\ddagger} = 17$ kcal/mol is a ring inversion, and nitrogen inversion processes are relatively slow.

(ii) The dynamic process observed is ring inversion and nitrogen inversion processes are relatively fast.

(iii) The dynamic process associated with $\Delta G_c^{\ddagger} = 17$ kcal/mol is a nitrogen inversion and ring inversion processes are relatively slow.

(iv) The dynamic process observed is a nitrogen inversion and ring inversion processes are relatively fast.

Equilibrium data[5] for compound (**20**) suggest that processes of nitrogen inversion in (**19**) will lead to interconversion between species of comparable energy. Hence, for case (i), complex spectra with more than two methyl resonances at lower temperatures are expected, but only two methyl resonances are observed. Similarly, case (iii) can be rejected as only two methyl resonances are observed at the lower temperatures. The activation energies for a series of comparable hydrazines[5] are

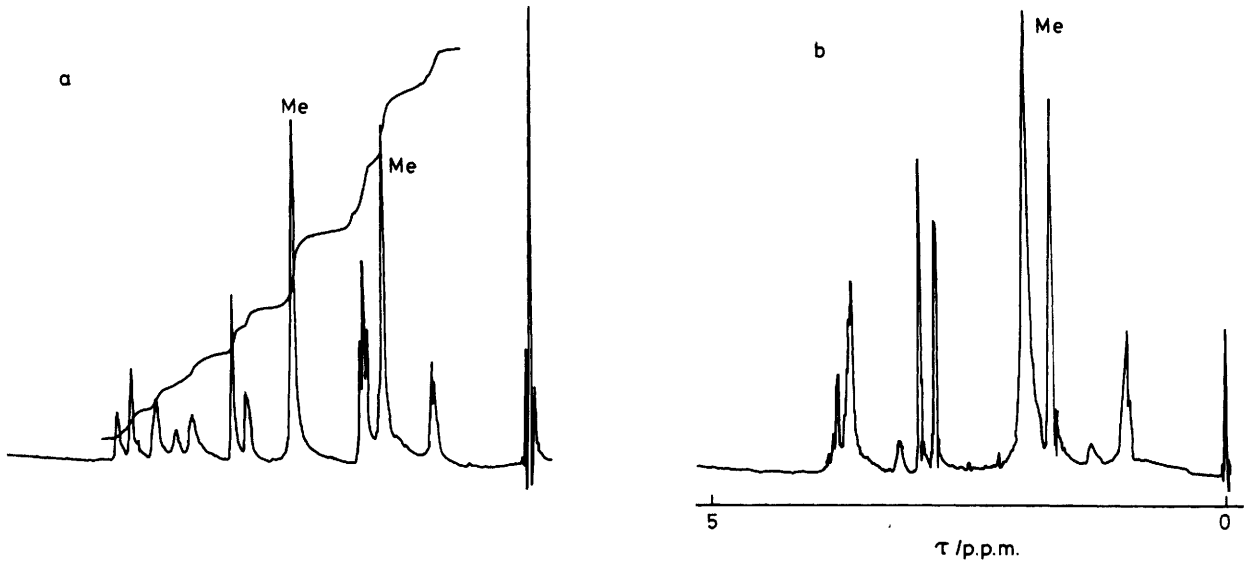
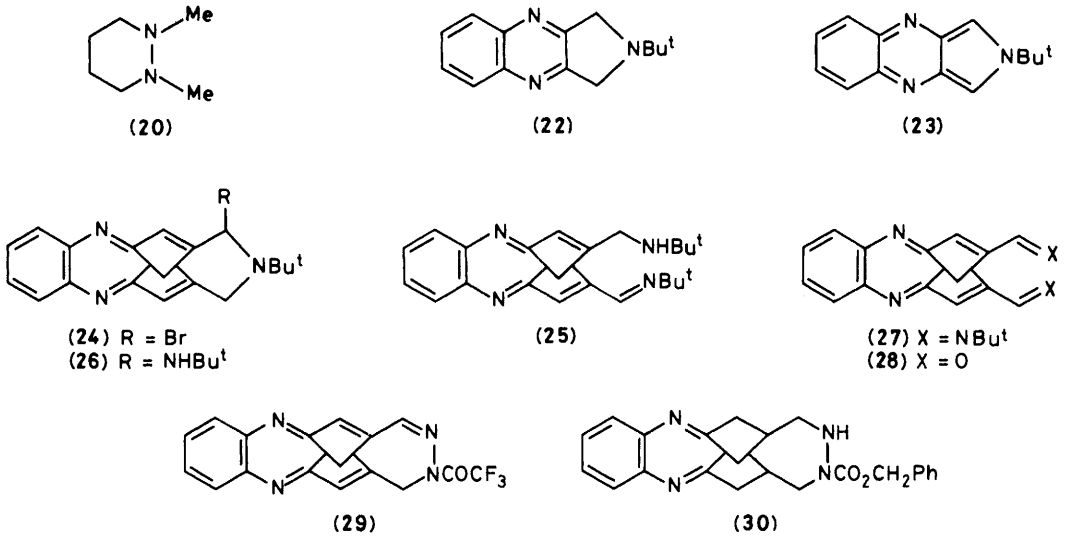


Figure. ^{1}H N.m.r. spectrum of compound (**19**) in chlorobenzene (a) at 20 °C and (b) at 110 °C



uniformly in the region 6—8 kcal/mol, and there is no good reason to expect substantially larger activation energies for nitrogen inversion in compound (**19**). Hence, we conclude that we are observing ring inversion and that the nitrogen inversion process is too fast for observation in our temperature range [*i.e.* case (ii) applies].

The large chemical shift difference between the two methyl resonances (*ca.* 0.75 p.p.m. at 30 °C in CD_2Cl_2) is readily explained by the substantial shielding effect of substituents placed on the *endo* face of compound (**19**). We have observed this effect in other compounds.[4] The rather high energy barrier to ring inversion in (**19**) may be explained as a consequence of the rigidity imposed by the bridging unit. These constraints permit substantial movement to only the two nitrogen atoms in the seven-membered ring. The other compounds that we have prepared with the same skeleton as (**19**) [*e.g.* (**16**)—(**18**) and (**21**)] show spectral changes on variation of temperature within the range 20—80 °C.

Following the successful synthesis of a number of dihydro precursors of (**5**) and tetrahydro precursors of (**7**), we have examined a variety of methods to effect oxidation to the 14π-annulenes. Kreher and Use[7] transformed the tricyclic compound (**22**) into the 14π-annulene (**23**) by oxidation with manganese dioxide in benzene. In contrast, in our hands under a variety of conditions the oxidation of compound (**10**) using manganese dioxide in benzene failed, and the starting amine (**10**) was always recovered.

In a second approach, oxidation of the amine (**10**) with *N*-bromosuccinimide was examined. The expected bromination of (**10**) to give (**24**), which could then be dehydrobrominated to give the desired product (**5**; R = Bu^t), did not take place. The reaction of (**10**) with *N*-bromosuccinimide in carbon tetrachloride, even at 0 °C, gave deeply coloured solutions from which only polymeric products were observed. An alternative route to (**24**) is by reaction of the tribromide (**8**) with t-butylamine. The use of an excess of t-butylamine gave a crystalline product which, by analysis of the ^{1}H n.m.r. spectrum, was assigned the structure (**25**) rather than the possible structure (**26**). In support of this assignment, oxidation of compound (**25**) with manganese dioxide gave the di-imine (**27**) which readily underwent hydrolysis to give the dialdehyde (**28**). The attempted reaction of (**8**) with t-butylamine (1 equiv.) failed to give other products that could be isolated. Further attempts to prepare compound (**5**; R = Bu^t) by the reaction of (**10**) with a

variety of oxidants (*e.g.* manganic acetate, lead tetra-acetate, mercuric acetate, or selenium dioxide) failed. Either (**10**) was recovered unchanged or polymeric products were obtained.

The synthesis of compound (**7**) was attempted by a variety of routes *from the* hydrazine derivatives (**16**)—(**18**) and (**21**). A common problem was deprotection to give compound (**6**) with a view to generate (**7**) by an appropriate oxidation. The attempted hydrolysis of the ester (**16**) with potassium hydroxide in ethanol gave only products of extensive decomposition. Similarly, only polymeric products were obtained with lithium chloride in dimethylformamide, or trimethylsilyl iodide in acetonitrile, as reagent. The reaction of the diester (**17**) with trifluroroacetic acid in methylene dichloride at 0 °C for 3 h and analytical t.l.c. showed that the starting material had disappeared and a very polar product had been formed. Since the product was very unstable, no attempt was made to isolate (**6**). Instead the crude product was oxidised by mercuric acetate, or manganese dioxide, or selenium dioxide. In the reaction with selenium dioxide, two products were isolated, the dialdehyde (**28**) and an amide tentatively assigned the structure (**29**). Attempts to isolate the compound (**6**) by hydrogenolysis of the diester (**18**) were frustrated by the observation that hydrogenation of the double bonds in (**18**) occurred at a rate comparable to the rate of hydrogenolysis. The failure to obtain (**6**) by the variety of procedures examined suggests that it is very unstable; thus alternative routes are required for the synthesis of the unsaturated compound (**7**).

From the above results, we conclude that the dibromide (**4**) can be usefully elaborated, in a manner analogous to the dibromides in the bimane series.[1] This synthetic utility is further reinforced in the following paper by the use of carbon nucleophiles leading to the formation of a novel bridged 14π-annulene. The above failure to synthesise the 14π-annulene (**7**) can be explained by the high reactivity of the chosen synthetic intermediate (**6**); at this stage there is no conclusive evidence concerning the potential stability of the 14π-annulenes (**5**) and (**7**).

Experimental

M.p.s were determined in a capillary tube and are uncorrected. I.r. spectra were obtained using a Perkin-Elmer 157 spectrometer. ^1H and ^{13}C N.m.r. spectra were obtained using a Varian XL100 spectrometer. U.v. spectra were obtained for solutions in ethanol using a Perkin-Elmer 402 spectrometer. Mass spectra weere obtained at 70 eV using a Kratos MS30 spectrometer. Thin layer chromatography (t.l.c.) was carried out using Merck Kieselgel 60HF (254 + 366). Flash chromatography was carried out on Macherey Nagel silica gel 60. Elemental analyses were performed at University College, London. Ether refers to diethyl ether.

4,6-Dibromomethyl-5,2,8-ethanylylidene-5H-1,9-benzodiazacycloundecine (**4**).—4,6-Dimethyl-5,2,8-ethanylylidene-5*H*-1,9-benzodiazacycloundecine[2] (**1**) (6.0 g, 24.1 mmol) and *N*-bromosuccinimide (10.3 g, 57.9 mmol) were heated under reflux in carbon tetrachloride (500 ml) for 3 h under nitrogen, while the solution was irradiated with white light (100-W lamp). Succinimide formed during the reaction was filtered off and the solvent was removed under reduced pressure to give a yellow solid. Recrystallisation from ethyl acetate afforded *4,6-dibromomethyl-5,2,8-ethanylylidene-5H-1,9-benzodiazacycloundecine* (**4**) as yellow crystals (6.5 g, 66.3%), m.p. 118—121 °C (decomp.) (Found: C, 49.8; H, 3.5; Br, 39.9; N, 6.9. $C_{17}H_{14}Br_2N_2$ requires C, 50.27; H, 3.47; Br, 39.35; N, 6.90%); *m/z* 404, 406, and 408 (M^+, 1:2:1); τ 2.34 (2 H, m, 10- and 13-H), 2.64 (2 H, m, 11- and 12-H), 3.44 (2 H, s, 3- and 7-H), 5.80 (4 H, s, 4- and 6-CH_2Br), 6.11 (1 H, m, 5-H), 7.84 (2 H, t, *J* 3 Hz, 15-H), and 8.51 (1 H, m, 14-H).

The mother-liquor, obtained after the isolation of (**4**), was purified by flash column chromatography on silica (50% ether–50% ethyl acetate) to give the unstable tribromide (**8**) (3.0 g, 25.6%) which was recrystallised from ethyl acetate to afford bright yellow crystals, m.p. 175—178 °C (decomp.); *m/z* 484 and 486 (M^+); τ 2.40 (2 H, m, 10- and 13-H), 2.70 (2 H, m, 11- and 12-H), 3.30 (1 H, s, 3-H), 3.45 (1 H, s, 7-H), 3.60 (1 H, s, 4-$CHBr_2$), 5.45 (1 H, d, *J* 12 Hz, 6-CH_2Br), 5.90 (1 H, d, *J* 12 Hz, 6-CH_2Br), 6.05 (1 H, m, 5-H), 7.90 (2 H, t, *J* 3 Hz, 15-H), and 8.54 (1 H, m, 14-H).

6,7-Dihydro-6-methyl-2,10,4,8-propane-1,3-diylidene-5H-1,6,11-benzotriazacyclotridecine (**3**).—4,6-Dibromomethyl-5,2,8-ethanylylidene-5*H*-1,9-benzodiazacycloundecine (**4**) (300 mg, 0.74 mmol) was dissolved in ethanol (25 ml). Methylamine (2.22 mmol, 33% aqueous solution; 0.3 ml) was added and the mixture was stirred at room temperature for 15 h under nitrogen. Removal of the solvent under reduced pressure gave a brown oil. This was dissolved in chloroform (100 ml), washed with water (3 × 50 ml), dried ($MgSO_4$), and filtered. Removal of the solvent afforded a brown solid (340 mg). Recrystallisation from ethyl acetate afforded the product (**3**) (106 mg, 52%) as yellow crystals, m.p. 135—137 °C (decomp.), $\nu_{max.}(CHCl_3)$ 1 610 and 1 565 cm^{-1}; *m/z* 275 (M^+, 100%); τ 2.26 (2 H, m, 12- and 15-H), 2.65 (2 H, m, 13- and 14-H), 3.82 (2 H, s, 3- and 9-H), 6.34 (2 H, d, *J* 12 Hz, 5- and 7-H), 6.96 (2 H, d, *J* 12 Hz, 5- and 7-H), 6.43 (1 H, m, 18-H), 8.04 (2 H, t, *J* 3 Hz, 17-H), 8.22 (3 H, s, NMe), and 9.00 (1 H, t, *J* 3 Hz, 16-H); ^{13}C n.m.r. (p.p.m.) 22.26 (C-17), 38.02, 41.32, and 43.32 (C-16, -18, and NMe), 60.58 (C-5 and -7), 119.52 (C-3 and -9), 124.85 (C-13 and -14), 127.99 (C-12 and -15), 139.65 (C-11a and -15a), 142.65 (C-4 and -8), and 143.55 (C-2 and -10).

6-Ethyl-6,7-dihydro-2,10,4,8-propane-1,3-diylidene-5H-1,6,11-benzotriazacyclotridecine (**9**).—4,6-Dibromomethyl-5,2,8-ethanylylidene-5*H*-1,9-benzodiazacycloundecine (**4**) (300 mg, 0.74 mmol) was dissolved in ethanol (50 ml) and ethylamine (0.2 ml, 2.22 mmol) was added. The mixture was stirred at room temperature for 18 h under nitrogen. Removal of the solvent under reduced pressure gave a brown oil which was dissolved in chloroform (100 ml), washed with water (3 × 50 ml), dried ($MgSO_4$), and filtered. Removal of the solvent under reduced pressure afforded a brown oil (280 mg) which was further purified by preparative t.l.c. (ethyl acetate) to give the product (**9**) (180 mg, 84%) as a yellow oil, $\nu_{max.}(CHCl_3)$ 1 610 and 1 565 cm^{-1}; *m/z* 289 (M^+, 100); τ 2.28 (2 H, m, 12- and 15-H), 2.65 (2 H, m, 13- and 14-H), 3.86 (1 H, s, 3- and 9-H), 6.47 (1 H, m, 18-H), 6.44 (2 H, d, *J* 13 Hz, 5- and 7-H), 6.82 (2 H, d, *J* 13 Hz, 5- and 7-H), 8.08 (2 H, t, *J* 3 Hz, 17-H), 8.20 (2 H, q, *J* 6 Hz, NCH_2Me), 9.06 (1 H, m, 16-H), and 9.14 (3 H, t, *J* 6 Hz, NCH_2Me); ^{13}C n.m.r. (p.p.m.) 13.17 (NCH_2Me), 22.12 (C-17), 38.01 (C-16), 43.84 (C-18), 46.62 (NCH_2Me), 57.95 (C-5 and -7), 118.94 (C-3 and -9), 124.78 (C-13 and -14), 127.93 (C-12 and -15), 139.57 (C-11a and -15a), 142.65 (C-4 and -8), and 143.96 (C-2 and -10).

6,7-Dihydro-2,10,4,8-propane-1,3-diylidene-6-t-butyl-5H-1,6,11-benzotriazacyclotridecine (**10**).—4,6-Dibromomethyl-5,2,8-ethanylylidene-5*H*-1,9-benzodiazacycloundecine (**4**) (200 mg, 0.49 mmol) was dissolved in ethanol (25 ml) and to this solution t-butylamine (108 mg, 1.47 mmol) was added. The resulting solution was stirred at room temperature for 24 h under nitrogen. Removal of the solvent under reduced pressure gave a brown oil. This was dissolved in chloroform (75 ml), washed with water (3 × 50 ml), dried ($MgSO_4$), and filtered. Removal of the solvent under reduced pressure afforded a brown solid. Recrystallisation from ethyl acetate gave the *product* (**10**) (65 mg, 41%) as yellow crystals, m.p. 177—180 °C (decomp.) (Found: C, 79.0; H, 7.3; N, 13.2. $C_{21}H_{23}N_3$ requires

C, 79.46; H, 7.30; N, 13.24%); $\nu_{max.}$($CHCl_3$) 1 610 and 1 560 cm^{-1}; $\lambda_{max.}$ 249 (ε 55 470), 257 (63 400), 295 (15 850), and 390 nm (6 340); τ 2.22 (2 H, m, 12- and 15-H), 2.64 (2 H, m, 13- and 14-H), 3.72 (2 H, s, 3- and 9-H), 6.48 (1 H, m, 18-H), 6.44 (2 H, d, *J* 11 Hz, 5- and 7-H), 6.61 (2 H, d, *J* 11 Hz, 5- and 7-H), 8.11 (2 H, t, *J* 3 Hz, 17-H), 8.85 (9 H, s, C*Me*$_3$), and 9.23 (1 H, t, *J* 3 Hz, 16-H); ^{13}C n.m.r. (p.p.m.) 21.54 (C-17), 26.40 (C*Me*$_3$), 38.00 (C-16), 41.57 (C-18), 51.72 (C-5 and -7), 55.40 (*C*Me$_3$), 120.30 (C-3 and -9), 124.65 (C-13 and -14), 128.02 (C-12 and -15), 139.12 (C-11a and 15a), 142.35 (C-4 and -8), and 143.54 (C-2 and -10).

6,7-*Dihydro*-6-*phenyl*-2,10,4,8-*propane*-1,3-*diylidene*-5H-1,6,11-*benzotriazacyclotridecine* (**11**).—4,6-Dibromomethyl-5,2,8-ethanylylidene-5*H*-1,9-benzodiazacycloundecine (**4**) (600 mg, 1.48 mmol) was dissolved in ethanol (50 ml). Aniline (145 mg, 1.56 mmol) and triethylamine (324 mg, 3.15 mmol) were added and the resulting solution was heated under reflux for 30 min under nitrogen. Removal of the solvent under reduced pressure gave a dark brown oil. This was dissolved in chloroform (100 ml), washed with water (3 × 50 ml), dried ($MgSO_4$), and filtered. Removal of the solvent under reduced pressure afforded a brown oil which crystallised on addition of ethyl acetate to give the product (**11**) (215 mg, 43%) as bright yellow crystals, m.p. 175—178 °C (decomp.), $\nu_{max.}$($CHCl_3$) 1 600, 1 565, and 1 505 cm^{-1}; *m/z* 337 (M^+, 62%); τ 2.23 (2 H, m, 12- and 15-H), 2.65 (2 H, m, 13- and 14-H), 2.70—3.30 (5 H, m, remaining aromatic protons), 3.68 (2 H, s, 3- and 9-H), 5.60 (2 H, d, *J* 12 Hz, 5- and 7-H), 6.16 (2 H, d, *J* 12 Hz, 5- and 7-H), 6.34 (1 H, t, *J* 3 Hz, 18-H), 8.08 (2 H, t, *J* 3 Hz, 17-H), and 9.20 (1 H, t, *J* 3 Hz, 16-H); ^{13}C n.m.r.* (p.p.m.) 21.17 (C-17), 38.26 (C-16), 39.02 (C-18), 53.22 (C-5 and -7), 112.77 (C-b and -f), 118.34 (C-d), 120.38 (C-3 and -9), 125.01 (C-13 and -14), 127.98 (C-12 and -15), 129.42 (C-c and -e), 139.01 (C-11a and -15a), 139.27 (C-4 and -8), 142.99 (C-2 and -10), and 148.51 (C-a).

6,7-*Dihydro*-6-(4-*methoxyphenyl*)-2,10,4,8-*propane*-1,3-*diylidene*-5H-1,6,11-*benzotriazacyclotridecine* (**12**).—4,6-Dibromomethyl-5,2,8-ethanylylidene-5*H*-1,9-benzodiazacycloundecine (**4**) (700 mg, 1.72 mmol) was dissolved in ethanol (50 ml) and triethylamine (385 mg, 3.74 mmol) and *p*-anisidine (255 mg, 2.03 mmol) were added. The resulting solution was heated under reflux for 15 min under nitrogen. The crude oil obtained after the removal of the solvent was dissolved in chloroform (100 ml), washed with water (3 × 50 ml), dried ($MgSO_4$), and filtered. Removal of the solvent under reduced pressure afforded a brown solid (660 mg). Recrystallisation from ethyl acetate gave the product (**12**) (408 mg, 64%) as yellow crystals, m.p. 170—171 °C (decomp.); $\nu_{max.}$($CHCl_3$) 1 610, 1 560, and 1 510 cm^{-1}; *m/z* 367 (M^+, 100%); τ 2.22 (2 H, m, 12- and 15-H), 2.63 (2 H, m, 13- and 14-H), 3.10—3.32 (4 H, m, remaining aromatic protons), 3.66 (2 H, s, 3- and 9-H), 5.71 (2 H, d, *J* 12 Hz, 5- and 7-H), 6.16 (2 H, d, *J* 12 Hz, 5- and 7-H), 6.26 (1 H, m, 18-H), 6.26 (3 H, s, O*Me*), 8.02 (2 H, t, *J* 3 Hz, 17-H), and 9.18 (1 H, t, *J* 3 Hz, 16-H); ^{13}C n.m.r.* (p.p.m.) 21.36 (C-17), 38.22 (C-16), 39.76 (C-18), 54.47 (C-5 and -7), 55.70 (OMe), 114.86 and 115.05 (C-b and -f; C-c and -e), 120.43 (C-3 and -9), 124.99 (C-13 and -14), 128.03 (C-12 and -15), 139.07 (c-11a and -15a), 140.05 (C-4 and -8), 143.19 (C-2 and -10), and 152.98 (C-a).

6-*Benzyl*-6,7-*dihydro*-2,10,4,8-*propane*-1,3-*diylidene*-5H-1,6,11-*benzotriazacyclotridecine* (**13**).—4,6-Dibromomethyl-5,2,8-ethanylylidene-5*H*-1,9-benzodiazacycloundecine (**4**) (400 mg, 0.99 mmol) was dissolved in ethanol (30 ml) and benzylamine (120 mg, 1.12 mmol) and triethylamine (220 mg, 2.13 mmol) were added. The resulting solution was stirred at room temperature for 20 h under nitrogen. The crude oil obtained after the removal of the solvent was dissolved in chloroform (100 ml). This solution was washed with water (3 × 50 ml), dried ($MgSO_4$), and filtered. Removal of the solvent under reduced pressure afforded a brown oil. Preparative t.l.c. (95% ether–5% ethyl acetate) afforded the product (**13**) (250 mg, 72%) as a yellow oil, $\nu_{max.}$($CHCl_3$) 1 627, 1 603, 1 563, and 1 500 cm^{-1}; *m/z* 351 (M^+, 100%); τ 2.23 (2 H, m, 12- and 15-H), 2.66 (2 H, m, 13- and 14-H), 2.74—3.00 (5 H, m, remaining aromatic protons), 3.83 (2 H, s, 3- and 9-H), 6.40 (1 H, m, 18-H), 6.33 (2 H, d, *J* 12 Hz, 5- and 7-H), 6.90 (2 H, d, *J* 12 Hz, 5- and 7-H), 7.18 (2 H, s, benzylic protons), 8.06 (2 H, t, *J* 3 Hz, 17-H), and 8.98 (1 H, t, *J* 3 Hz, 16-H); ^{13}C n.m.r.* (p.p.m.) 22.22 (C-17), 38.12 (C-16), 43.94 (C-18), 56.70, 57.90 (C-5, -7, and $-CH_2-$), 118.94 (C-3 and -9), 124.90 (C-13 and -14), 127.29 (C-12 and -15), 127.94 (C-d), 128.38 (C-c and -e), 129.07 (C-b and -f), 138.02 (C-a), 139.76 (C-11a and -15a), 142.83 (C-4 and -8), and 144.63 (C-2 and -10).

Methyl 6,7-*Dihydro*-2,10,4,8-*propane*-1,3-*diylidene*-5H-1,6,11-*benzotriazacyclotridecine*-6-*ylacetate* (**14**).—Glycine methyl ester hydrochloride (1.64 g, 13 mmol) was suspended in methylene dichloride (20 ml) and triethylamine (1.64 g, 18 mmol) was added. The resultant suspension was stirred at room temperature for 30 min and anhydrous ether (20 ml) was then added. The resultant suspension was stirred for a further 30 min. Filtration and evaporation of the solvent (bath temperature 25 °C) gave a white solid. This was dissolved in ethanol (50 ml) and to this stirred solution was added a solution of 4,6-dibromomethyl-5,2,8-ethanylylidene-5*H*-1,9-benzodiazacycloundecine (**4**) (500 mg, 1.23 mmol) in ethanol (20 ml). The resulting solution was stirred at room temperature for 20 h under nitrogen. Removal of the solvent under reduced pressure afforded a brown oil which was dissolved in chloroform (150 ml), washed with water (3 × 100 ml), dried ($MgSO_4$), and filtered. Removal of the solvent under reduced pressure gave an orange oil (360 mg) which was further purified by preparative t.l.c. (90% ethyl acetate–10% methanol) to afford the product (**14**) (220 mg, 54%) as a yellow oil; $\nu_{max.}$($CHCl_3$) 1 740, 1 610, and 1 560 cm^{-1}; *m/z* 333 (M^+, 100%); τ 2.28 (2 H, m, 12- and 15-H), 2.68 (2 H, m, 13- and 14-H), 3.84 (2 H, s, 3- and 9-H), 6.40 (1 H, m, 18-H), 6.40 (3 H, s, CO_2Me), 6.15 (2 H, d, *J* 12 Hz, 5- and 7-H), 6.82 (2 H, d, *J* 12 Hz, 5- and 7-H), 7.42 (2 H, s, NCH_2), 8.08 (2 H, t, *J* 3 Hz, 17-H), and 9.03 (1 H, t, *J* 3 Hz, 16-H); ^{13}C n.m.r. (p.p.m.) 22.07 (C-17), 38.01 (C-16), 43.19 (C-18), 51.69 (NCH_2), 53.67 (CO_2Me), 58.65 (C-5 and -7), 119.34 (C-3 and -9), 124.95 (C-13 and -14), 127.93 (C-12 and -15), 139.56 (C-11a and -15a), 142.94 (C-4 and -8), 143.64 (C-2 and -10), and 170.67 (*C*O_2Me).

Reaction of 4,6-*Dibromomethyl*-5,2,8-*ethanylylidene*-5H-1,9-*benzodiazacycloundecine* (**4**) *with Piperidine*.—4,6-Dibromomethyl-5,2,8-ethanylylidene-5*H*-benzodiazacycloundecine (**4**) (500 mg, 1.23 mmol) was dissolved in ethanol (50 ml), and piperidine (115 mg, 1.35 mmol) and triethylamine (125 mg, 1.21 mmol) were added. The resulting solution was heated under reflux for 1 h under nitrogen. Removal of the solvent under high vacuum gave a yellow solid (620 mg). Recrystallisation from ethanol–water (3:2) afforded the quaternary salt (**15**) (380 mg, 75%) as golden yellow crystals, m.p. 190—200 °C (decomp.); *m/z* 331 (21) and 330 (9%); τ 2.21 (2 H, m, 12- and 15-H), 2.48 (2 H, m, 13- and 14-H), 3.35 (2 H, s, 3- and 9-H), 5.29 (2 H, d, *J* 12 Hz, 5- and 7-H), 5.53 (2 H, d, *J* 12 Hz, 5- and 7-H), 5.82 (1 H, t, *J* 3 Hz, 18-H), 6.20 (2 H, t, *J* 6 Hz, a-H), 7.69 (2 H, br, s, e-H), 7.94 (2 H, t, *J* 3 Hz, 17-H), 8.05 (2 H, br s, c-H), 8.36 (4 H, br s, b- and d-H), and 8.98 (1 H, t, *J* 3 Hz, 16-H); ^{13}C n.m.r. (p.p.m.) 20.72, 21.34, 22.10, 38.96 (C-16), 42.18 (C-18), 55.72, 65.36, 66.12,

* In the n.m.r. assignments of compounds (**11**)—(**13**) the carbon atoms of the 6-phenyl substituent are labelled C-a—f (positions 1—6, respectively).

126.70 (C-3 and -9), 127.19 (C-13 and -14), 128.81 (C-12 and -15), 132.55 (C-11a and -15a), 140.01 (C-4 and -8), and 143.99 (C-2 and -10).

Dimethyl 5,6,7,8-Tetrahydro-2,11,4,9-propane-1,3-diylidene-1,6,7,12-benzotetra-azacyclotetradecine-6,7-dicarboxylate (**16**). —To a stirred solution of 4,6-dibromomethyl-5,2,8-ethanylylidene-5*H*-1,9-benzodiazacycloundecine (**4**) (2.0 g, 4.9 mmol) in dry tetrahydrofuran (100 ml) containing sodium hydride (0.5 g, 21 mmol) was added dropwise a solution of dimethyl hydrazodicarboxylate (0.84 g, 5.6 mmol) in dry tetrahydrofuran (10 ml). The resulting suspension was stirred for 14 h under nitrogen at room temperature. Excess of sodium hydride was removed by filtering the solution under suction and the solvent was removed under reduced pressure. The product obtained was then dissolved in chloroform (100 ml), washed with water (3 × 100 ml), dried ($MgSO_4$), and filtered. Evaporation of the solvent under reduced pressure gave a crude solid (2.35 g) which on recrystallisation from ethyl acetate afforded pale yellow crystals of *dimethyl 5,6,7,8-tetrahydro-2,11,4,9-propane-1,3-diylidene-1,6,7,12-benzotetra-azacyclotetradecine-6,7-dicarboxylate* (**16**) (1.3 g, 67%), m.p. 202—204 °C (decomp.) (Found: C, 63.7; H, 5.1; N, 14.1. $C_{21}H_{20}N_4O_4$ requires C, 64.27; H, 5.13; N, 14.27%); $\nu_{max.}$($CHCl_3$) 1 718, 1 623, and 1 573 cm^{-1}; *m/z* 392 (M^+, 50%); τ 2.33 (2 H, m, 13- and 16-H), 2.64 (2 H, m, 14- and 15-H), 3.68 (2 H, m, 3- and 10-H), 4.60—6.10 (4 H, m, complex, 5-and 8-H), 6.16, 6.18, 6.40, 6.44 (6 H, 4 s, CO_2Me), 6.46 (1 H, m, 19-H), 7.92 (2 H, m, 18-H), and 6.84 (1 H, m, 17-H).

Di-t-butyl 5,6,7,8-Tetrahydro-2,11,4,9-propane-1,3-diylidene-1,6,7,12-benzotetra-azacyclotetradecine-6,7-dicarboxylate (**17**).—To a stirred solution of 4,6-dibromomethyl-5,2,8-ethanylylidene-5*H*-1,9-benzodiazacycloundecine (**4**) (2.0 g, 4.9 mmol) in dry tetrahydrofuran (100 ml) containing sodium hydride (0.41 g, 17 mmol) was added dropwise a solution of di-t-butyl hydrazodicarboxylate (1.3 g, 5.6 mmol) in dry tetrahydrofuran (10 ml). The resulting suspension was stirred for 10 min under nitrogen at room temperature. Excess of sodium hydride was removed by filtering the solution under suction and the solvent was removed under reduced pressure. The product obtained was then dissolved in chloroform (100 ml), washed with water (3 × 100 ml), dried ($MgSO_4$), and filtered. Evaporation of the solvent under reduced pressure gave a crude brown oil. Filtration flash column chromatography (ether) afforded a yellow oil which crystallised on addition of ethyl acetate to give yellow crystals of the *product* (**17**) (1.8 g, 78%), m.p. 185—189 °C (decomp.) (Found: C, 67.7; H, 6.7; N, 11.7. $C_{27}H_{32}N_4O_4$ requires C, 68.04; H, 6.77; N, 11.76%); $\nu_{max.}$($CHCl_3$) 1 710, 1 625, 1 575, and 1 515 cm^{-1}; *m/z* 476 (M^+, 2%); τ 2.30 (2 H, m, 13- and 16-H), 2.64 (2 H, m, 14-and 15-H), 3.68 (2 H, m, 3- and 10-H), 4.60—6.30 (4 H, complex, 5- and 8-H), 6.45 (1 H, m, 19-H), 7.91 (2 H, m, 18-H), and 8.20—9.00 (19 H, complex, 17-H and Me).

Dibenzyl Hydrazodicarboxylate.—Benzyl chloroformate (15.0 g, 88 mmol) was added dropwise to a solution of hydrazine hydrate (2.0 g, 40 mmol) in methanol (200 ml) while the temperature was kept below 10 °C. During the addition of the last half of the benzyl chloroformate, a solution of sodium carbonate (9.3 g, 88 mmol) in water (150 ml) was added dropwise. The resulting slurry was stirred for 30 min and the precipitate was filtered off under suction, washed with ice–water (50 ml), and air-dried. The filtrate was concentrated under reduced pressure and then cooled in ice. The resultant precipitate was filtered off, washed with ice–water (50 ml), and air-dried. The combined crops of crude crystals were dried at 60 °C in a vacuum oven. Recrystallisation from toluene afforded white crystals of dibenzyl hydrazodicarboxylate (8.56 g, 71%), m.p. 102—103 °C (lit.,[8] m.p. 105.5—106 °C); *m/z* 300 (M^+), τ 2.10 (2 H, br s, NH), 2.70 (10 H, aromatic protons), and 4.90 (4 H, s, CH_2Ph).

Dibenzyl 5,6,7,8-Tetrahydro-2,11,4,9-propane-1,3-diylidene-1,6,7,12-benzotetra-azacyclotetradecine-6,7-dicarboxylate (**18**). —To a stirred solution of 4,6-dibromomethyl-5,2,8-ethanylylidene-5*H*-1,9-benzodiazacycloundecine (**4**) (2.0 g, 4.9 mmol) in dry tetrahydrofuran (100 ml) containing sodium hydride (0.41 g, 17 mmol) was added dropwise a solution of dibenzyl hydrazodicarboxylate (1.7 g, 5.7 mmol) in dry tetrahydrofuran (10 ml). The resulting suspension was stirred for 45 min under nitrogen at room temperature. Excess of sodium hydride was removed by filtering the solution under suction and the solvent was removed under reduced pressure. The product obtained was then dissolved in chloroform (100 ml), washed with water (3 × 100 ml), dried ($MgSO_4$), and filtered. Evaporation of the solvent under reduced pressure gave a crude brown oil (2.1 g). Filtration flash column chromatography (ether) afforded a yellow oil which crystallised on addition of ethyl acetate to give yellow crystals of the *diester* (**18**) (1.5 g, 56.5%), m.p. 162—163 °C (decomp.) (Found: C, 72.7; H, 5.2; N, 10.3. $C_{33}H_{28}N_4O_4$ requires C, 72.78; H, 5.18; N, 10.29%); $\nu_{max.}$($CHCl_3$) 1 720, 1 630, 1 580, and 1 510 cm^{-1}; *m/z* 544 (M^+); τ 2.20—3.20 (14 H, m, 13-, 14-, 15-, 16-H and remaining aromatic protons), 3.72 (2 H, m, 3- and 10-H), 4.60—6.20 (8 H, complex, 5- and 8-H and CH_2Ph), 6.50 (1 H, m, 19-H), 7.94 (2 H, t, *J* 3 Hz, 18-H), and 8.66 (1 H, m, 17-H).

5,6,7,8-Tetrahydro-6,7-dimethyl-2,11,4,9-propane-1,3-diyl idene-1,6,7,12-benzotetra-azacyclotetradecine (**19**).—To a stirred solution of 4,6-dibromomethyl-5,2,8-ethanylylidene-5*H*-1,9-benzodiazacycloundecine (**4**) (100 mg, 0.25 mmol) in ethanol (30 ml), *sym*-dimethylhydrazine dihydrochloride (156 mg, 1.2 mmol) was added dropwise. The solution turned orange. To this stirred solution, potassium carbonate (390 mg, 2.8 mmol) dissolved in water (5 ml) was added and the solution turned to the original yellow colour. The resulting solution was then heated under reflux for 3 h. Removal of the solvent under reduced pressure afforded a brown oil. This oil was dissolved in chloroform (50 ml), washed with water (3 × 50 ml), dried ($MgSO_4$), and filtered. Removal of the solvent under reduced pressure afforded a yellow oil (100 mg). Preparative t.l.c. (ethyl acetate) afforded the *product* (**19**) (50 mg, 67%) as an unstable yellow oil; *m/z* 304.1679 (M^+) ($C_{19}H_{20}N_4$ requires 304.1688); τ(CD_2Cl_2) 2.36 (2 H, m, 13- and 16-H), 2.68 (2 H, m, 14- and 15-H), 3.87 (2 H, m, 3- and 10-H), 6.02 (1 H, m, 19-H), 5.60—7.20 (4 H, complex 5- and 8-H), 7.45, 8.00, 8.22 (6 H, 3 s, Me), 8.00 (2 H, t, *J* 3 Hz, 18-H), and 8.80 (1 H, m, 17-H) (see Figure).

6,7-Dibenzoyl-5,6,7,8-tetrahydro-2,11,4,9-propane-1,3-diylidene-1,6,7,12-benzotetra-azacyclotetradecine (**21**).—To a stirred solution of 4,6-dibromomethyl-5,2,8-ethanylidene-5*H*-1,9-benzodiazacycloundecine (**4**) (2.0 g, 4.9 mmol) in dry tetrahydrofuran (125 ml) containing sodium hydride (1.13 g, 47 mmol) was added dropwise a solution of *sym*-dibenzoylhydrazine (1.81 g, 7.8 mmol) in dry tetrahydrofuran (15 ml). The resulting suspension was heated under reflux for 15 h under nitrogen. Excess of sodium hydride was removed by filtering the solution under suction and the solvent was removed under reduced pressure to obtain an oil. This was dissolved in chloroform (150 ml), washed with water (3 × 100 ml), dried ($MgSO_4$), and filtered. Removal of the solvent under reduced pressure gave a dark brown oil (2.5 g). Filtration flash column chromatography (50% ether–50% ethyl acetate) afforded a solid. Recrystallisation from ethyl acetate gave the *product* (**21**) (1.1 g, 46%) as yellow crystals, m.p. 187—190 °C (decomp.) (Found: C, 76.4; H, 4.9; N, 11.8. $C_{31}H_{24}N_4O_2$ requires C, 76.8;

H, 5.0; N, 11.6%); $\nu_{max.}$(CHCl$_3$) 1 680, 1 630, and 1 580 cm^{-1}; *m/z* 484 (M^+, 8%); τ 2.0—3.20 (14 H, m, 13-, 14-, 15-, 16-H) and remaining aromatic protons), 3.48 (2 H, m, 3- and 10-H), 3.60—6.60 (4 H, complex, 5- and 8-H), 6.36 (1 H, m, 19-H), 7.92 (2 H, m, 18-H), and 8.66 (1 H, m, 17-H).

Reaction of the Tribromide (**8**) *with t-Butylamine.*—(*a*) The tribromide (**8**) (365 mg, 0.75 mmol) and t-butylamine (330 mg, 4.5 mmol) were stirred in ethanol for 20 h at room temperature under nitrogen. The solvent was removed under reduced pressure and the resulting product was dissolved in chloroform (50 ml), washed with water (2 × 50 ml), dried ($MgSO_4$), and filtered. Rotary evaporation of the solvent gave a yellow oil (285 mg) which eventually crystallised on addition of ethyl acetate to afford unstable yellow crystals of 4-t-butylaminomethyl-6-t-butyliminomethyl-5,2,8-ethanylidene-5*H*-1,9-benzodiazacycloundecine (**25**), m.p. 178—180 °C (decomp.); $\nu_{max.}$(Nujol) 1 640 and 1 580 cm^{-1}; *m/z* 388 (M^+, 2%), 331 ($M - C_4H_9$, 100), and 275 (72); τ 1.78 (1 H, s, 6-C=NH), 2.30 (2 H, m, 10- and 13-H), 2.52 (2 H, m, 11- and 12-H), 3.18 (1 H, s, 7-H), 3.43 (1 H, s, 3-H), 5.72 (1 H, m, 5-H), 5.76, 6.12 (2 H, d, *J* 16 Hz, 4-CH_2N), 7.80 (2 H, m, 15-H), 8.33 (1 H, m, 14-H), 8.50 (9 H, s 3 Me), and 8.64 (9 H, s, 3 Me).

(*b*) The tribromide (**8**) (588 mg, 1.2 mmol), t-butylamine (90 mg, 1.2 mmol), and di-isopropylethylamine (328 mg, 2.52 mmol) were stirred in ethanol at room temperature for 5 h under nitrogen. No reaction was observed (monitored by t.l.c.). Then the contents of the flask were heated under reflux for 30 min and the solution turned dark brown. The solvent was removed under reduced pressure to give a brown oil. This was dissolved in chloroform (50 ml), washed with water (3 × 50 ml), dried ($MgSO_4$), and filtered. Rotary evaporation of the solvent afforded a dark brown oil. The ^{1}H n.m.r. spectrum of this oil suggested the formation of only polymeric products.

4,6-*Diformyl*-5,2,8-*ethanylylidene*-5H-1,9-*benzodiazacycloundecine* (**28**).—4-t-Butylaminomethyl-6-t-butyliminomethyl-5,2,8-ethanylylidene-5*H*-1,9-benzodiazacycloundecine (**25**) (200 mg) and freshly prepared manganese dioxide (300 mg) were heated under reflux in dry methylene dichloride for 15 h. Filtration and removal of the solvent under reduced pressure afforded a yellow oil (190 mg). This oil was vigorously stirred with methylene dichloride (25 ml) and water (10 ml) containing dilute hydrochloric acid (1 ml) for 2 h. The organic layer was washed with water (2 × 50 ml), dried ($MgSO_4$), and filtered. Removal of the solvent under reduced pressure afforded a yellow solid (138 mg). Recrystallisation [ethyl acetate–chloroform (1:1)] gave 4,6-*diformyl*-5,2,8-*ethanylidene*-5H-1,9-*benzodiazacycloundecine* (**28**), m.p. 227—229 °C (Found: C, 73.8; H, 4.4; N, 10.0. $C_{17}H_{12}N_2O_2$ requires C, 73.9; H, 4.39; N, 10.14%); $\nu_{max.}$ 1 695 cm^{-1}; τ 0.35 (2 H, s, CHO), 2.0—2.6 (4 H), 2.87 (2 H, s), 5.40 (1 H, t), 7.86 (1 H, t), and 8.39 (2 H, t).

Reaction of 4,6-*Dibromomethyl*-5,2,8-*ethanylylidene*-5H-1,9-*benzodiazacycloundecine* (**4**) *with Hydrazine.*—4,6-Dibromomethyl-5,2,8-ethanylylidene-5*H*-1,9-benzodiazacycloundecine (**4**) (100 mg, 0.25 mmol) was dissolved in ethanol (25 ml). Hydrazine hydrate (13.5 mg, 0.28 mmol) and triethylamine (50 mg, 0.5 mmol) were added and the mixture was stirred at room temperature under nitrogen for 18 h. Analytical t.l.c. showed that the total consumption of the starting material had occurred, and formation of a yellow solid was observed. This was filtered off and the solvent from the filtrate was removed under reduced pressure to give a yellow solid. The combined crops of the two solids were dissolved in chloroform (25 ml), washed with water (2 × 25 ml), dried ($MgSO_4$), and filtered. Removal of the solvent under reduced pressure afforded a yellow solid (60 mg). This solid on attempted t.l.c. failed to migrate and was shown by n.m.r. to have a complex structure (probably polymeric).

Attempted Alkaline Hydrolysis of Compound (**16**).—The diester (**16**) (100 mg, 0.25 mmol) was dissolved in ethanol (15 ml), and potassium hydroxide (37 mg, 0.65 mmol) was added. The mixture was stirred at reflux under nitrogen for 2 h and the solution turned dark brown. Removal of the solvent under reduced pressure afforded a brown oil (68 mg). This was found to be mainly polymeric material with some unchanged starting material (by n.m.r.).

Attempted Acid Hydrolysis of the Di-t-butyl Diester (**17**).—The diester (**17**) (100 mg) was dissolved in methylene dichloride (2 ml) and at 0 °C trifluroacetic acid (2 ml) was added. After 3 h at 0 °C, work-up afforded a green residue from which the diester (**17**) was absent (t.l.c.). Addition to the residue of selenium dioxide (50 mg) in methylene dichloride (7 ml) containing t-butyl hydroperoxide (0.1 ml) and work-up after 15 h at room temperature afforded a fraction (10 mg) tentatively considered to be the ester (**29**), *m/z* 370 (M^+, 8%) and, as a more polar fraction, the dialdehyde (**28**) (23 mg).

Hydrogenation of the Dibenzyl Diester (**18**).—Hydrogenation of compound (**18**) in methanol over palladium-on-charcoal (10%) at 1 atm, work-up, and preparative t.l.c. (10% ether–90% ethyl acetate) afforded unchanged (**18**) (70 mg), a fraction (24 mg) which was tentatively assigned to be a reduction product of (**18**); *m/z* 546 (M^+, 24.5%), the monoester (**30**) (40 mg) as an oil, $\nu_{max.}$(CHCl$_3$) 3 340, 1 700, 1 620, 1 575, and 1 500 cm^{-1}; *m/z* 410 (M^+, 14%); τ 2.2—3.0 (9 H, complex), 3.75 (2 H, m), 4.90 (2 H, s), 5.10—6.40 (5 H, complex), 7.95 (2 H, m), and 8.70 (1 H, m), and a minor fraction (13 mg), *m/z* 412 (M^+, 19%), considered to be a reduction product of benzyl 5,6,7,8-tetrahydro-2,11,4,9-propane-1,3-diylidene-1,6,7,12-benzotetra-azacyclotetradecine-6-carboxylate (**30**).

Attempted Hydrolysis of Compound (**18**).—The diester (**18**) was stirred in 45% hydrobromic acid in acetic acid at 10 °C for 30 min and on work-up afforded a green residue. Subsequent preparative t.l.c. afforded only the diester (**18**) and the more polar compound (**30**).

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