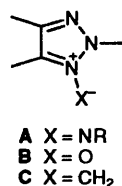


Generation and trapping of a 1,2,3-Triazolium 1-Unsubstituted Methanide. A Carbon Analogue of the Azole *N*-Oxide: Routes to Pyrrolo[1,2-*c*][1,2,3]triazoles and Substituted 1-Aminopyrroles

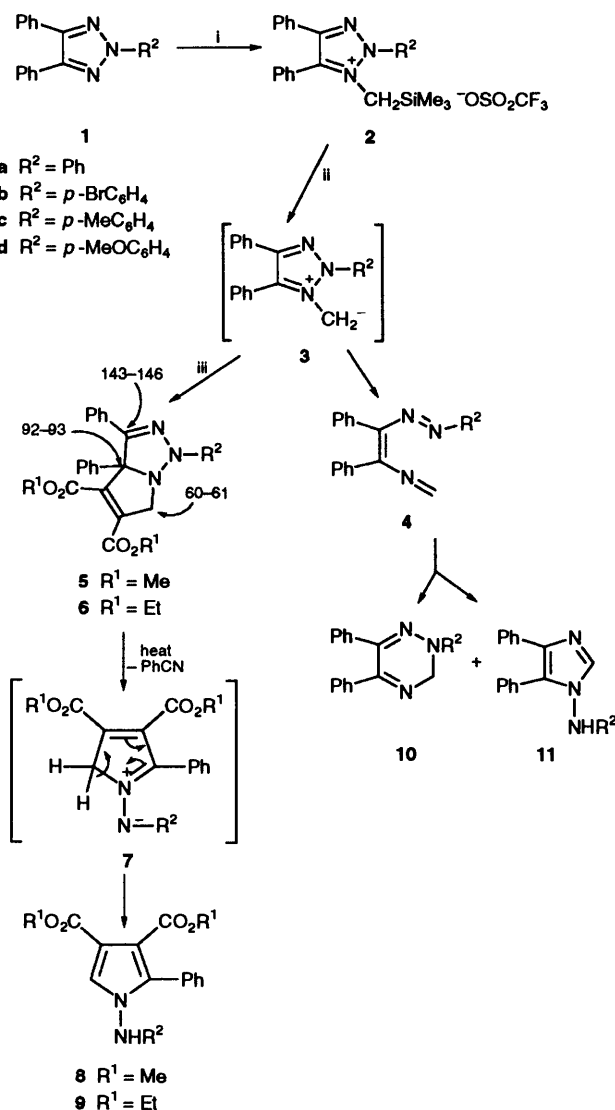
Richard N. Butler,* Peter D. McDonald, P. McArdle and D. Cunningham
Chemistry Department, University College Galway, Ireland

Trapping of the first azole *N*-unsubstituted methanide species, a carbon analogue of the ubiquitous azole *N*-oxide system is described; new synthetic routes to pyrrolo[1,2-*c*][1,2,3]triazoles and 1-aminopyrroles have resulted.

The wide synthetic scope of the cycloaddition–rearrangement reactions of 1,2,3-triazolium-1-aminide and -1-oxide systems **A**^{1,2} and **B**^{3,4} prompted a search for the analogous triazolium methanide species **C**. Despite the ubiquitous nature of the general azole *N*-oxide structure of type **B**, the unsubstituted carbon analogue **C** is unknown among the azoles, but systems containing two stabilising electron withdrawing groups, C=O or C≡N, bonded to the C⁻ atom are known^{5–9} among the lower azoles. Previous attempts to trap the species **C** from the likely precursor **2** gave **10** and **11** *via* electrocyclisations in the intermediate **4**.¹⁰ A key observation proved to be the high lability of the Me₃Si group of **2** when it was found that **10** and **11** were appearing during the alkylation before the isolation of **3**, the first full carbon analogue of an azole *N*-oxide. It provides a synthetic route to the pyrrolo[1,2-*c*][1,2,3]triazole ring systems **5** and **6** and through these a new route to substituted 1-aminopyrroles **8** and **9** has been opened.



After the alkylation of the 1,2,3-triazoles **1** in trimethylsilyl-methyl trifluoromethanesulfonate at 100 °C for 5 h, the system was cooled and, without isolation of the alkyl product **2** mol of dialkyl acetylenedicarboxylate in dichloromethane was introduced followed by CsF, using a literature^{11,12} procedure, and the mixture stirred at ambient temperature for *ca.* 8 h. After removal of salts, chromatographic separation of the products on a silica gel 60 column (270–400 mesh ASTM) with gradient mixtures of light petroleum (b.p. 40–60 °C)–dichloromethane gave the products **5** or **6** and **10** and **11** (Table 1). Compounds **5** and **6** arise from a direct trapping of the species **3** while **10** and **11** are formed *via* electrocyclisations in **4** from the rapid ring-opening of the triazolium methanide **3** which cannot be completely avoided. If the dipolarophile is added too late or if no dipolarophile is added the products **10** and **11** only are obtained. This is the first example where the fused 5,5-cycloadduct from any azolium ylide type 1,3-dipole did not rearrange or fragment *in situ*. Since the adducts **5** and **6** had been expected to rearrange *in situ* their thermal behaviour in toluene was examined. Heating resulted in extrusion of benzonitrile followed by a rapid 1,3-H migration in **7** giving the 1-aminopyrroles **8** and **9** in 85–90% yields (Table 1) thus providing a new route to 1-aminopyrroles. The intermediate



Scheme 1 Some ¹³C shift ranges shown. Reagents: i, trimethylsilyl-methyl trifluoromethanesulfonate; ii, CsF; iii, dialkyl acetylenedicarboxylate

1,3-dipole **7** was shortlived and was not trapped in cycloaddition reactions with alkyne dipolarophiles. The structures of the products **5**, **6**, **8** and **9** were supported by microanalyses, IR, ¹H and ¹³C NMR spectra which showed all of the expected signals. The assignments were further supported by X-ray

Table 1 Products

Compound	M.p. ^a (T/°C)	Yield (%)	10 Yield (%)	11 Yield (%)	Compound	M.p. ^c (T/°C)	Yield (%)
5a	129–130	50	23.5	8.5	8a	158–160	87
5b	142–144	49.5	25	7.5	8b	191–193	89
5c	171–173	52.5	21	7.5	8c	177–178	92
5d	154–156	47.5	22.5	8	8d	152–154	91
6a	123–125	40 ^b	9.5	4	9a	137–139	93
6b	108–110	39.5 ^b	17	4	9b	124–126	92
6c	126–128	34 ^b	17.5	5	9c	118–120	87
6d	124–125	36 ^b	16	5	9d	122–124	76

^a From pentane. ^b Low yields (1–3%) of another product, which appears to be isomeric with 6, were also encountered but the structure could not be characterised to date. ^c From ethanol.

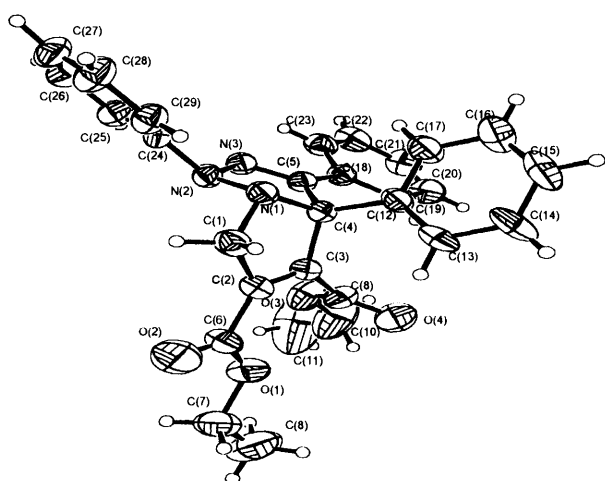


Fig. 1 X-Ray crystal structure of 6a

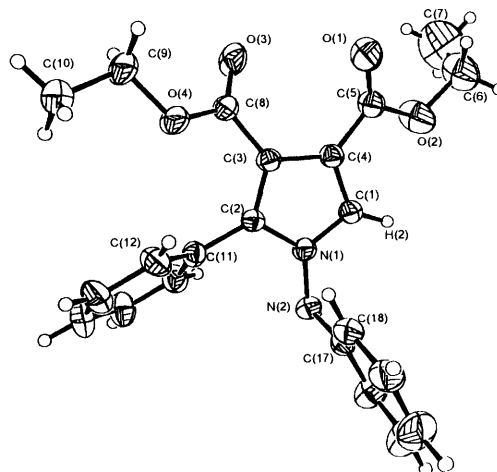


Fig. 2 X-ray crystal structure of 9a

crystal structure determinations for compounds 6a and 9a, Figs. 1 and 2.*

Experimental

The products 5–6 and 8–9 were prepared by the following typical procedures.

Preparation of Pyrrolo[1,2-c][1,2,3]triazole 5a.—A solution of 1a (0.50 g, 1.68 mmol) in trimethylsilylmethyl trifluoro-

* Crystal data for 6a, C₂₂H₂₂N₂O₄. Monoclinic, *a* = 8.706(2), *b* = 13.191(2), *c* = 17.818(2) Å, α = 90, β = 100.88, γ = 90.07°, *Z* = 4, space group *P*2₁/*n*, 6949 reflections observed with *I* > 2σ(*I*) using a CAD4F diffractometer and Mo-Kα radiation; 2θ_{max} = 63.94°. The structure was solved using SHELX 86 and refined with 259 variable parameters using SHELXL 93. After full matrix refinement; *R*₁ = 7.10 and *wR*₂ = 22.2. The maximum and minimum excursions in the final *F*_o–*F*_c difference map were 0.784 and –0.537 e Å^{–3}. The ORTEP program was used to obtain the drawings.

Crystal data for 9a, C₂₉H₂₇N₃O₄. Triclinic, *a* = 9.4784(10), *b* = 11.5639(10), *c* = 12.8436(10) Å, α = 80.414(8), β = 68.821(8), γ = 78.283(8)°, *Z* = 2, space group *P*₁, 8061 reflections observed *I* > 2σ(*I*) using a CAD4F diffractometer and Mo-Kα radiation; 2θ_{max} = 59.94°. The structure was solved using SHELX 86 and refined with 330 variable parameters using SHELXL 93. After full matrix refinement; *R*₁ = 7.04 and *wR*₂ = 22.20. The maximum and minimum excursions in the final *F*_o–*F*_c difference map were 0.553 and –0.333 e Å^{–3}. The ORTEP program was used to obtain the drawings.

Atomic coordinates, bond lengths and angles, and thermal parameters for compounds 6a and 9a have been deposited at the Cambridge Crystallography Data Centre. For details of the deposition scheme, see 'Instructions for Authors', *J. Chem. Soc., Perkin Trans. 1*, 1994, Issue 1.

methanesulfonate (0.44 cm³, 2.02 mmol) was heated to 100 °C and stirred for 5 h, cooled to ambient temperature, and then treated with dry dichloromethane (20 cm³) and dimethyl acetylenedicarboxylate (0.41 cm³, 3.36 mmol) followed by CsF (0.38 g, 2.52 mmol) and the mixture stirred at ambient temperature for 8 h. The solution was filtered to remove insoluble salts and the solvent removed under reduced pressure. The residue in dichloromethane (3 cm³) was placed on a silica gel-60 column (230–400 mesh ASTM) and the product 5a was eluted using a gradient mixture of light petroleum (b.p. 40–60 °C)–dichloromethane (1:0–1:1.5 v/v), m.p. 129–130 °C (from pentane) (50%) (Found: C, 71.4; H, 5.2; N, 9.1. C₂₇H₂₃N₃O₄ requires: C, 71.5; H, 5.1; N, 9.3%); *v*_{max}(Nujol)/cm^{–1} 1735 and 1724 (ester C=O); δ_{H} (CDCl₃) 3.3 (s, 3 H, OMe), 3.8 (s, 3 H, OMe), 4.2 (s, 2 H, CH₂N) and 7.1–7.6 (m, ArH); δ_{C} 52.2 and 52.4 (OMe), 60.8 (CH₂N), 165.6 and 162.6 (ester C=O), 146.3, 143.4, 142.1, 139.0 and 135.6 and 130.2 (quaternary C), 92.0 (bridgehead C), 129.4, 128.9, 128.7, 128.3, 127.7, 127.2, 126.7, 123.2 and 117.5 (aromatic CH). The other products recovered from the column were 10a (24%), 11a (9%), 1a (5%) and some intractable resins.

Preparation of 1-Aminopyrrole 8.—A solution of 5a (150 mg, 0.331 mmol) in dry toluene (10 cm³) was stirred under reflux for 46 h, cooled and then the solvent removed under reduced pressure. The residue was crystallized from EtOH giving compound 8a (87%), m.p. 158–160 °C (from EtOH) (Found: C, 68.3; H, 5.1; N, 7.8. C₂₀H₁₈N₂O₄ requires C, 68.6; H, 5.2; N, 8.0%); *v*_{max}(Nujol)/cm^{–1} 3318 (NH) and 1719 and 1694 (ester C=O); δ_{H} ([²H₆]DMSO) 3.65 (s, 3 H, OMe), 3.77 (s, 3 H, OMe), 7.70 (s, 1 H, pyrrole 5-H), 9.54 (s, 1 H, NH), 6.48 (d, 2 H, H_{ortho} N-Ph) and 6.8–7.5 (m, Ar-H); δ_{C} 51.5 and 51.8 (MeO), 165.2 and 162.9 (ester C=O), 147.7, 135.5, 129.3, 113.7 and 112.5 (quaternary C), 120.2 (pyrrole C-5), 129.5, 129.2, 128.5, 128.4, 128.0 and 127.8 (aromatic CH).

Acknowledgements

P. D. McD. thanks the Government Science Agency EOLAS for a grant.

References

- 1 R. N. Butler, A. M. Evans, J. P. James, E. McNeela, D. Cunningham and P. McArdle, *J. Chem. Soc., Perkin Trans. 1*, 1990, 2537.
- 2 R. N. Butler, A. M. Evans, E. McNeela, G. A. O'Halloran, P. D. O'Shea, D. Cunningham and P. McArdle, *J. Chem. Soc., Perkin Trans. 1*, 1990, 2527; R. N. Butler and D. M. Colleran, *J. Chem. Soc., Perkin Trans. 1*, 1992, 2159.
- 3 R. N. Butler, D. Cunningham, E. G. Marren and P. McArdle, *J. Chem. Soc., Perkin Trans. 1*, 1990, 3321.
- 4 R. N. Butler, D. Cunningham, E. G. Marren, P. McArdle and D. F. O'Shea, *J. Chem. Res. (S)*, 1992, 256.
- 5 R. N. Butler, H. A. Gavin, D. Cunningham and P. McArdle, *J. Chem. Soc., Perkin Trans. 1*, 1993, 883.
- 6 D. Moderhack and D.-O. Bode, *J. Chem. Soc., Perkin Trans. 1*, 1992, 1483; D. Moderhack, D.-O. Bode and D. Schomberg, *Chem. Ber.*, 1993, **126**, 129.
- 7 O. Meth-Cohn, *Tetrahedron Lett.*, 1975, 413.
- 8 O. Tsuge, Y. Shimiza, H. Shimoharada and S. Kanemasa, *Heterocycles*, 1982, **19**, 2259.
- 9 K. T. Potts, D. R. Choudbury and T. R. Westby, *J. Org. Chem.*, 1976, **41**, 187.
- 10 R. N. Butler, J. P. Duffy, D. Cunningham, P. McArdle and L. A. Burke, *J. Chem. Soc., Perkin Trans. 1*, 1992, 147.
- 11 E. Vedejs, S. Larsen and F. G. West, *J. Org. Chem.*, 1985, **50**, 2170.
- 12 R. C. F. Jones, J. R. Nichols and M. T. Cox, *Tetrahedron Lett.*, 1990, **31**, 2333.

Paper 4/02681K
Received 5th May 1994
Accepted 18th May 1994