1,2,3-Triazoles. Part 3.[1] 4-Aminotriazole-5-carbaldehydes from 4-Aminotriazoles †

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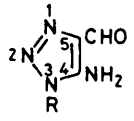
4-Amino-3-methyl- (and 3-benzyl-) 1,2,3-triazoles were converted by dimethylformamide and phosphoryl chloride into 4-dimethylaminomethyleneamino-5-carbaldehydes (2b and c), which were hydrolysed by dilute acid to the corresponding 4-amino-aldehydes (1a and b). 4-Amino-1-methyl-1,2,3-triazole gave only 4-dimethylaminomethyleneamino-1-methyl-1,2,3-triazole. Dichloromethyl methyl ether with tin(IV) chloride effected only 4-*N*-formylation of 4-aminotriazoles, but in the presence of dimethylformamide these reagents converted 4-amino-3-benzyl-1,2,3-triazole into the 4-dimethylaminomethyleneamino-derivative. Several 4-*N*-acetyl derivatives of the starting materials are reported. ^{1}H N.m.r. spectra are discussed.

THE 5-*C*-formylation of 4-amino-1,2,3-triazoles should furnish a more direct approach than is available [1,2] for the preparation of 4-amino-1,2,3-triazole-5-carbaldehydes, *e.g.* (1), which are useful intermediates.[3] Although the presence of a primary amino group usually disallows Friedel–Crafts-type reactions,[4] a combination of dimethylformamide and phosphoryl chloride seemed worth trying, because it has already been used [5] to convert 4-amino-1,2,3-triazole-5-carboxamides into 4-dimethylaminomethyleneamino-5-carbonitriles (2a). Hence it seemed likely that these Vilsmeier–Haack reagents [6] could give amidino-aldehydes, *e.g.* (2b), which could be hydrolysed to the desired amino-aldehydes, *e.g.* (1a).

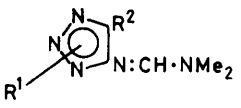
In the event, 4-amino-3-methyl-1,2,3-triazole gave the 4-dimethylaminomethyleneamino-5-carbaldehyde (2b) in good yield, and this was easily hydrolysed by dilute acid



(1)

a; R = Me

b; R = CH_2Ph



(2)

a; R^1 = 1-Me, 2-Me, 3-Me, or 3-CH_2Ph, R^2 = CN

b; R^1 = 3-Me, R^2 = CHO

c; R^1 = 3-CH_2Ph, R^2 = CHO

to the 4-amino-aldehyde (1a). 4-Amino-3-benzyl-1,2,3-triazole behaved similarly, but 4-amino-1-methyl-1,2,3-triazole gave only 4-dimethylaminomethyleneamino-1-methyl-1,2,3-triazole hydrochloride. Liberation of the base followed by resubjection to the reagents still produced no aldehyde. Severer conditions (*e.g.* higher temperatures, substitution of *N*-methylformanilide for dimethylformamide) caused decomposition. The standard conditions destroyed 4-amino-1,2,3-triazole, even after prior bistrimethylsilylation. 4-Amino-2-methyl-1,2,3-triazole is unknown.

The literature (*e.g.* ref. 4*b*) indicated another powerful *C*-formylating reagent that might cope with the feeble electron availability in the 5-position, namely dichloromethyl methyl ether [7] in the presence of a catalyst [tin(IV) chloride] that does not form highly insoluble complexes with primary amines as zinc and aluminium chlorides do. However, these conditions converted 4-amino-1-methyl-1,2,3-triazole only into 4-formamido-1-methyl-1,2,3-triazole; 4-amino-3-benzyl triazole behaved similarly, whereas 4-amino-3-methyltriazole did not react and 4-aminotriazole simply decomposed. With 4-amino-1-methyltriazole, increasing the temperature from 0 to 80 °C, varying the solvent, or substituting titanium(IV) chloride for the tin catalyst, brought about no improvement. Dimethylformamide, dichloromethyl methyl ether, and tin(IV) chloride converted 4-amino-3-benzyltriazole into 3-benzyl-4-dimethylaminomethyleneamino-1,2,3-triazole.

Several 4-*N*-acetyl derivatives were prepared, without a catalyst, as intermediates for reaction with acetic anhydride and aluminium chloride in an unsuccessful attempt to obtain ketones corresponding to the aldehydes (1).

EXPERIMENTAL

N.m.r. spectra were taken with a Varian HFT-80 instrument at 33 °C. Specimens said to be identical were compared by (i) mixed m.p., (ii) i.r. spectroscopy, and (iii) paper chromatography. Elemental analyses were performed by Galbraith Laboratories, Knoxville, Tennessee.

4-Amino-3-methyl-1,2,3-triazole-5-carbaldehyde (1a).—

† In this series, the amino group of aminotriazoles is consistently numbered 4 to facilitate comparisons.

[1] Part 2, A. Albert, *J.C.S. Perkin I*, 1973, 1634.
[2] A. Albert and H. Taguchi, *J.C.S. Perkin I*, 1973, 1629.
[3] A. Albert and H. Taguchi, *J.C.S. Perkin I*, 1973, 2034.
[4] G. A. Olah and S. J. Kuhn in 'Friedel–Crafts and Related Reactions,' ed. G. A. Olah, Interscience, New York, 1964, vol. 3, (*a*) p. 1211; (*b*) p. 1189.
[5] A. Albert, *J.C.S. Perkin I*, 1972, 461.
[6] A. Vilsmeier and A. Haack, *Ber.*, 1927, **60**, 119.
[7] A. Rieche, H. Gross, and E. Höft, *Chem. Ber.*, 1960, **93**, 88.

Phosphoryl chloride (0.16 g, 0.001 mol) was added to 4-amino-3-methyl-1,2,3-triazole [8] (0.05 g, 0.000 5 mol) in dimethylformamide (1 ml) at 0 °C. The mixture was then heated at 85 °C (bath) for 1 h, cooled, then poured on ice (15 g). The mixture was adjusted to pH 7, and extracted with chloroform (3 × 20 ml). The solvent was removed *in vacuo* from the dried (K_2CO_3) extract. The residue, recrystallized from 70 parts of benzene–cyclohexane (1 : 4) gave *4-dimethylaminomethyleneamino-3-methyl-1,2,3-triazole-5-carbaldehyde* (2b) (75%), m.p. 136° (Found: C, 46.15; H, 6.2; N, 38.4. $C_7H_{11}N_5O$ requires C, 46.4; H, 6.1; N, 38.65%), τ($CDCl_3$) 0.08 (1 H, CHO), 0.92 (1 H, N:CH), 6.13 (3 H, Me), and 6.78 and 6.97 (2 × 3 H, NMe_2). This amidine (2b) was heated under reflux for 20 min with 16 equiv. of N-hydrochloric acid. The solution was neutralized and extracted with chloroform. Evaporation of the dried (K_2CO_3) extract gave 4-amino-3-methyl-1,2,3-triazole-5-carbaldehyde (65%), identical with an authentic [2] specimen.

4-Amino-3-benzyl-1,2,3-triazole-5-carbaldehyde (1b).—4-Amino-3-benzyl-1,2,3-triazole,[9] treated similarly, gave 3-benzyl-4-dimethylaminomethyleneamino-1,2,3-triazole-5-carbaldehyde (2c) (85%), m.p. 97.5° (from 100 parts of cyclohexane), identical with an authentic [3] specimen. It underwent acidic hydrolysis, as in the foregoing, to the amino-aldehyde (1b).[2]

4-Dimethylaminomethyleneamino-1-methyl-1,2,3-triazole.—4-Amino-1-methyl-1,2,3-triazole [2], phosphoryl chloride, and dimethylformamide were treated as in the foregoing, but the product was filtered off before neutralization to give the *hydrochloride* of *4-dimethylaminomethyleneamino-1-methyl-1,2,3-triazole*, m.p. 210.5—212° (quantitative yield) (Found: C, 38.1; H, 6.35; Cl, 18.65; N, 36.75. $C_6H_{12}ClN_5$ requires C, 38.0; H, 6.4; Cl, 18.7; N, 36.9%), τ[$(CD_3)_2SO$] 1.27 (1 H, CH:N), 1.94 (1 H, 5-H), 5.95 (3 H, Me), and 6.65 and 6.72 (each 3 H, NMe_2). The *base*, liberated by neutralization of an aqueous solution with sodium hydroxide and recrystallized from 400 parts of light petroleum (b.p. 60—80 °C) (90% overall yield), had m.p. 98° (Found: C, 47.0; H, 7.3; N, 45.7. $C_6H_{11}N_5$ requires C, 47.0; H, 7.2; N, 45.7%), τ($CDCl_3$) 1.62 (1 H, CH:N), 2.82 (1 H, H-5), 6.00 (3 H, Me), and 6.97 (6 H, NMe_2).

4-Formamido-1-methyl-1,2,3-triazoles.—Tin(IV) chloride (0.52 g, 0.002 mol), then dichloromethyl methyl ether (0.23 g., 0.002 mol) were added dropwise to 4-amino-1-methyl-1,2,3-triazole (0.10 g, 0.001 mol) in dichloromethane (6 ml) at 0 °C. The mixture was stirred at 24 °C for 30 min, then poured on ice (10 g). The aqueous layer was neutralized with 10N-sodium hydroxide and clarified by filtration. The filtrate was taken to dryness at 50 °C and 25 mmHg, and further dried *in vacuo* at 24 °C ($CaCl_2$). The residue was extracted with boiling benzene (15 ml). The filtrate deposited *4-formamido-1-methyl-1,2,3-triazole*, m.p. 158° (55%) (Found: C, 38.2; H, 4.8; N, 44.2. $C_4H_6N_4O$ requires C, 38.1; H, 4.8; N, 44.4%), τ[$(CD_3)_2SO$] 1.69 (1 H, d, CHO), 2.93 (1 H, H-5), and 5.90 (3 H, Me) (the NH,CH-coupled doublet became a singlet after addition of D_2O). 4-Amino-3-benzyl-1,2,3-triazole was treated similarly, except that the product was mainly in the dichloromethane layer and the remainder was extracted (with the same solvent) from the aqueous layer. The combined extracts were dried (K_2CO_3), and freed from solvent. The residue, recrystallized from 360 parts of benzene, gave *3-benzyl-4-formamido-1,2,3-triazole* (50%), m.p. 139° (Found: C, 59.6; H, 5.0; N, 27.8. $C_{10}H_{10}N_4O$ requires C, 59.4; H, 5.0; N, 27.7%), τ[$(CD_3)_2SO$] 1.67 (1 H, d, CHO), 2.12 (1 H, C-5), 2.5—3.0 (5 H, m, Ph), and 4.39 (2 H, CH_2).

3-Benzyl-4-dimethylaminomethyleneamino-1,2,3-triazole.—Tin(IV) chloride (0.15 g, 2 equiv.) was very slowly added to a solution, at 0 °C, of 4-amino-3-benzyl-1,2,3-triazole (0.05 g) and dichloromethyl methyl ether (0.06 g) in dimethylformamide (2 ml). The mixture was then stirred at 24 °C for 1 h, and poured on ice (10 g). The mixture was extracted with chloroform (2 × 30 ml), the extract dried (K_2CO_3), and the volatile portion removed. The residue, crystallized from 60 parts of benzene–cyclohexane (1 : 1), gave the *title compound* (48%), m.p. 110° (Found: C, 63.0; H, 6.7; N, 30.4. $C_{12}H_{15}N_5$ requires C, 62.9; H, 6.6; N, 30.55%), τ($CDCl_3$) 2.31 (1 H, N : CH), 2.5—3.0 (5 H, m, Ph), 4.63 (2 H, CH_2), and 7.00 (6 H, NMe_2).

Acetyl Derivatives.—4-Amino-3-methyl-1,2,3-triazole, acetyl chloride, and triethylamine in tetrahydrofuran at 24° gave *4-acetamido-3-methyl-1,2,3-triazole* (86%), m.p. 157° (Found: C, 43.1; H, 5.7; N, 40.1. $C_5H_8N_4O$ requires C, 42.9; H, 5.75; N, 40.0%), τ(D_2O) 2.28 (1 H, H-5), 6.07 (3 H, N-Me), and 7.78 (3 H, COMe). 4-Amino-3-benzyl-1,2,3-triazole, gave *4-acetamido-3-benzyl-1,2,3-triazole* (quantitative), m.p. 130° (Found: C, 61.3; H, 5.7; N, 25.8. $C_{11}H_{12}N_4O$ requires C, 61.1; H, 5.6; N, 25.9%), τ($CDCl_3$) 2.45 (1 H, H-5), 2.6—2.9 (5 H, m, Ph), 4.65 (2 H, CH_2), and 8.00 (3 H, Me). 4-Amino-3-benzyl-1,2,3-triazole (0.05 g) in boiling acetic anhydride yielded 3-benzyl-4-diacetylamino-1,2,3-triazole quantitatively, τ($CDCl_3$) 2.44 (1 H, H-5), 2.71 (5 H, s, Ph), 4.68 (2 H, CH_2), and 8.00 (6 H, 2 × Me). This underwent partial deacetylation on attempted recrystallization from dried benzene.

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[8] A. Albert, *J. Chem. Soc.* (*C*), 1969, 2379.
[9] A. Albert, *J. Chem. Soc.* (*C*), 1970, 230.