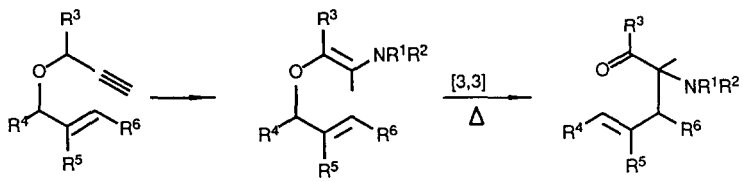
Tetrahedron Letters,Vol.29,No.39,pp 5029-5032,1988 0040-4039/88 $3.00 + .00
Printed in Great Britain Pergamon Press plc

MERCURY(II) INDUCED CYCLIZATION OF DIPROPARGYL ETHERS. REGIOSELECTIVE SYNTHESIS OF 2-(1-AMINOETHYL)FURANS

José Barluenga,* Fernando Aznar, Miguel Bayod
Departamento de Química Organometálica, Universidad de Oviedo,
33071 Oviedo, Spain

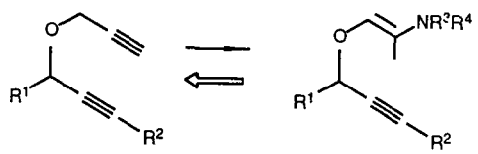
Summary: *The regioselective one-pot synthesis of 2-(1-aminoethyl)furans* **10** *is easily achieved by aminomercuriation of the readily available dipropargyl ethers* **4**.

We have previously reported that terminal acetylenes and alkoxypropargyl derivatives react, under mild conditions, with secondary amines in the presence of different mercury salts to give enamine derivatives.[1] When allyl propargyl ethers **1** were employed, β-allyloxyenamines **2** were isolated. These compounds undergo very easily [3,3]- and [1,3]-rearrangements, furnishing 2-aminopent-4--enals[2,3] **3** in nearly quantitative yield.



1 2 3

These results encouraged us to extend these reactions to the easily available dipropargyl ethers **4**, having at least one terminal triple bond.



4 5

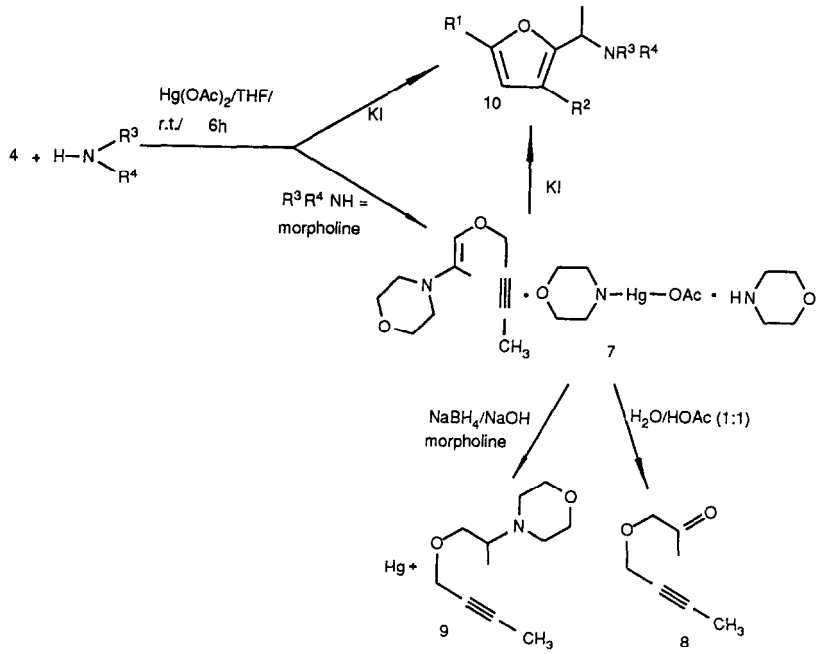
When compound **4b** (R^1 = H, R^2 = CH_3) was treated with morpholine in the presence of mercury(II) acetate (molar ratio 2:6:1.5) in THF at room temperature, the expected enamine derivative **5b** was surprisingly not obtained. Instead, a yellow oil **7**, insoluble in hexane, but highly soluble in ether, resulted.[4]

The ^{1}H- and ^{13}C-NMR spectra of this mercury-containing oil **7** are consistent with the presence of the enamine **5b**, along with an acetate function and two

extra morpholine units [*e. g.*, **7**: ^{1}H-NMR ($CDCl_3$) δ = 1.77 (d,3H, J=1 Hz); 1.85 (t,3H, J=2.3 Hz); 2.0 (s,3H); 2.7-2.8 (m,4H); 2.9-3.0 (m,8H); 3.5-3.8 (m,12H); 4.2 (q,2H, J=2.3 Hz); 5.7 (d,1H, J=1 Hz) ppm. ^{13}C-NMR ($CDCl_3$) δ = 3.3 (q); 12.1 (q); 23.0 (q); 44.8 (t); 49.5 (t); 59.7 (t); 66.3 (t); 66.6 (t); 74.2 (s); 83.5 (s); 128.5 (d); 132.4 (s); 177.3 (s) ppm].[5]

When **7** was hydrolysed with a mixture of acetic acid-water (1:1), the correspondig ketone **8** was obtained. The reduction of **7** with $NaBH_4$ in alkaline medium afforded the amine **9** and mercury metal (in a 1:1 molar ratio).[6]

Attempting to remove the mercury salt from the complex **7** by means of KI, surprisingly led to the formation of the furan derivative **10b**. The one pot preparation of **10b** can be achieved by adding KI to the reaction mixture.



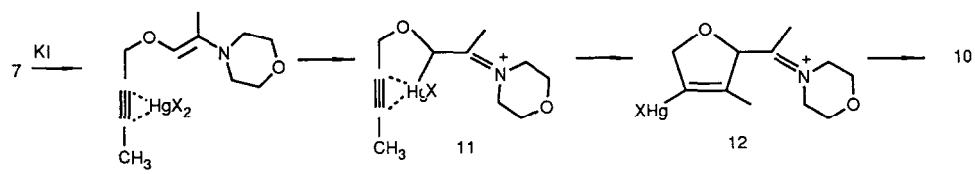
This reaction resulted in a general and simple process for the preparation of this kind of compound **10**. In a typical run, dry mercury(II) acetate (15 mmol) was added under argon during *ca.* 5 min to a stirred solution of dipropargyl ether **4** (20 mmol) in dry THF (80 ml). The mixture was stirred during 6 h at room temperature, and filtered under argon.[7] The filtrate was then treated with KI (30 mmol), and the reaction mixture stirred for 2 h. The mixture was filtered and evaporated under reduced presure (0.05 Torr). The resulting residue was treated with dry n-hexane (3×20 ml), filtered, and the liquid phase concentrated *in vacuo* (0.05 Torr); trap-to-trap condensation gave pure compounds **10a-f** (Table 1).[8]

Table 1. 2-(1-Aminoethyl)furans **10a-f**

Compound	R^1	R^2	R^3	R^4	Yield (%)[a]
10a	H	H	$-(CH_2)_2-O-(CH_2)_2-$		64
10b	H	Me	$-(CH_2)_2-O-(CH_2)_2-$		74
10c	H	Me	$-(CH_2)_4-$		58
10d	H	Me	$-(CH_2)_5-$		66
10e	Me	Ph	$-(CH_2)_2-O-(CH_2)_2-$		71
10f	Et	Ph	$-(CH_2)_2-O-(CH_2)_2-$		61

[a] Based on dipropargyl ethers.

A similar reaction path to that reported for the reaction of silyl enol ethers and mercury(II) chloride[9] could account for the formation of **10** from **7**. It involves a mercury(II) attack at the C_β enamine carbon[10] to give a β-mercury iminium salt **11**, which in turn transfers its mercury atom, *via* a six centered transition state, affording the vinyl mercurial **12**; then C-Hg protolysis of **12** and aromatization would give rise to **10**. All attempts to isolate either intermediates **11** or **12** have been unsuccessful.[11]



In conclusion, the process described here represents a very simple and general method for the synthesis of 2-(1-aminoethyl)furans; it involves carbon-carbon bond formation by mercuriation of dipropargyl ethers in the presence of secondary aliphatic amines. It is probable that an enamine is involved as intermediate in this process.

Acknowledgment. Financial support of this work by Comisión Aseosora de Investigación Científica y Técnica (CAICYT) is gratefully acknowledged.

References and notes

1. J. Barluenga, F. Aznar, R. Liz, *Synthesis*, **1984**, 304.
2. J. Barluenga, F. Aznar, R. Liz, M. Bayod, *J. Chem. Soc., Chem. Commun.*, **1984**, 1427.
3. J. Barluenga, F. Aznar, R. Liz, M. Bayod, *J. Org. Chem.*, **1987**, *52*, 5190.
4. The closely related enamine **2** was found to be very soluble in n-hexane.[3]
5. Recorded on a Bruker AC-300 spectrometer.
6. **8**: ^{1}H-NMR (Varian FT-80A) ($CDCl_3$/TMS) δ = 1.75 (t,3H); 2.1 (s,3H); 4.05 (s,2H); 4.15 (q, 2H) ppm. ^{13}C-NMR (Varian FT-80A) (neat) δ = 3.6 (q); 26.7 (q); 59.6 (t); 75.3 (t); 75.6 (s); 82.2 (s); 194.7 (s) ppm. MS, m/e = 215 (M^+-1).

9: ^{1}H-NMR (Varian FT-80A) ($CDCl_3$ / TMS) δ = 1.1 (d,3H); 1.8 (t,3H); 2.5-2.7 (m,4H); 2.8 (q, 1H); 3.65 (d,2H); 3.7-3.9 (m,4H); 4.15 (q,2H) ppm. ^{13}C-NMR (Varian FT-80A) (neat) δ = 3.5 (q); 13.6 (q); 51.2 (t); 59.1 (t); 60.3 (t); 67.6 (t); 72.3 (d); 76.7 (s); 82.4 (s) ppm. MS, m/e = 197 (M^+).

7. Although filtering is not need, it makes easier the subsequent work-up.

8. Spectroscopic data. **10a:** ^{1}H-NMR ($CDCl_3$/TMS) δ = 1.4 (d,3H); 2.4-2.6 (m, 4H); 3.6-3.9 (m, 5H); 6.1 (d,1H); 6.3 (t,1H); 7.35 (d,1H) ppm; ^{13}C-NMR ($CDCl_3$) δ = 15.2 (q); 49.6 (t); 57.1 (d); 66.7 (t); 106.7 (d); 109.4 (d); 141.2 (d); 154.9 (s) ppm. MS, m/e = 181 (M^+).
10b: ^{1}H-NMR ($CDCl_3$/TMS) δ = 1.4 (d,3H); 1.95 (s,3H); 2.4-2.6 (m,4H); 3.4-3.9 (m,5H); 6.1 (d,1H); 7.2 (d,1H) ppm; ^{13}C-NMR ($CDCl_3$) δ = 9.7 (q); 16.2 (q); 50.5 (t); 55.5 (d); 66.8 (t); 112.3 (d); 115.7 (s); 140.4 (d), 148.9 (s) ppm. MS, m/e = 195 (M^+).
10c: ^{1}H-NMR ($CDCl_3$/TMS) δ = 1.4 (d,3H); 1.5-1.9 (m,4H); 1.95 (s,3H); 2.3-2.6 (m,4H); 3.4 (q,1H); 6.1 (d,1H); 7.2 (d,1H) ppm; ^{13}C-NMR ($CDCl_3$) δ = 9.6 (q); 18.9 (q); 23.0 (t); 47.0 (t); 54.5 (d); 112.1 (d); 114.6 (s); 140.0 (d); 151.1 (s) ppm. MS, m/e = 179 (M^+).
10d: ^{1}H-NMR ($CDCl_3$/TMS) δ = 1.4 (d,3H); 1.4-1.7 (m,6H); 1.95 (s,3H); 2.2-2.5 (m,4H); 3.6 (q,1H); 6.15 (d,1H); 7.2 (d,1H) ppm; ^{13}C-NMR ($CDCl_3$) δ = 9.9 (q); 16.7 (q); 24.3 (t); 25.9 (t); 51.0 (t); 55.5 (d); 112.2 (d); 115.8 (s); 140.1 (d); 150.4 (s) ppm. MS, m/e = = 193 (M^+).
10e: ^{1}H-NMR ($CDCl_3$/TMS) δ = 1.4 (d,3H); 2.2 (s,3H); 2.3-2.6 (m,4H); 3.4-3.6 (m,4H); 3.7 (q,1H); 5.9 (s,1H); 7.2-7.4 (m,5H) ppm; ^{13}C-NMR ($CDCl_3$) δ = 13.3 (q), 15.8 (q); 50.2 (t); 55.6 (d); 66.8 (t); 107.2 (d); 124.1 (s); 126.2 (d); 128.0 (d); 129.1 (d); 133.9 (s); 148.5 (s); 150.4 (s) ppm. MS, m/e = 271 (M^+).
10f: ^{1}H-NMR ($CDCl_3$/TMS) δ = 1.15 (t,3H); 1.4 (d,3H); 2.25-2.4 (m,4H); 2.6 (q,2H); 3.3-3.8 (m,5H); 6.0 (s,1H); 6.9-7.5 (m,5H) ppm; ^{13}C-NMR ($CDCl_3$) δ = 11.8 (q); 15.7 (q); 21.1 (t); 50.2 (t); 55.7 (d); 66.9 (t); 105.7 (d); 124.1 (s); 126.4 (d); 128.2 (d); 129.2 (d); 134.1 (s); 148.3 (s); 156.3 (s) ppm.
All the NMR data were recorded on a Bruker AC-300 spectrometer.

9. J. Drouin, M. A. Boaventura, J. M. Conia, *J. Am. Chem. Soc.*, **1985**, *107*, 1726.
10. R. D. Bach, D. K. Mitra, *J. Chem. Soc., Chem. Commun.*, **1971**, 1433.
11. In our quite long experience in the aminomercuriation of C≡C triple bond, we have never been able to isolate the corresponding vinyl mercurial intermediate.

(Received in UK 27 July 1988)