Pergamon

Tetrahedron Letters 39 (1998) 2851–2852

TETRAHEDRON
LETTERS

Second Generation Benzannulation Reactions : Sugar-Derived Fischer Chlorocarbene Complexes in Organic Synthesis

Michael. R. Hallett, James E. Painter, Peter Quayle* and Dean Ricketts

Department of Chemistry
The Victoria University of Manchester
Manchester M13 9PL, UK
E-mail: Peter.Quayle@man.ac.uk

Prakash Patel

Zeneca Specialties
Hexagon House
Blakley
Manchester, UK.

Received 4 December 1997; revised 3 February 1998; accepted 6 February 1998

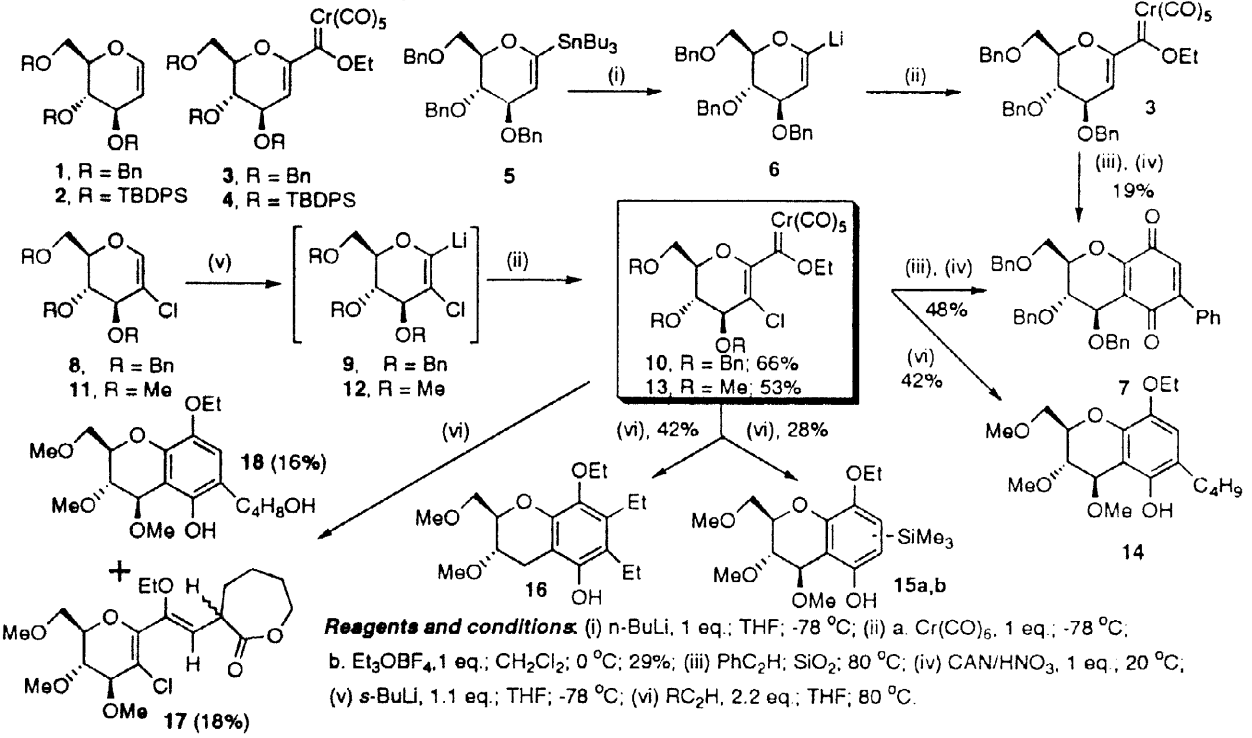
Abstract: The facile metallation of 2-chloroglucal derivatives **8** and **11** affords ready access to the corresponding Fischer carbene complexes **10** and **13**. Carbene complexes **10** and **13** undergo benzannulation reactions with acetylenes to provide functionalised benzopyrans in moderate overall yields.

Since the first report[1] of the Dötz benzannulation reaction in 1975 a number of groups have demonstrated its potential for the synthesis of hydroquinones and quinones. In most cases the vinyl or aryl carbenes employed in such reactions contained little in the way of other functionality.[2] As a continuation of our interest in the use of Fischer carbene complexes in synthesis[3] we decided to prepare the sugar-derived carbene complexes **3** and **4** and investigate their benzannulation chemistry. A major obstacle facing such an endeavour is the capricious nature[4] of the metallation reactions of functionalised vinyl ethers such as **1** and **2**. In our initial experiments the lithiated glucal **6**, prepared[5] by tin-lithium exchange of the stannane **5**, was treated with chromium hexacarbonyl followed by triethyloxonium tetrafluoroborate,[6] affording the sugar carbene complex **3** as a red oil in 29% isolated yield.[7] Similarly the silylated glucal **2** was metallated using Friesen's two step procedure[8] and the resulting anion converted to the red-coloured carbene complex **4** in 60% yield using the standard Fischer procedure.[6] In our hands, thermolysis of the carbene complex **4** with phenylacetylene (5 eq.) in tetrahydrofuran at 80 °C led to none of the desired benzannulated products, presumably due to adverse steric effects. Treatment of complex **3** with phenylacetylene using Kerr's dry-state conditions[9] followed by oxidative work-up (CAN, 1 eq.) did however afford the quinone **7** in 19% overall yield.

Recently we observed[10] that chloroglucal derivatives **8** and **11** undergo facile deprotonation at C_2 with *s*-BuLi or *t*-BuLi to afford the stable organolithium intermediates **9** and **12**. These organometallics undergo

PII: S0040-4039(98)00315-3

glucal derivatives. We now report that conversion of **9** and **12** to the corresponding carbene complexes **10** and **13** is also possible using the standard Fischer procedure (66% and 53% respectively). Moreover benzannulation of **10** with phenylacetylene under DSA conditions followed by oxidative work-up (1 eq. CAN; acetone; 20 °C) afforded the quinone **7** in 48% overall yield. In the case of the carbene complex **13**, treatment with terminal acetylenes (2.2 eq.) such as 1-hexyne (thermolysis in degassed THF; 80 °C) proceeded in a regioselective manner affording the hydroquinone **14** in 42% yield (regiochemistry by analogy). Benzannulation with TMS-acetylene afforded a mixture of regioisomeric hydroquinones **15a,b** in 28% yield. Reaction of the more hindered substrate 3-hexyne with complex **13** was relatively sluggish, and proceeded with concomitant benzylic de-oxygenation, affording hydroquinone **16** as the only identifiable product in 42% yield. In the case of hex-1-yne-6-ol, the reaction took yet another course,[11] generating a 1:1 mixture of the diastereoisomeric[12] lactones **17** (18% yield) together with the expected quinol **18** (16% yield), **Scheme**.



Reagents and conditions: (i) n-BuLi, 1 eq.; THF; -78 °C; (ii) a. $Cr(CO)_6$, 1 eq.; -78 °C; b. Et_3OBF_4,1 eq.; CH_2Cl_2; 0 °C; 29%; (iii) PhC_2H; SiO_2; 80 °C; (iv) CAN/HNO_3, 1 eq., 20 °C; (v) *s*-BuLi, 1.1 eq.; THF; -78 °C; (vi) RC_2H, 2.2 eq.; THF; 80 °C.

Scheme

ACKNOWLEDGEMENTS

We thank the EPSRC and Zeneca for support of this research programme.

REFERENCES AND NOTES

1. Dötz, K. H. *Angew. Chem., Int. Ed. Engl.*, **1975**, *14*, 644.
2. Whilst this *Letter* was in preparation a single benzannulation reaction on a sugar-derived carbene complex was reported: Dötz, K. H.; Ehlenz, R; Paetsch, D. *Angew. Chem., Int. Ed. Engl.*, **1997**, *36*, 2376.
3. Beddoes, R. L.; Painter, J. E.; Quayle, P.; Patel, P. *Tetrahedron*, **1997**, *53*, 17297.
4. Paquette, L. A.; Oplinger, J. A. *Tetrahedron*, **1989**, *45*, 107.
5. Dubois, E.; Beau, J.-M. *Carbohydr. Res.*, **1992**, *228*, 103.
6. Fischer, E. O.; Massbol, A. *Angew. Chem., Int. Ed. Engl.*, **1964**, *3*, 580.
7. All new compounds were fully characterised (^1H and ^{13}C nmr, ir, mass spec. and/ or microanalysis).
8. Friesen, R. W.; Sturino, C. F.; Daljeet, A. K.; Kolaczewska, A. *J. Org. Chem.*, **1991**, *56*, 1944.
9. Harrity, J. P. A.; Kerr, W. J.; Middlemiss, D. *Tetrahedron*, **1993**, *49*, 5565.
10. Painter, J. E. PhD Thesis, University of Manchester, 1997; Hallett, M. R.; Quayle, P. unpublished.
11. *c.f.* Harrity, J. P. A.; Heron, N. M.; Kerr, W. J.; McKendry, S.; Middlemiss, D.; Scott, J. S. *Synlett*, **1996**, 1184 and refs. therein.
12. Alkene geometry by analogy to that observed in ref. 11.