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# An Enantiospecific Cobaloxime π-Cation Initiated Carbocyclisation

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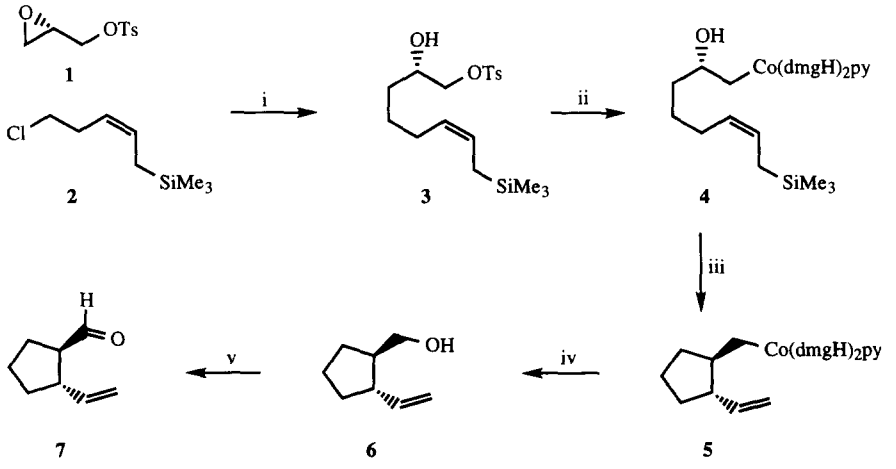
***Abstract:*** The cationic carbocyclisation of the allyl silane substituted β-hydroxycobaloxime (+)-**4** was effected by treatment with catalytic amounts of *p*TSA to form the cyclopentane derivative (+)-**5** which was elaborated to the aldehyde (-)-**7** *via* the alcohol (-)-**6**. Both the optical rotation of (-)-**7** and the *ee* of (-)-**6** determined by Mosher esterification revealed that (+)-**5** had been formed in an enantiospecific fashion with retention of configuration at the inducing stereogenic centre. © 1998 Elsevier Science Ltd. All rights reserved.

In recent publications Branchaud *et al.*[1] and ourselves[2] have illustrated the considerable scope for cobaloxime π-cations in the synthesis of carbocycles and heterocycles by trapping with carbon and hetero atom nucleophiles. One of the unique features of these reactions is that the cobaloxime moiety is retained during the cyclisations thereby making itself available to participate in subsequent radical-based organocobalt chemistry.[3] In further exploitations of the use of the aforementioned cobaloxime π-cations in carbocyclic ring constructions we have now demonstrated that when they are performed with non-racemic precursors, they proceed with retention of configuration leading to chiral alkylcobaloximes.

Thus, we prepared the optically active (*S*)-(+)-allylsilane **3** using a sequence which involved regioselective ring-opening of the epoxide moiety of (*S*)-glycidyl tosylate **1**[4] (91% *ee*) with a copper-modified Grignard reagent derived from the chloride **2**[5] as a key step (Scheme 1).[6] Treatment of **3** with cobaloxime(I)pyridinato sodium then produced the corresponding cobaloxime **4**, which was obtained as a stable orange solid, mp. 62-63°C, $[\alpha]_D^{20}$ +54 (*c* 0.9, $CHCl_3$).




*Reagents:* i, Mg, THF, 65°C; then $Li_2CuCl_4$ (0.05 eq.), -40°C; then **1**, -78°C -> -40°C, 52 %; ii, Na[Co$^I$(dmgH)$_2$py], MeOH aq., 68%; iii, *p*TSA (0.3 eq.), THF, -78°C -> RT, 74 %; iv, hv, TEMPO; then Zn, HOAc; then $K_2CO_3$, MeOH, 22% overall; v, TPAP, NMO, 30%.

**Scheme 1**


*PII:* S0040-4039(98)00163-4

When a solution of **4** was treated with a catalytic amount of *p*TSA it underwent smooth electrophilic cyclisation to the (+)-*trans*-substituted cyclopentane **5**, contaminated by *ca.* 10% of the corresponding *cis*-diastereomer. After conversion of **5** into the corresponding primary alcohol **6**,[2] a Mosher's ester analysis showed that the alcohol was obtained with >85% *ee*. Finally, oxidation of **6** using TPAP/NMO led to the chiral cyclopentane aldehyde **7** which had an optical rotation ($[\alpha]_D^{20}$ -54 (*c* 0.9, $d_6$-acetone) almost identical with the optical rotation ($[\alpha]_D^{20}$ -48, *c* 1.1, acetone) of the same aldehyde synthesised by Koga *et al.*[7] who had used a procedure involving an amino acid derived chiral auxiliary.

The formation of the (*1R,2S*) enantiomer of **5** is consistent with the expectation of overall retention of configuration (double inversion) at the reactive *sec*-OH centre in **4** *via* the corresponding cobalt-π-cation during the cyclisation to **5**.[8] Further work is now in progress to develop this chemistry with alternative non-racemic β-hydroxycobaloximes and alternative carbon nucleophiles in concert with polycyclic ring constructions.[9]

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**REFERENCES AND NOTES**

1. Gage, J. L.; Branchaud, B. P. *J. Org. Chem.* **1996**, *61*, 831-837; Grubb, L. M.; Branchaud, B. P. *J. Org. Chem.* **1997**, *62*, 242-243.
2. Gill, G. B.; Pattenden, G.; Roan, G. A. *Tetrahedron Lett.* **1996**, *37*, 9369-9372.
3. Giese, B.; Hartung, J.; Pattenden, G.; Clark, A. J. *Encyclopedia of Reagents for Organic Synthesis*; Paquette, L., Ed.; John Wiley & Sons: Chichester, West Sussex, 1995, pp. 498-503; Pattenden, G.; Clark, A. J. *ibid.* pp. 1295-1296; Pattenden, G.; Clark, A. J. *ibid.* pp.1296-1298; Branchaud, B. P.; Friestad, G. K. *ibid.* pp. 5511-5514.
4. Gao, Y.; Hanson, R. M.; Klunder, J. M.; Ko, S. Y.; Masamune, H.; Sharpless, K. B. *J. Am. Chem. Soc.* **1987**, *109*, 5765-5780.
5. For the synthesis of the alcohol precursor to **2** see: Hiemstra, H.; Sno, M. H. A. M.; Vijn, R. J.; Speckamp, W. N. *J. Org. Chem.* **1985**, *50*, 4014-4020; Schinzer, D.; Allegiannis, C.; Wichmann, S. *Tetrahedron* **1988**, *44*, 3851-3868. For the copper mediated ring opening of **1** see: Klunder, J. M.; Onami, T.; Sharpless, K. B. *J. Org. Chem.* **1989**, *54*, 1295-1304; Rotstein, D. M.; Walker, K. A. M. *Tetrahedron: Asymmetry* **1993**, *4*, 1521-1526.
6. Satisfactory spectroscopic and chiroptical data, together with microanalytical and/or mass spectrometry data, were obtained for all new compounds. **5**: decomposes without melting at >130°C. - $^1$H-NMR (360 MHz, $CDCl_3$): δ = 8.55 (d, *J* = 5.1 Hz, 2 H), 7.68 (t, *J* = 7.6 Hz, 1 H), 7.30 (d, *J* = 6.9 Hz, 2 H), 5.53 (ddd, *J* = 17.9, 10.2, 8.0 Hz, 1 H), 4.88 - 4.73 (m, 2 H), 2.11 (s, 12 H), 1.87 - 1.73 (m, 2 H), 1.72 - 1.35 (m, 5 H), 1.31 - 1.14 (m, 1 H), 1.12 - 0.98 (m, 1 H), 0.96 - 0.80 (m, 1 H). - $^{13}$C-NMR (67.5 MHz, $CDCl_3$): δ = 149.9 (d), 149.1 (s), 143.0 (d), 137.3 (d), 125.1 (d), 112.8 (t), 52.8 (d), 47.2 (d), 37.6 (t br, *C*-Co), 33.4 (t), 32.2 (t), 24.3 (t), 12.0 (q). - HRMS (FAB): Calculated: 398.1364 ([M$^+$] - py), Found: 398.1370. - $[\alpha]_D^{20}$ + 48 (*c* 0.8, $CHCl_3$).
7. Hashimoto, S.; Kogen, H.; Tomioka, K.; Koga, K. *Tetrahedron Lett.* **1979**, 3009-3012.
8. Golding, B. T.; Holland, H. L.; Horn, U.; Sakrikar, S. *Angew. Chem. Int. Ed. Engl.* **1970**, *9*, 959-960; Golding, B. T.; Sakrikar, S. *J. Chem. Soc., Chem. Comm.* **1972**; 1183-1184, see also: Brown K. L.; Ramamurthy, S.; Marynick, D. S. *J. Organomet. Chem.* **1985**, *287*, 377-394.
9. After completion of our work, Gage and Branchaud described some striking and similar studies with chiral cobaloximes and with pyrrole nucleophiles, leading to the concise enantiospecific synthesis of indolizidine alkaloids: Gage, J. L.; Branchaud, B. P. *Tetrahedron Lett.* **1997**, *38*, 7007-7010.