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LETTERS

Intramolecular Diels-Alder Reaction of Chiral Silatrienes. Synthesis of 4-Sila-3,4,4a,5-tetrahydro-2*H*-isoquinolin-1-one.

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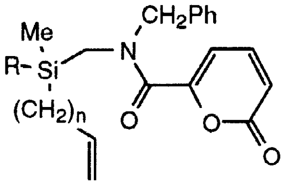
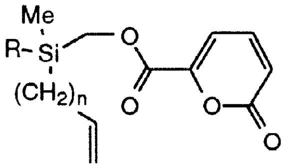
Abstract :The intramolecular Diels-Alder reaction of a pyran-2-one-6-carboxamide linked to a vinyl dienophile by a chiral silicon atom, followed by CO_2 elimination through a retro Diels-Alder reaction, afforded diastereoselectively a 4-silatetrahydroisoquinolin-2-one.

Chiral silicon compounds are rarely used in asymmetric synthesis and the reactions in which they are involved are, in general, poorly diastereoselective.[1] However excellent diastereoselectivities were reported for some reactions carried out at very low temperatures.[2] All these reports concern intermolecular reactions. Since intramolecular reactions could be more selective than intermolecular ones we studied intramolecular Diels-Alder reactions of silatrienes **1** and **2** in which an alkenyl substituent and a pyranone group [3] are linked by a chiral silicon atom.



1a (n = 0) **1b** (n = 1)

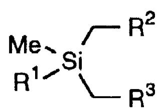
R = CH_2-O_2C-$CH(CH_3)_2$



2a (n = 0) **2b** (n = 1)

The silatrienes **1a,b** and **2a,b** were prepared starting from the commercially available chlorobis(chloromethyl)methylsilane **3** as shown as follows.

3 $R^1 = R^2 = R^3 = Cl$



4 $R^1 = R$, $R^2 = R^3 = Cl$

5 $R^1 = R$, $R^2 = R^3 = OAc$

6 $R^1 = R$, $R^2 = R^3 = OH$

7 $R^1 = R$, $R^2 = OH$, $R^3 = O_2C$-$CH(CH_3)_2$

8 $R^1 = R$, $R^2 = Br$, $R^3 = O_2C$-$CH(CH_3)_2$

9 $R^1 = R$, $R^2 = NH$-CH_2Ph, $R^3 = O_2C$-$CH(CH_3)_2$

a R = CH=CH_2 **b** R = CH_2-CH=CH_2

$$3 \xrightarrow{a} \begin{matrix}\mathbf{4a}\ 75\%\\ \mathbf{4b}\ 75\%\end{matrix} \xrightarrow{b} \begin{matrix}\mathbf{5a}\ 98\%\\ \mathbf{5b}\ 88\%\end{matrix} \xrightarrow{c} \begin{matrix}\mathbf{6a}\ 93\%\\ \mathbf{6b}\ 83\%\end{matrix} \xrightarrow{d^{5}} \begin{matrix}\mathbf{7a}\ 60\%\\ \mathbf{7b}\ 65\%\end{matrix} \xrightarrow{g} \begin{matrix}\mathbf{2a}\ 89\%\\ \mathbf{2b}\ 90\%\end{matrix}$$

$$\begin{matrix}\mathbf{7a}\\ \mathbf{7b}\end{matrix} \xrightarrow{e} \begin{matrix}\mathbf{8a}\ 98\%\\ \mathbf{8b}\ 92\%\end{matrix} \xrightarrow{f} \begin{matrix}\mathbf{9a}\ 67\%\\ \mathbf{9b}\ 72\%\end{matrix} \xrightarrow{g} \begin{matrix}\mathbf{1a}\ 93\%\\ \mathbf{1b}\ 85\%\end{matrix}$$

a) RMgCl, CuCN (5%), Et_2O, rt b) KOAc, NBu_4Br, TiO_2, 80°C c) $LiAlH_4$, Et_2O, -20°C to rt
d) Lipase from *Candida rugosa*, $(CH_3)_2CHCO_2CH_3$, 20°C, 1 d[4] e) CBr_4, PPh_3, CH_2Cl_2, rt
f) $PhCH_2NH_2$, 100°C g) Pyran-2-one-6-carbonyl chloride[6], NEt_3, CH_2Cl_2, 0°C

Heating 2.5 hours at 140°C a dilute solution of carboxamide **1a** in xylene afforded 4-silatetrahydro-2*H*-isoquinolin-1-one **10**[7] in 78% yield as a mixture of two diastereomers (de[8] = 36%) which were not

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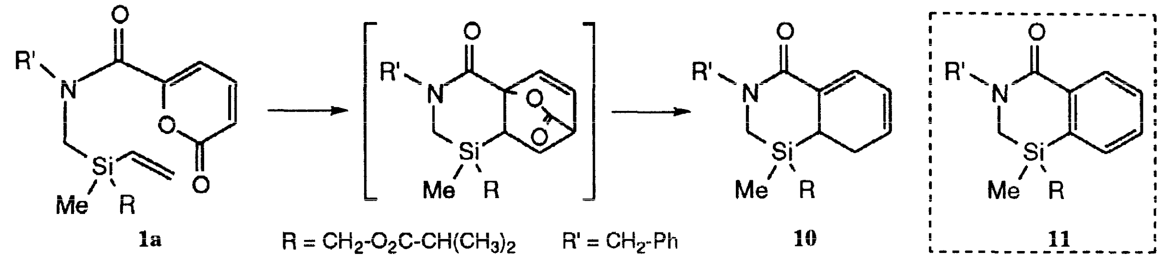
separated by silica gel chromatography and no trace of the tricyclic intermediate was observed. When the reaction was performed at 110°C for 1 day, the yield of the silaisoquinolinone **10** decreased to 42% and 4-siladihydro-2*H*-isoquinolin-1-one **11**, probably formed by aromatisation of compound **10**, was isolated (8% yield). The diastereomeric excess of the compound **10** (de [8] = 36%) was similar to that of the compound obtained at 140°C.

Recently it has been reported that commercially available chromatography silica gel (EM Science # 60) promotes cycloaddition reactions of 2-pyrones with dienophiles at room temperature and prevents loss of CO_2 from the initial cycloadducts.[9] Stirring, at room temperature during 7 days, a solution of carboxamide **1a** in CH_2Cl_2 in the presence of chromatography silica gel 60 (SDS, 70-250 mesh) afforded the same silaisoquinolinone **10**, resulting from the retro Diels-Alder reaction, in a 50% yield with a 40% diastereomeric excess.[8]



On the other hand the longer carboxamide homolog **1b** and pyran-2-one-6-carboxylates **2a** and **2b** were less reactive. After heating at 180°C during 1 day (toluene solutions, sealed tube) most part of these compounds remained untransformed. Further heating at 200°C (1 day) leads to complete transformation of these compounds and cycloaddition products were never detected.

In conclusion, the inverse electron demand Diels-Alder reactions of N-(vinylsilylmethyl)pyran-2-one-6-carboxamide followed by CO_2 extrusion through a retro Diels-Alder reaction allows the preparation of still unknown 4-silatetrahydro-2*H*-isoquinolin-1-one. Further studies to maximize stereocontrol are pursued and the results will be reported in due course.

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References and notes

1. a) Daniels, R.G.; Paquette, L.A. *Organometallics* **1982**, *1*, 1449-1453; b) Hathaway, S.J.; Paquette, L.A. *J. Org. Chem.* **1983**, *48*, 3351-3353; c) Fry, J.L.; McAdam, M.A. *Tetrahedron Lett.* **1984**, *25*, 5859-5862; d) Larson, G.L.; Torres, E. *J. Organomet. Chem.* **1985**, *293*, 19-27.
2. a) Brook, A.G.; Duff, J.M.; Anderson, D.J. *J. Am. Chem. Soc.* **1970**, *92*, 7567-7572; b) Larson, G.L.; Sandoval, S.; Cartledge, F.; Fronczek, F.R. *Organometallics* **1983**, *2*, 810-815; c) Bonini, B.F.; Mazzanti, G.; Zani, P.; Maccagnani, G. *J. Chem. Soc. Chem. Comm.* **1988**, 365-367; d) Bonini, B.F.; Maccagnani, G.; Masiero, S.; Mazzanti, G.; Zani, P. *Tetrahedron Lett.* **1989**, *30*, 2677-2680; e) Huber, P.; Bratovanov, S.; Bienz, S.; Pietzsch, M. *Tetrahedron: Asymmetry* **1996**, *7*, 69-78 and references noticed therein.
3. For a review on the inverse electron demand DA of 2-pyrones see Afarinkia, K.; Vinader, V.; Nelson, T.D.; Posner, G.H. *Tetrahedron* **1992**, *48*, 9111-9171.
4. Djerourou, A.; Blanco, L. *Tetrahedron Lett.* **1991**, *32*, 6325-6326. This enzymatic monoacylation was generally more chemoselective than usual chemical reactions. In these conditions the corresponding diesters were isolated in 20% yields.
5. ^{1}H-NMR spectroscopy of monoester **7b** in the presence of Eu(hfc)$_3$ show a 6% ee. The e.e. of **7a** was not dertermined.
6. For the synthesis of this acid chloride see Dunkelblum, M.R.; Allain, R.; Dreiding, A.S. *Helv. Chim. Acta* **1970**, *53*, 2159-2175 and Wiley, R.H.; Hart, A.J. *J. Am. Chem. Soc.* **1954**, *76*, 1942-1944.
7. ^{1}H-NMR (200 MHz, $CDCl_3$) 7.40-7.20 (m, 5H), 6.90-6.70 (m, 1H, H_8), 6.10-5.80 (m, 2H, H_6 and H_7), 4.76 (d, J = 14.4) and 4.61 (d, J = 14.4) (AB system, minor isomer) and 4.68 (s, major isomer) [2H, CH_2Ph], 3.94 (d, J = 14.7) and 3.83 (d, J = 14.7) (AB system, minor isomer) and 3.78 (s, major isomer) [2H, CH_2O], 2.80-2.10 (m, 6H, $SiC\underline{H}_2$-N, H_{4a}, H_5 and $C\underline{H}Me_2$), 1.12 (m, 6H, $CH(CH_3)_2$), 0.17 (s, $SiCH_3$, major isomer, 2.04H), 0.16 (s, $SiCH_3$, minor isomer, 0.96H).
8. Determined by ^{1}H-NMR integration of the $SiCH_3$ singulets.
9. Posner, G.H.; Carry, J.C.; Lee, J.K.; Bull, D.S.; Dai, H. *Tetrahedron Lett.* **1994**, *35*, 1321-1324.