Diastereofacial selectivity in reactions of 2,3,5-trichloro-4,4-dimethoxy-5-allyl- and 2,3-dichloro-3-diethylamino-4-oxo-5-allylcyclopent-2-en-1-ones with MeMgI

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Cyclopentenones **1** and **2** react with MeMgI to give predominantly *tert*-alcohols **3** and **5** of opposite configurations.

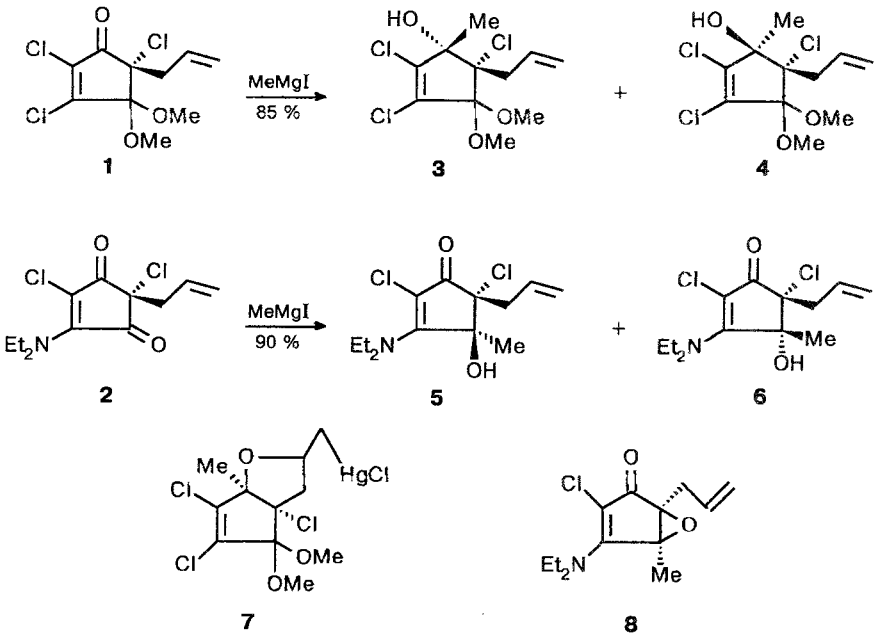
Key words: facial selectivity, nucleophiles, trichlorocyclopentenones.

We observed an interesting example of diastereofacial selectivity reversal in the reactions of MeMgI with related cyclopentenones (**1**)[1,2] and (**2**).[3] Enone **1** reacts with MeMgI (1.5 equiv.) to give a mixture of epimeric alcohols (**3**) and (**4**) in 4 : 1 ratio (overall yield 85 %) (Scheme 1). The stereochemical selectivity of the reaction suggests that steric control occurs, *i.e.*, the bulky Cl atom at C(5) directs the attack to the β-position of molecule **1**. However, the direction of a similar reaction of enaminodiketone **2** with MeMgI is reversed, and opposite selectivity is observed: epimeric alcohols (**5**) and (**6**) are formed in 93 % overall yield and in 9 : 1 ratio.

The structures of the products were determined by spectral methods. The stereochemistry was confirmed by transforming epimer **4** into bicycle (**7**) and epimer **5** into epoxide (**8**).

The ^{13}C NMR spectra of isomeric alcohols **3**,**4** and **5**,**6** are characterized by signals of the methyl and allyl CH_2 groups, which are shifted upfield in the case of

Scheme 1



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cis-chlorohydrins **3** and **6**. The ^{1}H NMR spectra display inequivalence of the CH_2 diastereotropic protons of the allyl group, which is markedly higher for *cis*-chlorohydrin **6** than for the *trans* isomer **5**.

It is difficult to unambiguously interpret the results obtained based on the data available for cyclopentenones **1** and **2** (see Refs. 4 and 5).

Experimental

IR spectra were obtained on a UR-20 spectrophotometer in thin films or in suspensions in Nujol. ^{1}H and ^{13}C NMR spectra were recorded on a Bruker AM-300 spectrometer at working frequencies of 300 and 75.47 MHz, respectively, using $SiMe_4$ as the internal standard and $CDCl_3$ as the solvent. Mass spectra were measured on an MKh-1306 instrument with an ionizing voltage of 70 eV and a temperature of the ionization chamber of 75—100 °C.

(±)-2,3,5α-Trichloro-4,4-dimethoxy-5β-allyl-1β-methylcyclopent-2-en-1α-ol (3) and its 1β-hydroxyepimer (4). A 0.2 *N* ethereal solution of MeMgI (1.4 mL) was added dropwise under argon to a stirred solution of enone **1** (1.0 g) in dry ether (15 mL). The mixture was stirred for an additional 0.5 h at −40 °C, saturated NH_4Cl (10 mL) was added, and the product was extracted with ether. The combined extracts were dried with Na_2SO_4 and concentrated. Chromatography of the residue on SiO_2 gave 0.9 g (85 %) of epimeric alcohols **3** and **4** in 4 : 1 ratio (^{1}H NMR data).

Compound **3**. IR, ν/cm^{-1}: 3544, 3080, 1640, 1440, 1432, 924, 760. ^{1}H NMR ($CDCl_3$), δ: 1.45 (s, 3 H, CH_3); 2.70—2.80 and 3.01—3.10 (m, 2 H, CH_2); 3.10 (s, 1 H, OH); 3.48 and 3.49 (s, 6 H, 2 MeO); 5.08—5.18 (m, 2 H, $CH=CH_2$); 5.80—6.00 (m, 1 H, $CH=CH_2$). ^{13}C NMR ($CDCl_3$), δ: 20.13 (CH_3); 39.87 (CH_2); 50.67 (OMe); 52.09 (OMe); 81.19 (C(5)); 85.96 (C(1)); 104.80 (C(4)); 118.21 and 132.74 ($CH=CH_2$); 129.61 (C(3)); 140.86 (C(2)). MS, *m/z*: 300 $[M]^+$ absent, 282 $[M-H_2O]^+$, 269 $[M-CH_3O]^+$, 265 $[M-Cl]^+$, 233 $[M-Cl-CH_3OH]^+$.

Compound **4**. ^{1}H NMR ($CDCl_3$), δ: 1.50 (s, 3 H, CH_3); 2.7—2.8 and 3.0—3.1 (m, 2 H, CH_2); 3.28 (s, 1 H, OH); 3.43 and 3.50 (s, 6 H, 2 MeO); 5.08—5.18 (m, 2 H, $CH=CH_2$); 5.80—6.00 (m, 1 H, $CH=CH_2$). ^{13}C NMR ($CDCl_3$), δ: 22.58 (CH_3); 39.62 (CH_2); 51.39 (OMe); 51.76 (OMe); 81.82 (C(1)); 83.00 (C(5)); 104.41 (C(4)); 118.45 and 133.90 ($CH=CH_2$); 131.42 (C(3)); 140.15 (C(2)).

(±)-2,5α-Dichloro-3-diethylamino-5β-allyl-4β-hydroxy-4α-methylcyclopent-2-en-1-one (5) and its 4α-hydroxyepimer (6). Compound **5** (0.8 g) and epimer **6** (0.09 g) were obtained in 93 % overall yield from enedione **2** (0.9 g) by a procedure similar to that for compounds **3** and **4**.

Compound **5**. ^{1}H NMR ($CDCl_3$), δ: 1.26 (t, 6 H, 2 CH_3, J = 6.9 Hz); 1.67 (s, 3 H, CH_3); 2.70—2.90 (m, 2 H, CH_2); 3.60—3.90 (m, 4 H, 2 CH_2—N); 4.10 (br.s, 1 H, OH); 5.10 and 5.70—5.90 (m, 3 H, $CH=CH_2$). ^{13}C NMR, $CDCl_3$, δ: 14.28 (CH_3); 29.06 (CH_3); 45.27 (CH_2); 46.04 (CH_2—N); 80.26 (C(5)); 81.75 (C(4)); 98.45 (C(2)); 119.78 and 133.77 (CH=CH); 167.70 (C(3)); 186.97 (C(1)).

Compound **6**. M.p. 87—89 °C. IR, ν/cm^{-1}: 3360—3500, 3095, 1710—1720, 1690, 1655, 1610, 1560—1590. ^{1}H NMR ($CDCl_3$), δ: 1.25 (t, 6 H, 2 CH_3, J = 7.0 Hz); 1.60 (s, 3 H, CH_3); 2.60 and 3.00 (m, 2 H, CH_2); 3.45 (s, 1 H, OH); 3.60—3.90 (m, 4 H, 2 CH_2—N); 5.15—5.25 and 5.95—6.10 (m, 3 H, $CH=CH_2$). ^{13}C NMR ($CDCl_3$), δ: 14.45 (CH_3); 25.22 (CH_3); 36.93 (CH_2); 45.61 (CH_2—N); 78.83 (C(4)); 79.67 (C(5)); 97.40 (C(2)); 119.10 and 132.03 ($CH=CH_2$); 168.02 (C(3)); 186.34 (C(1)).

(±)-1β-Methyl-4β,6,7-trichloro-5,5-dimethoxy-3β-mercuriochloromethylenebicyclo[3.3.0]octane (7). $Hg(OAc)_2$ (0.5 g) was added to a solution of a mixture of isomers **2** and **3** (0.3 g) in CH_2Cl_2 (10 mL). The suspension was stirred for 20 min and treated with aqueous NaCl (1 mL). Stirring was continued for an additional 10 min. The organic layer was washed with saturated NaCl (2 × 10 mL), dried, and concentrated. The residue was chromatographed on a column with SiO_2 to give 0.17 g (57 %) of unreacted isomer **3** and 0.08 g (35 %) of bicyclic compound **7**. The IR spectrum of **7** does not contain typical absorption bands of the allylic double bond and hydroxy group. ^{1}H NMR ($CDCl_3$), δ: 1.40 (s, 3 H, CH_3); 2.12 (dd, 1 H, $-CH_2Hg$, J = 5.8 Hz and −12.0 Hz); 2.28 (dd, 1 H, CH_2—Hg, J = 5.2 Hz and −12 Hz); 2.32 (dd, 1 H, C(4)—Hβ, J = 10.8 Hz and −14 Hz); 2.58 (dd, 1 H, C(4)—Hα, J = 5.4 Hz and −14.0 Hz); 3.45 (s, 3 H, OMe); 3.52 (s, 3 H, OMe); 4.85 (ddd, 1 H, C(3)—H, J = 10.7 Hz, 5.2 Hz, 5.4 Hz, 5.8 Hz). ^{13}C NMR ($CDCl_3$), δ: 20.86 (CH_3); 37.58 (CH_2Hg); 49.32 (C(4)); 51.10 (OMe); 52.25 (OMe); 77.79 (C(3)); 82.90 (C(5)); 92.20 (C(1)); 102.40 (C(6)); 128.39 (C(7)); 141.28 (C(8)). MS, *m/z*: 536±4 $[M]^+$, 505 $[M-Cl]^+$, 299 $[M-HgCl]^+$, 267 $[M-HgCl-CH_3OH]^+$, 263 $[M-HgCl-HCl]^+$, 233 $[M-HgCl-HCl-CH_2O]^+$ (max), 229 $[M-HgCl_2-Cl]^+$.

(±)-2-Chloro-3-diethylamino-4b,5b-epoxy-4a-methyl-5a-allylcyclopent-2-en-1-one (8). K_2CO_3 (0.23 g) was added to a stirred solution of *trans*-chlorohydrin **5** (0.1 g) in MeOH (5 mL). After the reaction ceased (TLC monitoring), the mixture was diluted with $CHCl_3$, filtered, and concentrated. The residue was chromatographed to give 0.07 g (81 %) of epoxide **8**. IR, ν/cm^{-1}: 3080, 3056, 1724, 1702, 1695, 1568. ^{1}H NMR, $CDCl_3$, δ: 1.30 (t, 6 H, 2 CH_3, J = 7.2 Hz); 1.70 (s, 3 H, CH_3); 2.25—2.38 and 3.00—3.10 (m, 2 H, CH_2); 3.50—3.80 (m, 4 H, 2 CH_2—N); 5.10 and 5.80 (m, 3 H, $CH=CH_2$). ^{13}C NMR, $CDCl_3$, δ: 13.58 (CH_3); 13.99 (CH_3); 28.88 (CH_2); 45.24 (CH_2—N); 61.41 (C(4)); 68.02 (C(5)); 101.90 (C(2)); 118.28 and 130.97 ($CH=CH_2$); 167.01 (C(3)); 190.09 (C(1)).

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