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Chemistry of 2-Methoxy-2,5-cyclohexadienones. III.[1] Syntheses of 2-Methoxy-4,4-diphenyl-2,5-cyclohexadienone and 4-Dichloromethyl-2-methoxy-4-methyl-2,5-cyclohexadienone[2]

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2-Methoxy-4,4-diphenyl-2,5-cyclohexadienone (Ib) was synthesized by phenylselenylation of 2-methoxy-4,4-diphenyl-2-cyclohexenone (Va) followed by oxidative deselenylation of the resultant 6-phenylselenyl derivative (Vc). 4-Dichloromethyl-2-methoxy-4-methyl-2,5-cyclohexadienone (Ic) was prepared by the Reimer–Tiemann reaction of 2-methoxy-4-methylphenol (IIa).

Keywords——cyclohexadienone; 2-methoxy-2,5-cyclohexadienone; bromoepoxyketone; Reimer–Tiemann reaction; β-cyclodextrin

The photoirradiation and epoxidation of 2-methoxy-4,4-dimethyl-2,5-cyclohexadienone (Ia), which is of chemical and biological interest, were reported in our preceding papers.[1,3] In this paper, we wish to report the synthesis of 2-methoxy-4,4-diphenyl-2,5-cyclohexadienone (Ib) and the result of a reexamination of Krajniak's work[4] on the Reimer–Tiemann (R–T) reaction of 2-methoxy-4-methylphenol (IIa) to obtain 4-dichloromethyl-4-methyl-2,5-

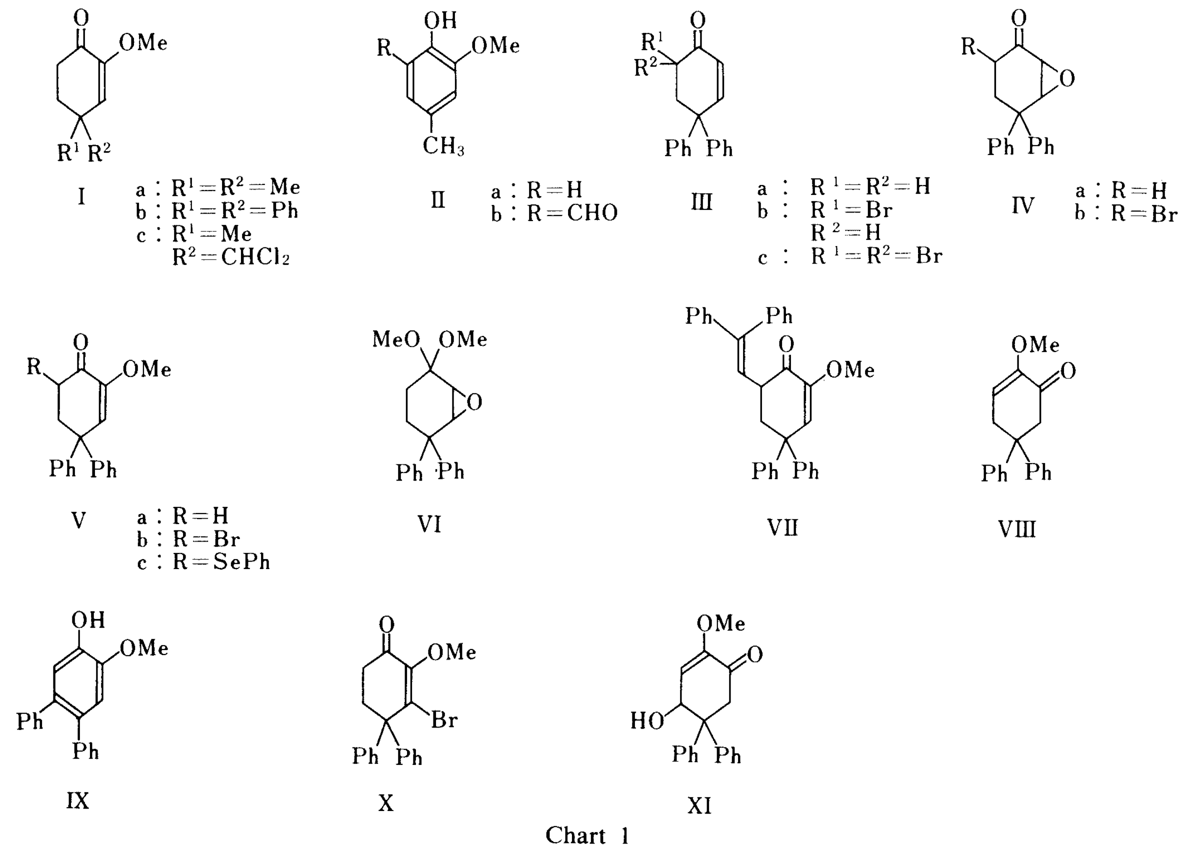

Chart 1

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cyclohexadienone (Ic).

4,4-Diphenyl-2-cyclohexenone (IIIa) was prepared according to the literature[5] from diphenylacetaldehyde and methyl vinyl ketone in 67.3% yield. Epoxidation of IIIa was carried out with 35% hydrogen peroxide in 6 N Na_2CO_3 solution to give 2,3-epoxy-4,4-diphenylcyclohexanone (IVa) in 96.8% yield.

In order to prepare 2-methoxy-4,4-diphenyl-2-cyclohexenone (Va), IVa was treated with potassium hydroxide in methanol, but the yield of Va was low (23.8%). On the other hand, IVa was treated with a catalytic amount of concentrated sulfuric acid in methanol to give the methyl ketal of IVa (VI). Compound Va was alternatively synthesized according to the reported method[6] for the preparation of the corresponding 4,4-dimethyl derivative. Thus, the reaction of 1,4-dimethoxy-2-butanone with diphenylacetaldehyde in the presence of Triton B afforded Va in a relatively high yield (66.6%) along with 2-methoxy-6-(2,2-diphenylvinyl)-2-cyclohexenone (VII) as a by-product.[3] Compound Va was stable toward trifluoroacetic acid. However, a methanolic solution of Va was treated with borontrifluoride etherate at reflux temperature to give Va and 2-methoxy-5,5-diphenyl-2-cyclohexenone (VIII) in the ratio of 1 : 2. In the nuclear magnetic resonance (NMR) spectrum, VIII exhibited a triplet signal ($J = 10$ Hz) at δ 5.87 due to the vinylic proton (*cf.* Va: singlet at δ 6.00). In the ultraviolet (UV) spectrum, VIII showed an absorption maximum at 262 nm and Va showed more intense ones at 261 and 266 nm. This difference in UV maxima suggests that the lowest excited state in Va may involve energy transfer to the phenyl group.[7] This transfer of energy in Va is reflected in the streching band of the double bond at 1625 cm^{-1} (*cf.* VIII: 1641 cm^{-1}) in the infrared (IR) spectrum. In the high-resolution mass spectrum (MS), the parent peak was the base peak in Va, whereas in VIII the base peak was *m/e* 98, corresponding to $C_5H_6O_2$, which may be a fragment derived by a retro Diels–Alder reaction.

Several attempts were made to obtain the dienone, Ib, from Va. Treatment of Va with chloranil in dioxane gave a complex mixture of products, while treatment with selenium dioxide in *tert*-amyl alcohol and acetic acid gave 2-methoxy-4,5-diphenylphenol (IX) as a minor product together with a large amount of the starting material. We next examined the route to Ib from Vb. The requisite compound IVb was prepared by bromination of IIIa and successive epoxidation of the resulting bromide IIIb (see Experimental). An attempt was made to convert IVb to Vb under reflux with potassium hydroxide in methanol, but gave a complex mixture of products. The isolated compound was suggested to be 4-hydroxy-2-methoxy-5,5-diphenyl-2-cyclohexenone (XI) on the basis of the physical data and the elemental analysis. The carbonyl band and ethylenic band in the IR spectrum, the absorption maximum in the

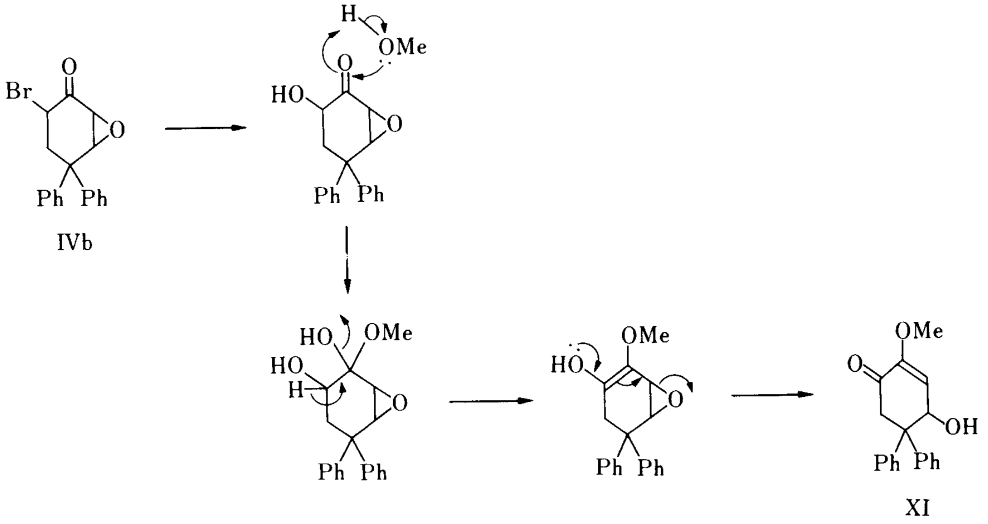

Chart 2

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UV spectrum, and the chemical shift of the vinylic proton in the NMR spectrum were similar to those of Va. In the NMR spectrum, the broad singlet signal at δ 1.75 disappeared on the addition of deuterium oxide, suggesting that a hydroxy group exists in XI. The mechanism of formation of XI from IVb is proposed to be as shown in Chart 2.

Recently Huchins *et al.*[8] reported an efficient method for the dehydrogenation of spiroenones to spirodienones *via* an organoselenium compound. We examined the feasibility of application of this method to Va. Thus Va was converted to the corresponding enolate by the use of lithium diisopropylamide (LDA), followed by treatment with phenylselenyl chloride to give 2-methoxy-4,4-diphenyl-6-phenylselenyl-2-cyclohexenone (Vc) in 53.6% yield together with Va (33.2%). Next, Vc was oxidized with *m*-chloroperbenzoic acid (*m*CPBA) in methylene chloride to give the expected dienone, Ib, in high yield. Compound Ib melted at 158—160 °C, and exhibited the parent peak as the base peak in the MS, while in the NMR spectrum it showed signals at δ 6.20, 6.43, and around δ 7.25 due to the three vinylic protons and the C_3 and C_5 protons were coupled to each other (W rule, $J = 3$ Hz).

The preparation of Ic was carried out by means of the R–T reaction of IIa, Krajniak *et al.*[4] had examined the R–T reaction of IIa by using sodium hydroxide, chloroform, and aqueous ethanol to obtain Ic, 6-formyl-2-methoxy-4-methylphenol (IIb), and IIa in yields of 3.2, 19.2, and 18.0%, respectively. We duplicated their experimental work on IIa, but with no ethanol, and obtained Ic, IIb, and IIa in isolated yields of 34.0, 12.5, and 34.5%, respectively. Thus the yield of Ic was dramatically improved. As Ohara and Fukuda[9] reported that the R–T reaction using β-cyclodextrin (CD) suppressed the formation of *ortho*-substituted product, we examined the R–T reaction of IIa using β-CD. When 0.5 mol eq of β-CD was used, IIa afforded Ic, IIb, and IIa in 28.9, 9.0, and 42.5% yields, respectively. Thus, by using β-CD, the ratio of Ic to IIb increased, but the yield of Ic was not improved. The results of the photochemical reaction of Ib and Ic will be reported elsewhere in the near future.

Experimental

All melting points were taken on a Kofler block, and are uncorrected. IR spectra were determined by using a JASCO A 102 or a JASCO IR-A1 differaction grating spectrophotometer; absorption data are given in cm^{-1}. NMR spectra were recorded on a Varian EM-360, JEOL PMX-60, Varian EM-390, or Varian XL-200 spectrometer with tetramethylsilane (TMS) as an internal standard. The chemical shifts and coupling constants (J) are given in δ and Hz, respectively. MS were measured with JEOL D-300 and D-200 (70 eV, direct inlet system) spectrometers. UV spectra were obtained in MeOH with Hitachi 200-10 and Hitachi-220 spectrometers, and absorption maxima are given in nm. Gas chromatography (GC) was carried out using a Shimadzu GC-6AM instrument with a stainless steel column packed with 5% SE-30. The N_2 gas flow was 40 ml/min. All solvents were removed by evaporation under reduced pressure after drying of the solution over anhyd. $MgSO_4$.

2,3-Epoxy-4,4-diphenylcyclohexanone (IVa)——A methanolic suspension of 4,4-diphenyl-2-cyclohexenone[4] (IIIa) 6.41 g, 25.8 mmol), 6 N Na_2CO_3 soln. (2.1 ml, 6.3 mmol), and 35% hydrogen peroxide (HPO) (6.2 ml, 63.8 mmol) was stirred at *ca.* 25 °C for 26 h. The crystalline product was filtered off and combined with that obtained by addition of water to the mother liquor. The combined product was recrystallized from Et_2O or Et_2O–hexane. The yield was 6.66 g (96.8%). IVa: mp 74—77 °C. IR (Nujol): $\nu_{C=O}$ 1701. NMR (CCl_4): 1.2—2.3 (3H, m, C_5– and C_6–H), 2.4—3.1 (1H, m, C_6–H), 3.30 (1H, d, $J=4$, C_2–H), 3.93 (1H, dd, $J=4$, 1.2, C_3–H), 7.24 (10H, s, aromatic H). MS *m/e* (%): 264 (M^+, 48), 193 ($Ph_2\overset{+}{C}CH=CH_2$, base peak). *Anal.* Calcd for $C_{18}H_{16}O_2$: C, 81.79; H, 6.10. Found: C, 81.55; H, 6.17.

2-Methoxy-4,4-diphenyl-2-cyclohexenone (Va)——A methanolic mixture of IVa (1 g, 3.8 mmol) and KOH (85.5%, 0.3 g, 4.6 mmol) was refluxed for 10 h. The resulting mixture was concentrated and extracted with $CHCl_3$. The organic layer was washed with brine and dried. The residue obtained after removal of the solvent was fractionated through an Al_2O_3 column, and Va was obtained from the benzene fraction as a yellow oil, which was crystallized by adding Et_2O and recrystallized from Et_2O. The yield was 0.23 g (23.8%) mp 111—113 °C. GC (250 °C): t_R 2.7 min. IR (Nujol): $\nu_{C=O}$ 1690, 1625. UV λ_{max} nm (ε): 261 (12300), 266 (sh., 11900). NMR (CCl_4): 2.1—2.5 and 2.5—3.0 (each 2H, sym. m, C_5– and C_6–H), 3.68 (3H, s, –OMe), 6.00 (1H, s, C_3–H), 7.20 (10H, s, aromatic H). MS *m/e* (%): 278 (M^+, 50), 250 (13), 236 (39), 219 (89), 204. High resolution MS *m/e* (%): 278 ($C_{19}H_{18}O_2$, base peak), 249 ($C_{18}H_{17}O$, 15), 236 ($C_{17}H_{16}O$, 70), 235 ($C_{17}H_{15}O$, 50), 178 ($C_{14}H_{10}$, 40), 173 ($C_{12}H_{13}O$, 41). *Anal.* Calcd for $C_{19}H_{18}O_2$: C, 81.98; H, 6.52. Found: C, 82.01; H, 6.55.

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2,3-Epoxy-1,1-dimethoxy-4,4-diphenylcyclohexane (VI)——A methanolic mixture of IVa (1.32 g, 5 mmol) and conc. H_2SO_4 (1 drop) was refluxed for 0.5 h. The solid was filtered off and recrystallized from MeOH. mp 144—148 °C. 1.03 g (66.4%). IR (Nujol): δ_{C-O} 1050, 1110. NMR (CCl_4): 1.0—1.8 (2H, m, C_6-H), 1.8—2.4 (2H, m, C_5-H), 3.25 and 3.45 (each 3H, s, OMe), 3.48 (1H, d, $J=4$, C_2-H), 3.83 (1H, d, $J=4$, C_3-H), 7.29 and 7.32 (each 5H, s, aromatic H). MS *m/e* (%): 310 (M^+, 0.4), 101 (92), 88 (base peak). *Anal.* Calcd for $C_{20}H_{22}O_3$: C, 77.39; H, 7.14. Found: C, 77.04; H, 7.09.

2-Methoxy-6-(2,2-diphenylvinyl)-2-cyclohexenone (VII)——1,4-Dimethoxy-2-butanone (3.73 g, 28.2 mmol) was added to a methanolic mixture of diphenylacetaldehyde (7.53 g, 38 mmol) and 40% methanolic Triton B (2.83 g) over 30 min. The methanolic solution was refluxed for 14 h and then diluted with water. The $CHCl_3$ extract was concentrated and fractionated through an Al_2O_3 column. Va and VII were eluted successively with benzene. Va: 5.4 g (66.6%). VII: mp 202—205 °C, 0.21 g (1.6%). NMR ($CDCl_3$): 2.65 (2H, d, $J=10$, C_5-H), 3.57 (1H, td, $J=10$, 10, >CH-), 3.77 (3H, s, OMe), 6.21 (1H, s, C_3-H), 6.28 (1H, d, $J=10$, vinylic H), 6.8—7.4 (20H, s like, aromatic H). MS *m/e* (%): 457 (M^++1, 22), 456 (M^+, 56), 220 (Ph_2CH-$CH=C=C=O$, base peak). *Anal.* Calcd for $C_{33}H_{28}O_2+1/4H_2O$: C, 85.97; H, 6.23. Found: C, 86.10; H, 6.05.

2-Methoxy-5,5-diphenyl-2-cyclohexenone (VIII)——A methanolic solution of Va (0.11 g) was refluxed in the presence of BF_3-etherate (1 ml) under anhydrous conditions. The residue obtained after concentration was basified with NH_3 solution and then extracted with CH_2Cl_2. The composition of the material (0.1 g) obtained from the organic layer was analyzed by means of the NMR technique. Va: VIII = 1 : 2. The material relatively insoluble in Et_2O was recrystallized from Et_2O. VIII: mp 158—160 °C. IR (Nujol): $\nu_{C=O}$ 1690, $\nu_{C=C}$ 1641. UV λ_{max} (ε) 262 (7800). NMR (CCl_4): 3.1—3.4 (4H, d like C_4- and C_6-H), 3.58 (3H, s, -OMe), 5.87 (1H, t, $J=10$, C_3-H), 7.29 (10H, s, aromatic H). MS *m/e* (%): 278 (M^+, 22), 250 (8), 98 (base peak), 70 (68), 55 (97). High resolution MS (%): 278 ($C_{19}H_{18}O_2$, 22), 250 ($C_{18}H_{18}O$, 11), 98 ($C_5H_6O_2$, base peak), 70 (C_4H_6O, 41), 55 (C_3H_3O, 40). *Anal.* Calcd for $C_{19}H_{18}O_2$: C, 81.98; H, 6.52. Found: C, 81.72; H, 6.40.

2-Methoxy-4,5-diphenylphenol (IX)——SeO_2 (0.21 g, 1.77 mmol) was added to a solution of Va (0.41 g, 1.47 mmol) in *tert*-amyl alcohol (6.3 ml) and AcOH (1.6 ml). After the mixture had been refluxed for 40 h under an Ar atmosphere, undissolved material was filtered off and the filtrate was concentrated. The residue was fractionated through an SiO_2 column. IX (*ca.* 0.1 g) and V (0.23 g) were eluted successively with benzene. IX: mp 148—152 °C. GC (250 °C), t_R 6.6 min (*cf*, Va: 8.8 min). IR (Nujol): ν_{OH} 3400 (br). NMR (CCl_4): 3.98 (3H, s, -OMe), 6.82 and 6.95 (each 1H, s, aromatic H), 7.13 (10H, s, aromatic H). *Anal.* Calcd for $C_{19}H_{16}O_2$: C, 82.58; H, 5.84. Found: C, 81.92; H, 5.74. *cf.* Calcd for $C_{19}H_{16}O_2+0.1\ H_2O$: C, 82.03; H, 5.79.

3-Bromo-2-methoxy-4,4-diphenyl-2-cyclohexenone (X)——Benzoyl peroxide (50 mg) and *N*-bromosuccinimide (NBS) (0.52 g, 2.92 mmol) were added to a CCl_4 soln. of Va (0.4 g, 1.43 mmol). After being refluxed for 6.5 h under an Ar atmosphere, the mixture was washed twice with water and dried. The residue obtained after removal of the solvent was fractionated through an SiO_2 column. X (0.26 g, 51.0%) and Va (0.50 g, 12.6%) were eluted with benzene and $CHCl_3$, respectively. X: mp 158—160 °C (from Et_2O-hexane). NMR (CCl_4): 2.1—2.6 and 2.6—3.1 (each 2H, t, $J=6$, C_5- and C_6-H), 3.86 (3H, s, -OMe), 7.39 (10H, s, aromatic H). MS *m/e* (%): 358 (M^++2, 1.8), 356 (M^+, 1.8), 277 (M^+-Br, base peak). *Anal.* Calcd for $C_{19}H_{17}BrO_2$: C, 63.88; H, 4.80. Found: C, 64.13; H, 4.83.

6-Bromo-4,4-diphenyl-2-cyclohexenone (IIIb) and 6,6-Dibromo-4,4-diphenyl-2-cyclohexenone (IIIc)——Benzoyl peroxide (0.1 g) and NBS (0.64 g, 3.6 mmol) were added to a soln. of IIIa (0.72 g, 2.9 mmol) in CCl_4-DMSO (1 : 1). After being refluxed for 23.5 h, the mixture was diluted with water. The CCl_4 layer was combined with the $CHCl_3$ extract of the aq. layer. The organic solvent was evaporated off to give an oily residue, which was fractionated through an SiO_2 column. From the benzene, IIIc (0.09 g, 7.6%) and IIIb (0.58 g, 61.2%) were eluted successively with benzene, and IIIa (0.21 g, 29.2%) was recovered from the $CHCl_3$ eluate. IIIb: mp 108—112 °C (from Et_2O-hexane). NMR ($CDCl_3$): 3.12 (1H, t, $J=13$, C_5-H), 3.24 (1H, ddd, $J=13$, 5, 2, C_5-H), 4.72 (1H, dd, $J=13$, 5, C_6-H), 6.34 (1H, d, $J=10$, C_2-H), 7.1—7.6 (11H, m, aromatic and C_3-H). MS *m/e* (%):328 (M^++2, 1.8), 326 (M^+, 2.2); 247 (M^+-Br, 28), 245 (69), 219 (base peak). *Anal.* Calcd for $C_{18}H_{15}BrO$: C, 66.07; H, 4.62. Found: C, 66.22; H, 4.43. IIIc: mp 130—132 °C (from Et_2O-hexane). NMR ($CDCl_3$): 4.03 (2H, s, C_5-H), 6.32 (1H, d, $J=12$, C_2-H), 7.0—7.4 (11H, s like, C_3- and aromatic H). MS *m/e* (%): 408 (M^++4, 5), 406 (M^++2, 10), 404 (M^+, 5), 245 ($M^+-2Br-H$, 81), 217 (*m/e* 245−CO, base peak). *Anal.* Calcd for $C_{18}H_{14}Br_2O$: C, 53.24; H, 3.47. Found: C, 53.22; H, 3.57.

6-Bromo-2,3-epoxy-4,4-diphenylcyclohexanone (IVb)——HPO (35% soln. 0.92 ml, 9.45 mmol) and 6 N Na_2CO_3 (0.31 ml, 0.93 mmol) were added to a methanolic soln. of IIIb (1.25 g, 3.8 mmol). After being stirred for 39.5 h, the reaction mixture was diluted with water and extracted with $CHCl_3$. The organic layer was washed with brine and dried. The residue was crystallized and recrystallized from Et_2O-hexane to give IIIb (0.3 g). The mother liquor was concentrated and fractionated through an SiO_2 column. IVb was eluted with benzene and recrystallized from Et_2O-hexane. Yield, 0.26 g (19.8%). mp 132—142 °C. IVb: NMR ($CDCl_3$): 2.74 (1H, ddd, $J=13$, 7, 1.5, C_5-H), 3.20 (1H, dd, $J=13$, 12, C_5-H), 3.69 (1H, d, $J=4$, C_2-H), 3.98 (1H, dd, $J=12$, 7, C_6-H), 4.07 (1H, dd, $J=4$, 1.5, C_3-H), 7.1—7.5 (10H, m, aromatic H). MS *m/e* (%):344 (M^++2, 6), 342 (M^+, 6), 246 ($M^+-HBr-O$, 19), 245 (base peak). *Anal.* Calcd for $C_{18}H_{15}BrO_2$: C, 62.99; H, 4.41. Found: C, 62.94; H, 4.46.

4-Hydroxy-2-methoxy-5,5-diphenyl-2-cyclohexenone (XI)——A methanolic soln. of IVb (0.26 g, 0.76 mmol) and KOH (85.5%, 0.06 g, 0.92 mmol) was refluxed for 10 h and then diluted with water. The $CHCl_3$ extract was

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fractionated through an SiO_2 column. XI was obtained from the acetone eluate and recrystallized from Et_2O–hexane. mp 88—94 °C. IR (Nujol): ν_{OH} 3520, 3280, $\nu_{C=O}$ 1690, $\nu_{C=C}$ 1641. UV λ_{max}: 261. NMR ($CDCl_3$): 3.26 (1H, dd, J=15, 1, C_6–H), 3.63 (1H, d, J=15, C_6–H), 1.75 (1H, br s, –OH), 3.51 (3H, s, OMe), 5.25 (1H, dd, J=6, 1, C_4–H), 5.80 (1H, d, J=6, C_3–H), 6.8—7.5 (10H, m, aromatic H). MS m/e (%): 294 (M^+, 5), 276 ($M^+ - H_2O$, 16), 181 (62), 104 (95), 86 (99), 71 (base peak). *Anal.* Calcd for $C_{19}H_{18}O_3 + 1/2H_2O$: C, 75.23; H, 6.31. Found: C, 75.25; H, 6.08.

2-Methoxy-4,4-diphenyl-6-phenylselenyl-2-cyclohexenone (Vc)——A THF solution of Va (0.45 g, 1.61 mmol) was added to an LDA solution prepared from diisopropylamine (0.26 ml, 1.77 mmol) and n-BuLi (1.6 M solution in hexane, 1.19 ml, 1.77 mmol) at −78 °C. After 20 min, a THF solution of phenylselenyl chloride (0.342 g, 1.79 mmol) was added to the mixture at the same temperature. The mixture was allowed to warm to room temperature. After being diluted with water, the mixture was extracted with Et_2O, and the organic layer was washed with $NaHCO_3$ soln. and brine, then dried. The solvent was removed to give the residue (0.78 g), which was fractionated through an SiO_2 column. Vc (0.41 g, 53.6%) and Va (164 mg, 33.2%) were eluted with benzene and $CHCl_3$, respectively. Vc was recrystallized from MeOH. mp 130—132 °C. NMR (CCl_4): 2.80 (2H, d, J=9.5, C_5–H), 3.62 (3H, s, –OMe), 4.15 (1H, t, J=9.5, C_6–H), 6.01 (1H, s, C_3–H), 6.8—7.6 (15H, m, aromatic H). IR (Nujol): $\nu_{C=O}$ 1685, $\nu_{C=C}$ 1620. MS m/e (%): 434 ($M^+ + 2$, 18), 432 (M^+, 16), 277 ($M^+ -$PhSe, base peak). *Anal.* Calcd for $C_{25}H_{22}O_2Se$: C, 69.29; H, 5.12. Found: C, 69.41; H, 5.12.

2-Methoxy-4,4-diphenyl-2,5-cyclohexadienone (Ib)——mCPBA (purity 70%, 66 mg, 0.27 mmol) was added to a CH_2Cl_2 soln. of Vc (92 mg, 0.21 mmol) at room temperature. After being stirred for 1.5 h, the mixture was washed with sat. $NaHCO_3$ soln. and brine. The residue obtained after removal of the solvent was crystallized, and Ib thus obtained was recrystallized from Et_2O. mp 160—165 °C. 54.2 mg (928). IR (Nujol): $\nu_{C=O}$ 1660, $\nu_{C=C}$ 1640, 1630, 1605. UV λ_{max} (ε): 204 (55900), 217 (sh, 34700), 240 (sh, 19000). NMR ($CDCl_3$): 3.78 (3H, s, –OMe), 6.20 (1H, d, J=3, C_3–H), 6.43 (1H, d, J=10, C_6–H), 7.25 (1H, dd, J=10, 3, C_5–H), 7.1—7.6 (10H, m, aromatic H). MS m/e (%): 276 (M^+, base peak), 233 ($M^+ - CO - CH_3$, 44). *Anal.* Calcd for $C_{19}H_{16}O_2$: C, 82.59; H, 5.84. Found: C, 82.50; H, 5.88.

Reimer–Tiemann Reaction of 2-Methoxy-4-methylphenol (IIa)——i) Normal Conditions: IIa (0.93 g, 6.73 mmol) and then $CHCl_3$ (2 ml, 25.4 mmol) were added to a mixture of NaOH (2.03 g, 48.2 mmol) and H_2O (50 ml). After being warmed at 65—75 °C for 4 h, the mixture was cooled and extracted with Et_2O. The residue (0.79 g) obtained after removal of the solvent was fractionated through an SiO_2 column. IIa (0.23 g) was recovered from the benzene fraction and 4-dichloromethyl-2-methoxy-4-methyl-2,5-cyclohexadienone (Ic, 0.50 g, 34.0%) was obtained from the $CHCl_3$ fraction. Ic: mp 63—65 °C (recrystallized from Et_2O, lit.[4] 63—64 °C). NMR (CCl_4): 1.56 (3H, s, Me), 3.74 (3H, s, OMe), 5.85 (1H, d, J=3, C_3–H), 5.94 (1H, s, $CHCl_2$), 6.93 (1H, d, J=10, C_6–H), 6.99 (1H, dd, J=10, 3, C_5–H). The mother liquor was acidified with 10% HCl and extracted with $CHCl_3$ to give IIa (0.09 g) and 6-formyl-2-methoxy-4-methylphenol (IIb, 0.14 g, 12.5%). The amounts of IIa and IIb were calculated from the integral of the OMe signal (δ 3.39) of IIa and IIb and the CHO signal (δ 9.76) of IIb in the NMR spectra.

ii) Using β-Cyclodextrin (CD): IIa (0.93 g, 6.73 mmol) and then $CHCl_3$ (2 ml, 25.4 mmol) were added to a mixture of NaOH (2.03 g, 48.2 mmol), β-CD (3.82 g, 3.37 mmol), and H_2O (25 ml). The mixture was warmed at 70 °C for 2 h. The dark aq. mixture was extracted with Et_2O and the organic layer was washed with water and then dried. The residue obtained after removal of the solvent was fractionated through an SiO_2 column. IIa (0.06 g) and Ic (0.11 g) were eluted with benzene and $CHCl_3$, respectively. The mother liquor was acidified with 10% HCl. The precipitated β-CD was filtered off and the filtrate was extracted with Et_2O and $CHCl_3$. The residues obtained from both extracts were combined, and the NMR spectrum indicated that it contained IIa (0.25 g) and IIb (0.1 g). The β-CD was washed with $CHCl_3$ to obtain IIa (0.09 g) and Ic (0.32 g). Total yield: IIa, 0.40 g (42.5%); IIb, 0.1 g (9.0%); Ic, 0.43 g (28.9%).

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References and Notes

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