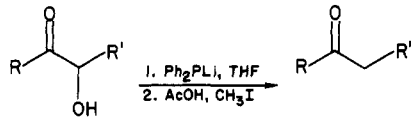
Scheme I



Scheme II

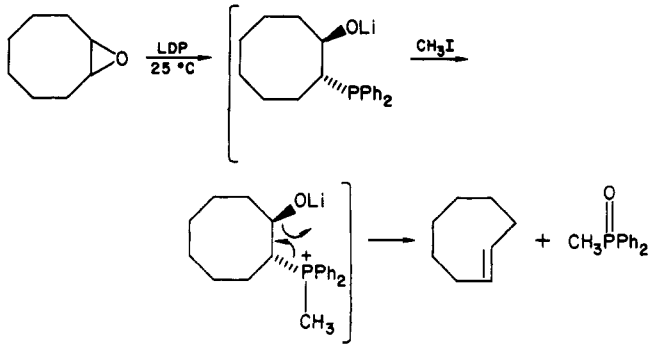
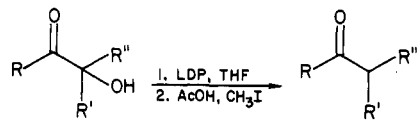


Table I. Dehydroxylation of α-Hydroxy Ketones with Lithium Diphenylphosphide (LDP)



R	R′	R″	% yield product
Ph	Ph	H	76[a]
anisoyl	anisoyl	H	86[a]
Me	Me	Me	60[b]
$(CH_2)_{10}$		H	72[a]
n-Pr	*n*-Pr	H	52[a]
furyl	furyl	H	81[a]

[a] Isolated yield. [b] GC yield.

A reasonable mechanism can be envisioned that considers initial deprotonation of the α-hydroxyl group by the first equivalent of LDP, followed by nucleophilic attachment of the second equivalent on the ketone carbonyl. Methyl iodide then reacts with the dianion formed to give the betaine intermediate **2**, which undergoes elimination of methyldiphenylphosphine oxide through standard Wittig-type fragmentation. Quenching of the reaction with acetic acid gives the observed α-methylene ketone product (Scheme III) via the enolate **2**. The intermediacy of the enolate **2** is substantiated by treatment of the reaction mixture with excess methyl iodide to obtain the expected α-methyl ketone as the only product. This information and the analogy of this mechanism to that proposed by Vedejs and Fuchs[5] for the isomerization of the *cis*-cyclooctene support our proposal for a mechanism.

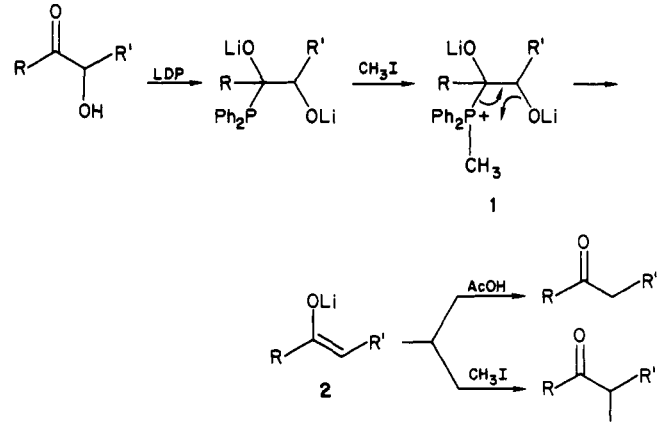
In addition to providing support for our proposed mechanism, this trapping experiment expands the utility of our reaction. By variation of the workup conditions, we are able to effect either simple hydroxyl reduction or alkylative hydroxyl replacement. Workup of the crude reaction mixture with excess methyl iodide gives the α-methylated ketone product through overall replacement of the hydroxyl function by an alkyl group in one synthetic step. Similarly, aqueous workup gives the dehydroxylated methylene ketone product.

Thus, we have developed a novel reaction in the field of organophosphorus chemistry, which should be a useful tool for the synthetic chemist.

Experimental Section

All reactions were conducted under a nitrogen atmosphere. In each case, the reaction products were characterized by comparison

Scheme III



to authentic samples and found to be identical. The term MPLC refers to medium-pressure liquid chromatography on a prepacked lobar column size C at 20 psi. Although we chose to prepare LDP from lithium and diphenylphosphinous chloride, this reagent may also be made by treatment of diphenylphosphine with *n*-butyllithium.[6] The following experimental procedure is representative of the dehydroxylation of α-hydroxy ketones by use of lithium diphenylphosphide.

Dehydroxylation of Benzoin. Diphenylphosphinous chloride (5.0 g, 22.6 mmol) was added dropwise to a suspension of lithium shot (237 mg, 28.3 mmol) in THF (10 mL) at room temperature. After about 2 h most of the lithium had dissolved. The orange LDP solution was separated from the unreacted lithium, and a solution of benzoin (2.4 g, 11.3 mmol) in THF (25 mL) was added to it dropwise. The clear yellow reaction mixture was stirred overnight at room temperature. Acetic acid (678 mg, 11.2 mmol) was then added, followed by methyl iodide (1.6 g, 11.3 mmol). After stirring for an additional 30 min, the reaction mixture was poured into water (100 mL) and extracted with ethyl acetate. The combined organic extracts were dried over magnesium sulfate and concentrated in vacuo, giving a yellow oil. MPLC purification on silica gel (eluting solvent, ethyl acetate) gave desoxybenzoin (1.7 g, 76%) as a white crystalline solid.

Registry No. PhCOCH(OH)Ph, 119-53-9; $CH_3OC_6H_4COCH(OH)C_6H_4OCH_3$, 30587-18-9; $CH_3COC(CH_3)_2OH$, 115-22-0; $CH_3(CH_2)_2COCH(OH)(CH_2)_2CH_3$, 496-77-5; $CH_3OC_6H_4COCH_2C_6H_4OCH_3$, 97981-16-3; $CH_3COCH(CH_3)_2$, 563-80-4; $CH_3(CH_2)_2CO(CH_2)_3CH_3$, 589-63-9; $PhCOCH_2Ph$, 451-40-1; Li, 7439-93-2; LDP, 4541-02-0; 2-hydroxydodecanone, 19025-38-8; 1,2-difurylhydroxyacetaldehyde, 552-86-3; cyclododecanone, 830-13-7; 1,2-difurylacetaldehyde, 51490-07-4; diphenylphosphinous chloride, 1079-66-9.

(6) Ireland, R. E.; Valba, D. M. *Org. Synth.* **1977**, *56*, 44–48.

An Unusual Synthesis of 5-Methoxy-7,12-dimethylbenz[*a*]anthracene[1]

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In an attempt to work out an improved synthesis of 1,4-dimethoxy-7,12-dimethylbenz[*a*]anthracene the con-

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0022-3263/86/1951-2379$01.50/0

densation of 2-acetylbenzoic acid with 1,4-dimethoxynaphthalene was studied.[3] A high yield of **1** was obtained. Reduction yielded **2** which was readily condensed with methyllithium to produce **3** in 59% overall yield from 1,4-dimethoxynaphthalene. Reduction of **3** yielded two isomers of **4** in a ratio[4] of about 3 to 1. No attempt to separate these isomers was made. Treatment of **4** with *p*-toluenesulfonic acid (TSA) in benzene at reflux produced **6** in 61% yield.

This unexpected result evidently occurs by an ipso-type electrophilic attack of the benzylic cation produced from **4** on the carbon bearing the 1-methoxy group of the naphthalene ring to form **5**. The cation, **5**, then stabilizes itself by loss of methanol from adjacent carbons and a proton to produce **6**. To our knowledge this reaction represents the first example of an ipso-type displacement of a methoxy groups on carbon.[5] It is noteworthy that an ipso attack occurs in preference to ring closure at carbon three of the naphthalene moiety to form a dihydronaphthacene derivative.

On the other hand when the acid, **2**, was treated with acidic reagents, a high yield of **7** was obtained. In this case there is no ready way for an ipso-type intermediate such as cation **8** to stabilize itself. Hence the ipso-type cation reverses to an oxo-type cation which cyclizes to **7**. Treatment of **7** with methyllithium followed by dilute HCl treatment of the product yielded 65% of **9** No trace of a naphthacene derivate was formed when **9** was treated with potassium *tert*-butoxide.[6] The NMR spectra of **7** and **9** agree with the proposed structures. However, each was so unstable that samples pure enough to give satisfactory analyses were not obtained.

Experimental Section[7]

3-(1,4-Dimethoxy-2-naphthyl)-3-methylphthalide,* 1. The addition of 19.7 g of *o*-acetylbenzoic acid to 20.3 g (0.108 mol) of 1,4-dimethoxylnaphthalene in 140 mL of sulfolane was carried out essentially as described[3] to yield 33.1 g (92%) of **1**: mp 151–152 °C; NMR δ 2.20 (s, 3, CH_3), 3.73 (s, 3, OCH_3), 3.96 (s, 3, OCH_3), 6.88 (s, 1, Ar H), 7.30–8.36 (m, 8, Ar H); IR (KBr) 1756 cm^{-1} (CO); MS, 334.1209, calcd for $C_{21}H_{18}O_4$, 334.1204.

***o*-[1-(1,4-Dimethoxy-2-naphthyl)ethyl]benzoic Acid,* 2.** A mixture of 22.73 g of **1**, 90 g of zinc dust activated with 1 g of $CuSO_4$, 650 mL of 10% KOH, and 40 mL of pyridine was held at reflux for 8 h. From the neutral product there was isolated 20.26 g (89%) of **2**: mp 168–170 °C, as colorless prisms: NMR 1.75 (d, 3, CH_3), 3.63 (s, 3, OCH_3), 4.01 (s, 3, OCH_3), 5.75 (q, 1, CH), 6.90 (s, 1, Ar H), 7.13–8.36 (m, 8, Ar H), 10.40–11.23 (m, 1, OH); MS, 336.1365, calcd for $C_{21}H_{20}O_4$, 336.1361.

***o*-[1-(1,4-Dimethoxy-2-naphthyl)ethyl]acetophenone,* 3.** To a stirred mixture of 14.80 g of **2** in a solution of 20.7 g of tetramethylethylenediamine in 600 mL of ether was added 114 mL of 1.55 M methyllithium. After being held at reflux for 24 h there was added dilute HCl. From the neutral fraction there was obtained 10.68 g (73%) of **3**: mp 120.0–121.5 °C; NMR 1.77 (d, 3, CH_3), 2.56 (s, 3, CH_3CO), 3.80 (s, 3, OCH_3), 4.03 (s, 3, OCH_3), 5.40 (q, 1, CH), 6.80 (s, 1, Ar H), 7.26–8.46 (m, 8, Ar H); IR (KBr) 1690 cm^{-1}; MS, 334.1575, calcd for $C_{22}H_{22}O_3$, 334.1568.

***o*-[1-(1,4-Dimethoxy-2-naphthyl)ethyl]phenylmethylcarbinol,* 4.** Reduction of 2.50 g of **3** in 80 mL of methanol by 0.84 g of sodium borohydride for 1 h afforded 2.25 g (89%) of colorless **4**: mp 103–104 °C; NMR 1.55 (d, 3, CH_3), 1.66 (d, 3, CH_3), 2.10–2.43 (m, 1, OH exchangeable with D_2O), 3.76 and 3.88 (s, 3, OCH_3 one isomer), 3.83 and 3.93 (s, 3, OCH_3 other isomer), 5.00 (q, 1, CH) 5.43 (q, 1, CH), 5.43 (q, 1, CH), 6.50 (s, 1, Ar H corresponds to 3.83–3.93 isomer), 6.70 (s, 1, Ar H corresponds to 3.76–3.88 isomer, major component), 7.16–8.33 (m, 8, Ar H); IR (KBr) 3475 cm^{-1}; MS, 336.1688, calcd for $C_{22}H_{24}O_3$, 336.1725.

5-Methoxy-7,12-dimethylbenz[*a*]anthracene, 6. A solution of 2.50 g of **4** in 85 mL of benzene was refluxed with 0.15 g of TSA for 3 h. After chromatography of the neutral fraction over neutral alumina using benzene–hexane there was obtained 2.30 g (61%) of **6**, mp alone and mixed with authentic[8] **6**, 125–126 °C. The UV spectra of the two samples were identical.

5,12-Dimethoxy-11-methyl-6-oxo-6,11-dihydronaphthacene, 7. In the best of several experiments a solution of 10.10 g of **2** and 0.6 g of $ZnCl_2$ in 60 mL of acetic acid and 30 mL of acetic anhydride was held at reflux for 3 h. Chromatography of the neutral product over silica gel yielded 8.10 g (85%) of an oil, **7**: NMR 1.60 (d, 3, CH_3), 4.1 (s, 3, OCH_3), 4.20 (s, 3, OCH_3), 4.73 (q, 1, CH), 7.36–8.56 (m, 8, Ar H); IR (neat) 1660 cm^{-1} (CO); MS, 318.1225 calcd for $C_{21}H_{18}O_3$, 318.1255. A single spot on TLC was obtained on freshly prepared **7**. On standing this oil gradually darkened, even in a refrigerator.

5,12-Dimethoxy-6-methylene-11-methyl-6,11-dihydronaphthacene, 9. To a solution of 7.95 g of **7** in 200 mL of ether was added 32 mL of 1.55 M methyllithium at −50 °C. After overnight at room temperature the product was treated with cold dilute HCl. The product was chromatographed over alumina to yield 5.10 g (65%) of an oil, **9**: NMR 1.40 (d, 3, CH_3CH), 3.80 (s, 3, OCH_3), 4.0 (s, 3, OCH_3), 4.63 (q, 1, CH), 6.0 (d, 1, =CH), 6.33 (d, 1, =CH), 7.20–8.33 (m, 8 H, Ar H); MS, 316.1481, calcd for $C_{22}H_{20}O_2$, 316.1463. A single spot on TLC was obtained on freshly prepared **9**. On standing this compound markedly deteriorated.

Registry No. **1**, 102235-10-9; **2**, 102235-11-0; **3**, 102235-12-1; **4** (isomer 1), 102235-13-2; **4** (isomer 2), 102235-16-5; **6**, 53306-03-9; **7**, 102235-14-3; **9**, 102235-15-4; CH_3Li, 917-54-4; *o*-acetylbenzoic acid, 577-56-0; 1,4-dimethoxylnaphthalene, 10075-62-4.

(2) Postdoctoral Research Associate.
(3) Compare: Newman, M. S.; Venkateswaran, S.; Sankaran, V. *J. Org. Chem. 40*, 2996.
(4) The proportion of these isomers was estimated as 3 to 1 by the difference in integrated amount of the Ar H bands at δ 6.50 and 6.70 (Ar H at the 3-position of the naphthalene nucleus).
(5) No mention of such loss of methoxide was made in Traynham (Traynham, J. G. *J. Chem. Ed.* **1983**, *60*, 937 or in March (March, J. *Advanced Organic Chemistry*; John Wiley and Sons: New York, 1985).
(6) As judged by the fact that no change in the UV spectrum of **9** in glyme was noted on addition of potassium *tert*-butoxide.
(7) All compounds denoted by an asterisk gave acceptable C, H analyses (Galbraith).
(8) Newman, M. S.; Sankaran, V.; Olson, D. R. *J. Am. Chem. Soc.* **1976**, *98*, 3237.