removed under reduced pressure. The crude olefin was purified by chromatography on silica gel. Elution with ether/hexane (1:8) gave 148 mg (75%) of pure **12** as an oil: IR (film) 3075, 3010, 2990, 2940, 2920, 2890, 2860, 2830, 1635, 1460, 1450, 1435, 1414, 1360, 1338, 1315, 1275, 1250, 1225, 1195, 1176, 1125, 1075, 1055, 1010, 990, 975, 945, 910, 900, 885, 865, 850, 830, 732, 690 cm^{-1}; NMR (360 MHz) ($CDCl_3$) δ 1.40 (m, 1 H), 1.57 (ddd, 1 H, J = 14.1, 11.2, 3.6 Hz), 1.82 (ddd, J = 14.1, 5.1, 2.5 Hz), 1.97–2.19 (m, 3 H), 2.39 (m, 1 H), 3.35 (s, 3 H), 3.41 (AB q, 2 H, J = 11.2 Hz, $\Delta\nu_{AB}$ = 152.6 Hz), 4.60 (t, 1 H, J = 2.9 Hz), 5.09 (d, 1 H, J = 11.2 Hz), 5.10 (d, 1 H, J = 17.7 Hz), 5.61 (m, 2 H), 5.68 (dd, 1 H, J = 17.7, 11.2); high-resolution mass spectrum, calcd for $C_{12}H_{18}O_2$ 194.1307, found 194.1298.

(±)-(3α,4aα,8aα)-8a-Ethenyl-4,4a,8,8a-tetrahydro-3-methoxy-1*H*-2-benzopyran-7(3*H*)-one (1). To 200 mg (2.0 mmol) of chromium trioxide in 2.0 mL of dry methylene chloride at −20 °C was added 193 mg (2.0 mmol) of 3,5-dimethylpyrazole in one portion. After being stirred at −20 °C for 15 min, a solution of olefin **12** (19.4 mg, 0.10 mmol) in 2.0 mL of methylene chloride was added dropwise. The mixture was stirred at −20 °C for 1 h and at 0 °C for 4 h. The reaction was quenched at 0 °C by the addition of 2 mL of a 1.0 M solution of sodium hydroxide. The organic layer was separated and successively washed with 5% hydrochloric acid, water, sodium bicarbonate solution, and brine and dried over magnesium sulfate. Evaporation of the solvent under reduced pressure gave a crude product that was purified on silica gel. Elution with ether/hexane, 2:3, afforded in order of elution 1.0 mg (5%) of enone **13** [R_f 0.58, ether/hexane, 2:1; IR ($CHCl_3$) 2990, 2920, 2830, 1670, 1445, 1420, 1390, 1360, 1290, 1265, 1210, 1125, 1095, 1055, 995, 975, 925, 905, 835 cm^{-1}; NMR (360 MHz) ($CDCl_3$) δ 1.75 (ddd, 1 H, J = 13.4, 12.3, 3.6 Hz), 1.81 (ddd, 1 H, J = 13.4, 5.4, 1.1 Hz), 2.22 (dd, 1 H, J = 19.5, 5.8 Hz), 2.86 (dd, 1 H, J = 12.3, 5.4 Hz), 3.04 (ddd, 1 H, J = 19.5, 2.9, 2.2 Hz), 3.36 (ABq, 1 H, J = 11.6 Hz, $\Delta\nu_{AB}$ = 126.5 Hz), 3.36 (s, 3 H), 4.74 (dd, 1 H, J = 3.6, 1.1 Hz), 5.06 (d, 1 H, J = 17.7 Hz), 5.13 (d, 1 H, J = 11.2 Hz), 5.55 (dd, 1 H, J = 17.7, 11.2 Hz), 5.95 (dd, 1 H, J = 10.1, 2.9 Hz), 6.88 (ddd, 1 H, J = 10.1, 5.8, 2.2 Hz)] and 10 mg (48%) of pure enone **1** as colorless plates, mp 52.0–52.5 °C (lit.[2d] 51.0–52.5 °C) [R_f 0.52; IR ($CHCl_3$) 2995, 2950, 2930, 2905, 2870, 2840, 1675, 1445, 1410, 1380, 1360, 1125, 1088, 1050, 1010, 995, 970, 925, 915, 890, 850 cm^{-1}; NMR (360 MHz) ($CDCl_3$) δ 1.63 (ddd, 1 H, J = 14.1, 12.3, 3.2 Hz), 1.96 (ddd, 1 H, J = 14.1, 4.7, 1.1 Hz), 2.71 (AB q, 2 H, J = 17.0 Hz, $\Delta\nu_{AB}$ = 211.9 Hz), 2.74 (dt, 1 H, J = 12.3, 5.8 Hz), 3.38 (AB q, 2 H, J = 11.9 Hz, $\Delta\nu_{AB}$ = 208.2 Hz), 3.39 (s, 3 H), 4.77 (dd, 1 H, J = 3.2, 1.1 Hz), 5.08 (d, 1 H, J = 17.6 Hz), 5.14 (d, 1 H, J = 10.9 Hz), 5.56 (dd, 1 H, J = 17.6, 10.9 Hz), 5.95 (d, 1 H, J = 10.0 Hz), 6.79 (dd, 1 H, J = 10.0, 5.8 Hz)].

Acknowledgment. This investigation was supported by a Public Health Service Research Grant (GM 33605) from the National Institute of General Medical Sciences.

Registry No. (±)-**1**, 93111-71-8; (±)-**2**, 59598-29-7; **3**, 61700-12-7; **4**, 86668-91-9; (±)-**5**, 93111-72-9; (±)-**6**, 93111-73-0; (±)-**8**, 93111-74-1; (±)-**9**, 93111-75-2; (±)-**10**, 93111-76-3; (±)-**11**, 93111-77-4; (±)-**12**, 93111-78-5; (±)-**13**, 93111-79-6; methyl (*E*)-3,5-hexadienoate, 32775-94-3; 4-(benzyloxy)butanal, 5470-84-8; (*E*)-3,5-hexadienoic acid, 32775-95-4.

Observation of a Sterically Hindered Hydroxyarenesulfenyl Chloride: Novel Base-Catalyzed Dimerization to a Diphenoquinone

Stephen D. Pastor

Research and Development Laboratories, Plastics and Additives Division, CIBA-GEIGY Corporation, Ardsley, New York 10502

Received June 8, 1984

The chemistry of the sulfur–chlorine bond continues to be an active area of interest from both a mechanistic and synthetic point of view.[1] The preparation of sulfenate esters and sulfenamides by the reaction of sulfenyl halides with alcohols and amines, respectively, is well documented in the literature.[2] Sulfenyl derivatives have been used to protect amines, alcohols, and thiols in organic synthesis and have, for example, been used in the synthesis of peptides, penicillins, and nucleosides.[3] Little is known, however, about the chemistry of hydroxy-substituted arenesulfenyl halides, which is no doubt due to their propensity for rapid self-condensation.[4] Hydroxyarenesulfenyl halides are proposed as intermediates in the reaction of phenols with sulfur dichloride leading to the formtion of bisphenol sulfides.

A report in the patent literature[5] claims the preparation of 2,6-dialkyl-4-hydroxybenzenesulfenyl chlorides, although their existence was based solely upon the analysis of the reaction products.

The kinetic stabilization of both reactive intermediates and strained molecules[6] by sterically large substituents is a well-known tool which recently has been used effectively to study the chemistry of phosphorus doubly bonded to itself and other elements.[7] These reports suggested that arenesulfenyl chlorides prepared from hindered phenols may be kinetically stable and capable of study. This paper reports the first spectroscopic observation of a hindered 4-hydroxybenzenesulfenyl chloride and a novel base-catalyzed dimerization to a diphenoquinone.

Results and Discussion

The reaction of a disulfide with elemental chlorine is a standard method for the preparation of a sulfenyl chloride.[2a] The reaction of a solution of **1** in heptane at −30 °C with chlorine gas gave a reddish orange solution characteristic of a sulfenyl chloride. After the addition of 2 equiv of dibutylamine to the solution of **2** at −50 °C, the reaction mixture rapidly turned dark red. Surprisingly, the diphenoquinone **3** was isolated (56% yield) rather than the expected sulfenamide. The diphenoquinone **3** was characterized by its MS, IR, ^1H and ^{13}C NMR spectra, and elemental analysis.

The course of the reaction was monitored by both ^1H NMR (200 MHz) and IR spectroscopy. An equivalent of chlorine gas was introduced to a solution of **1** in carbon tetrachloride at −10 °C. The ^1H NMR spectrum of the reaction mixture had a new singlet resonance at δ 1.12,

(1) For reviews, see: (a) Russ, C. R.: Douglass, I. B. In "Sulfur in Organic and Inorganic Chemistry"; Senning, A., Ed.; Marcel Dekker: New York, 1971; Vol. 1, Chapter 8. (b) Kuhle, E. *Synthesis* **1971**, 563. (c) Kuhle, E. *Synthesis* **1971**, 617. (d) Field, L. *Synthesis* **1972**, 101. (e) Field, L. *Synthesis*, **1978**, 713. (f) Hardstoff, W. H.; Langler, R. F. In "Sulfur in Organic and Inorganic Chemistry"; Senning, A., Ed.; Marcel Dekker: New York, 1982; Vol. 4; Chapter 5.

(2) (a) Kharasch, N.; Potempa, S. J.; Wehrmeister, A. *Chem. Rev.* **1946**, *39*, 269. (b) Langford, R. B.; Kharasch, A. *J. Org. Chem.* **1958**, *23*, 1049. (c) Chang, L. L.; Denney, D. B.; Denney, D. Z.; Kazior, R. J. *J. Am. Chem. Soc.* **1977**, *99*, 2293. (d) Denney, D. B.; Denney, D. Z.; Gavrilovic, D. M. *Phosphorus Sulfur* **1981**, *11*, 1.

(3) For examples, see: Greene, T. W. "Protective Groups in Organic Synthesis"; Wiley-Interscience: New York, 1981.

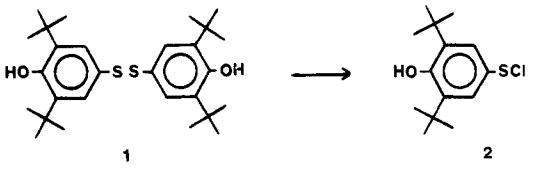
(4) (a) Meyers, C. Y.; Picciola, G. *Tetrahedron Lett.* **1962**, 971. (b) Cabiddu, S.; Ciuccatosta, F.; Cocco, M. T.; Loi, G.; Secci, M. *J. Heterocycl. Chem.* **1977**, *14*, 123.

(5) Cisney, M. E. U.S. Pat. 4 056 568; *Chem. Abstr.* **1979**, *91*, 107797.

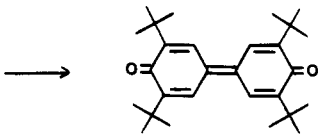
(6) For examples, see: Wentrup, C. "Reactive Intermediates"; Wiley-Interscience: New York, 1984; pp 265–326.

(7) (a) Yoshifuji, M.; Shima, I.; Inamoto, N.; Hirotsu, K.; Higuchi, T. *J. Am. Chem. Soc.* **1981**, *103*, 4587. (b) Niecke, E.; Ruger, R. *Angew. Chem., Int. Ed. Engl.* **1983**, *22*, 155. (c) Cowley, A. H.; Lasch, J. G.; Norman, N. C.; Pakulski, M.; Whittlesey, B. R. *J. Chem. Soc., Chem. Commun.* **1983**, 881. (d) Cowley, A. H.; Kilduff, J. E.; Norman, N. C.; Pakulski, M. *J. Am. Chem. Soc.* **1983**, *105*, 4845. (e) Yoshifuji, M.; Shibayama, K.; Inamoto, N.; Matsushita, T.; Nishimoto, K. *J. Am. Chem. Soc.* **1983**, *105*, 2495. (f) Yoshifuji, M.; Shima, I.; Shibayama, K.; Inamoto, A. *Tetrahedron Lett.* **1984**, *25*, 411.

0022-3263/84/1949-5260$01.50/0



1 2



3

which was assigned to the protons of two equivalent *tert*-butyl groups.[8,9] The signal at δ 7.32 for the aromatic protons of 1 disappeared and a new singlet resonance at δ 7.00 appeared whose peak area integrated to two protons. The ^{1}H NMR spectrum had a singlet resonance at δ 4.92 whose peak area integrated to a single proton, which was assigned to the hydroxyl proton. The IR spectrum of the reaction mixture had an absorption at 3630 cm^{-1} indicative of a hindered phenolic group. These observations are totally consistent with the formation of the sulfenyl chloride **2**.

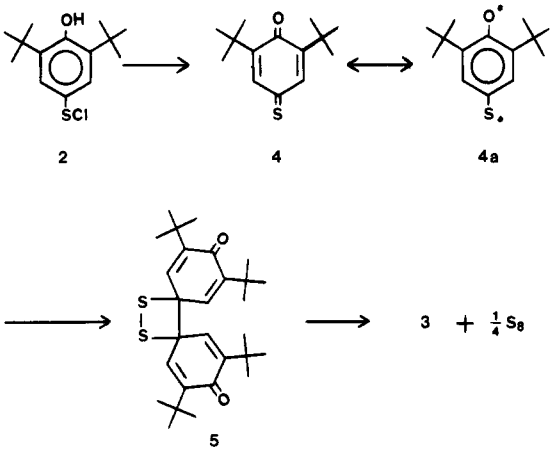
The addition of triethylamine to a solution of **2** in heptane at −30 °C also led to the formation of **3** (89% yield recrystallized). The yield of **3** was essentially quantitative, as the ^{1}H NMR spectrum of the crude reaction product showed only **3**. The observation that the reaction of triethylamine with **2** gave **3** strongly suggests that a sulfenamide intermediate is *not* involved in the reaction of **2** with dibutylamine. In a control experiment, **1** was recovered unchanged after treatment with triethylamine under the reaction conditions.

The participation of the 4-hydroxy substituent of **2** during the formation of **3** is evident since the reaction of benzenesulfenyl chloride with amines occurs in the expected fashion.[2a] A reasonable mechanism which accounts for the formation of **3** involves the base-catalyzed 1,6-elimination of hydrogen chloride from **2** to give the monothioquinone **4** (Scheme I). Rapid dimerization of **4** to the dithietane **5**, presumably through the thiyl radical **4a**, followed by the elimination of sulfur would give the observed product **3**. This mechanism is consistent with the known radical reactions of thiones, which emphasizes the importance of the canonical form **6b** to the resonance

6a 6b 6c

hybrid.[10] A similar mechanism has been proposed to account for the formation of a dipyrylene from a thiopyrone.[11] Consistent with the suggested mechanism in Scheme I, both elemental sulfur and triethylamine hydrochloride were isolated from the reaction of **2** with triethylamine.[12]

Scheme I



2 4 4a

5

The reactions of **2** as an electrophile proceeded in the expected manner and will be reported at a later date.

Experimental Section

All melting points were determined in open capillary tubes on a Thomas-Hoover melting point apparatus and are uncorrected. ^{1}H NMR spectra were taken on a Varian Model CFT-20 or XL-200 spectrometer. ^{13}C NMR spectra were taken on a Varian Model XL-200 spectrometer using a 55° flip angle, a 0.8-s repetition rate with no pulse delay, and full proton decoupling. All ^{1}H and ^{13}C chemical shifts are reported relative to tetramethylsilane, where a positive sign is downfield from the standard. IR spectra (1% solution in carbon tetrachloride–sodium chloride cells) were recorded on a Perkin-Elmer Model 710 or 467 spectrometer.

Mass spectra were obtained on a AEI (KRATOS) MS 902 spectrometer. All solvents were dried prior to use. Reagents were purchased frm Aldrich Chemical Company. Reactions were carried out in flame-dried apparatus under a dry nitrogen atmosphere. Elemental analyses were performed by Analytical Research Services, CIBA-GEIGY Corporation.

Bis(3,5-di-*tert*-butyl-4-hydroxyphenyl) Disulfide (1). To a stirred solution of 319 g (1.5 mol) of 2,6-di-*tert*-butylphenol and 1.48 g (8 mmol) of anhydrous titanium tetrachloride in 800 mL of toluene at −6 °C was added dropwise 101 g (0.75 mol) of sulfur monochloride over a 35-min duration.[13] The reaction mixture was stirred at −6 °C for 2.5 h and then it was washed sequentially with 3 N hydrochloric acid and water. The organic phase was dried over anhydrous sodium sulfate and the volatiles were removed in vacuo. The residue was recrystallized twice from hexane to give 168 g (47%) of a white solid: mp 143–146 °C (lit.[14] 144–147 °C); ^{1}H NMR (deuteriochloroform) δ 1.38 (s, $(CH_3)_3C$, 36 H), 5.18 (s, OH, 2 H), 7.32 (s, Ar H, 4 H). Anal. Calcd for $C_{28}H_{42}O_2S_2$: C, 70.8; H, 8.9; S, 13.5. Found: C, 70.7; H, 8.8; S, 13.6.

3,5-Di-*tert*-butyl-4-hydroxybenzenesulfenyl Chloride (2). To a stirred solution of 2.37 g (5 mmol) of **1** in 50 mL of carbon tetrachloride at −15 °C was added 0.35 g (5 mmol) of chlorine gas through a gas inlet below the surface of the solution over a 15–20-min duration. The reaction mixture was stirred at −10 to −15 °C for 15 min and then the spectral data were obtained immediately: IR 3630 cm^{-1} (OH); ^{1}H NMR δ 1.12 (s, $(CH_3)_3C$, 18 H), 4.92 (s, OH, 1 H), 7.00 (s, Ar H, 2 H).

3,3′,5,5′-Tetra-*tert*-butyldiphenoquinone (3). Method A: Triethylamine. To a stirred suspension of 2.37 g (5 mmol) of **1** in 50 mL of heptane at −30 °C was added 0.35 g (5 mmol) of chlorine gas through a gas inlet tube below the surface of the reaction mixture over a 15–20-min duration. The reaction mixture was allowed to warm slowly to 0 °C during which time the reaction

(8) An equal volume of deuteriochloroform was added to the sample in order to provide a deuterium lock for the NMR spectrometer.

(9) The signals for the protons of the *tert*-butyl groups of **1** and **2** are accidentally equivalent at 80 MHz using benzene-d_6 as a lock.

(10) For a discussion, see: Ohno, A. In "Organic Chemistry of Sulfur"; Oae, S., Ed.; Plenum Press: New York, 1977; Chapter 5.

(11) (a) Arndt, F.; Nachtwey, P. *Chem. Ber.* **1923**, *56*, 2406. (b) See ref 9, pp 214–216. (c) Ishibe, N.; Odani, M.; Teramura, K. *J. Chem. Soc., Chem. Commun.* **1970**, 371.

(12) Triethylamine hydrochloride was identified by its melting point and ^{1}H NMR spectrum. Elemental sulfur was identified by its characteristic mass spectrum.

(13) Due to a variable induction period, the first several drops of sulfur monochloride were added at 0 °C until an exotherm was observed. The reaction mixture was then cooled to −6 °C and the addition was completed.

(14) Coffield, T. H. U.S. Pat. 3250712; *Chem. Abstr.* **1966**, *65*, P2175h.

mixture became homogeneous. The reaction mixture was immediately cooled to −30 °C, and then 2.23 g (22 mmol) of triethylamine was added. The reaction mixture was stirred at room temperature for 3 days. The precipitate was removed by filtration and the solvent was removed in vacuo. The residue was recrystallized from a heptane–petroleum ether mixture to give 1.82 g (89%) of deep red crystals: mp 243–245 °C (lit. mp 240–241 °C,[15] 245–246 °C,[16] 245–247 °C[17]); ^{1}H NMR (deuteriochloroform) δ 1.33 (s, 36 H), 7.71 (s, 4 H); ^{13}C NMR (deuteriochloroform) δ 29.3 (s, CH_3), 35.7 (s), 126.1 (s), 136.5 (s), 150.9 (s), 186.9 (s, C=O); IR 2960, 2930, 2890, 1600, 1470, 1395, 1370, 1260, 1200, 910, 895 cm^{-1}; MS, m/z 408 ($M^{+\cdot}$). Anal. Calcd for $C_{28}H_{40}O_2$: C, 82.3; H, 9.9. Found: C, 82.2; H, 9.7.

Method B: Dibutylamine. The procedure of method A was followed with 23.7 g (50 mmol) of **1**, 3.9 g (55 mmol) of chlorine, and 25.9 (200 mmol) of dibutylamine in a total of 130 mL of heptane. The residue was triturated with hot petroleum ether (bp 35–60 °C) to give 11.5 g (56%) of deep red crystals identical in every respect with that prepared by method A.

Acknowledgment. S.D.P. thanks CIBA-GEIGY Corporation for support and permission to publish this work. S.D.P. thanks Dario Bini and Timothy Geran for NMR spectra, Constantin Patrianakos for MS, and Derry Lounsbury and Dianna DiPasquale for preparation of the manuscript.

Registry No. **1**, 6386-58-9; **2**, 93110-24-8; **3**, 2455-14-3; 2,6-di-*tert*-butylphenol, 128-39-2; titanium tetrachloride, 7550-45-0; toluene, 108-88-3; sulfur monochloride, 10025-67-9; carbon tetrachloride, 56-23-5; chlorine, 7782-50-5; heptane, 142-82-5; triethylamine, 121-44-8; dibutylamine, 111-92-2.

(15) Cook, C. D.; English, E. S.; Wilson, B. J. *J. Org. Chem.* **1958**, *23*, 755.
(16) Taimr, L.; Pospisil, J. *Tetrahedron Lett.* **1971**, 2809.
(17) Hart, H.; Cassis, F. A. *J. Am. Chem. Soc.* **1951**, *73*, 3179.

Preparation and Utilization of Corticosteroidal (π-Allyl)palladium Complexes. A Novel Entry to 6α,β-(Carboxymethyl)cortisol

David A. Hunt,*† J. Michael Quante, Richard L. Tyson, and Luther W. Dasher

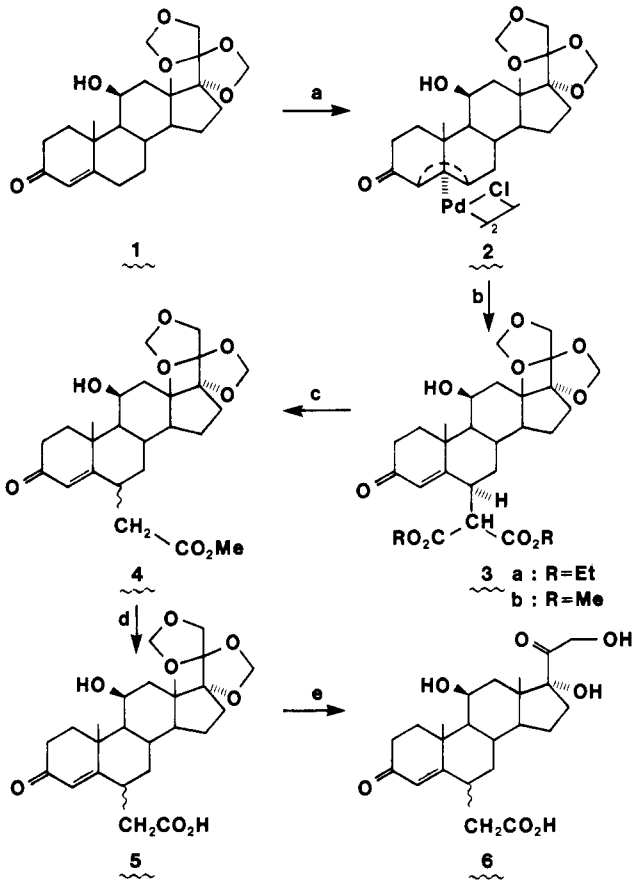
Organic Chemistry Section, Immunodiagnostics Department, Becton Dickinson Research Center, Research Triangle Park, North Carolina 27709

Received May 5, 1984

Corticosteroids possessing functionality at C-6 are valuable intermediates for the preparation of immunologically useful protein–hapten conjugates. Antibodies obtained from these conjugates often possess low in vitro cross-reactivities when compared to structurally similar steroids.[1] Thus, there is need for convenient preparations of C-6 functionalized precursors. Some of the more common routes to these compounds entail epoxidation of the 5-ene, 3-one ketal, followed by nucleophilic ring opening and dehydration–deprotection of the 6-substituted 3-one ketal, 4-ol.[1a,2] Many of these routes require several steps and suffer low to moderate yields.

During the past decade, several groups have demonstrated the synthetic utility of steroidal (π-allyl)palladium complexes;[3] however, to the best of our knowledge, no attempts have been made to prepare complexes from 11-substituted 3-oxo-4-ene steroids.

Scheme I



Reagents: a)Na_2PdCl_4/THF; b)$(RO_2C)_2CH_2$/NaH/DMSO; c)LiI/DMF; d)K_2CO_3/KOH/H_2O-MeOH; e)40% HCO_2H

We now wish to report the preparation of the steroidal (π-allyl)palladium complex **2** as an intermediate useful in the preparation of C-6 substituted corticosteroids. Treatment of the bis(methylenedioxy) ether **1**[4] with Na_2PdCl_4 in refluxing THF gave the corresponding complex **2** in 24% yield. The complex was purified by recrystallization and the product characterized by ^{1}H and ^{13}C NMR, as well as elemental analysis.

† Current address: Barberton Technical Center, PPG Industries, Inc., P.O. Box 31, Barberton, OH 44203.

(1) (a) Sone, H.; Kojima, M.; Ogawa, H. *Yakugaku Zasshi* **1975**, *95*, 185. (b) Tsuji, A.; Smulowitz, J. S.; Liang, C.; Fukushima, D. K. *Steroids* **1974**, *24*, 739. (c) Kojima, M.; Sone, H.; Ogawa, H.; Nakazawa, N.; Tachibana, S. U.S. Patent 4 277 460, 1981.
(2) (a) Fried, J. H.; Arth, G. E.; Sarett, L. H. *J. Am. Chem. Soc.* **1959**, *81*, 1235. (b) Jones, C. D.; Mason, N. R. *Steroids* **1975**, *25*, 23. (c) Littell, R. L.; Bernstein, S. *J. Org. Chem.* **1962**, *27*, 2544. (d) Bowers, A.; Denot, E.; Sanchez, M. B.; Ringold, H. J. *Tetrahedron* **1959**, *7*, 153. (e) Jones, C. D.; Mason, N. R. *Steroids* **1975**, *25*, 23. (f) FR Patent 2 201 287, 1974. (g) Collins, D. J.; Jackson, W. R.; Timms, R. N. *Aust. J. Chem.* **1980**, *33*, 2767. (h) Collins, D. J.; Horn, C. M.; Welker, V. J. *Aust. J. Chem.* **1976**, *29*, 2077.
(3) (a) Trost, B. M. *Tetrahedron* **1977**, *33*, 2615. (b) Trost, B. M.; Verhoeven, T. R. *J. Am. Chem. Soc.* **1978**, *100*, 3435. (c) Horirchi, C. A.; Satoh, J. Y. *J. Chem. Soc., Perkin Trans. 1* **1982**, 2595. (d) Jones, D. N.; Knox, S. D. *J. Chem. Soc., Chem. Commun.* **1975**, 165. (e) Riediker, M.; Schwartz, J. *Tetrahedron Lett.* **1981**, 22, 4655. (f) Haynes, R. K.; Jackson, W. R.; Stragalinou, A. *Aust. J. Chem.* **1980**, *33*, 1537. (g) Collins, D. J.; Jackson, W. R.; Timms, R. N. *Aust. J. Chem.* **1977**, *30*, 2167. (h) Collins, D. J.; Jackson, W. R.; Timms, R. N. *Aust. J. Chem.* **1980**, *33*, 2663. (i) Howsam, R. W.; McQuillin, F. J. *Tetrahedron Lett.* **1968**, 3667. (j) Harrison, I. T.; Kimura, E.; Bohme, E.; Fried, J. H. *Tetrahedron Lett.* **1969**, 1589. (k) Collins, D. J.; Jackson, W. R.; Timms, R. N. *Tetrahedron Lett.* **1976**, 495.
(4) (a) Beyler, R. E.; Hoffman, F.; Sarett, L. H. *J. Am. Chem. Soc.* **1960**, *82*, 178. (b) Fukushima, D. K.; Duam, S. *J. Org. Chem.* **1961**, *26*, 520. (c) Beyler, R. E.; Hoffman, F.; Moriarty, R. Mm.; Sarett, L. H. *J. Org. Chem.* **1961**, *26*, 2421. (d) Edwards, J. A.; Calzada, M. C.; Bowers, A. *J. Med. Chem.* **1964**, *7*, 528.

0022-3263/84/1949-5262$01.50/0