of pyrimidine 2'-azido-2'-deoxynucleosides.

Experimental Section

All chemicals were of reagent grade and used as received except that DMF was dried by distillation under reduced pressure and storage over 4-A molecular sieves and Me_3SiCl was freshly distilled. Column chromatography was performed on E. Merck silica gel 60 (7734) and all TLC was performed on E. Merck silica gel 60 plates (5539). IR spectra were recorded on a Perkin-Elmer Model 137 spectrophotometer. NMR spectra were recorded on a Varian EM 390 spectrometer with Me_4Si as an internal reference. UV spectra were recorded on a Cary Model 14 spectrophotometer. Melting points were determined on a Thomas-Hoover capillary melting-point apparatus and are corrected.

2',3'-*O*-(Methoxyethylidene)uridine (2a).[13] To a magnetically stirred suspension of 300 mg (1.23 mmol) of 1 in 1.5 mL of $CH_3C(OMe)_3$ was added 28.6 mg (0.15 mmol) of *p*-toluenesulfonic acid monohydrate. After 16 h at room temperature, excess MeOH-washed Amberlite IR-45 exchange resin ($^-$OH form) suspended in several milliliters of MeOH was added. After 15 min, the mixture was filtered and the filtrate evaporated to dryness on a rotary evaporator. The residue was coevaporated several times with benzene to give a colorless glass. TLC of this material showed two spots for the epimers of **2a** and the complete absence of 1. This material was used in subsequent reactions without any further purification.

5'-*O*-Acetyl-2',3'-*O*-(methoxyethylidene)uridine (2b).[14] Standard acetylation of **2a** with acetic anhydride in pyridine gave **2b** in quantitative yield and this material was used directly as isolated without further purification.

3',5'-Di-O-acetyl-2'-azido-2'-deoxyuridine (3b). Method A. To a magnetically stirred solution of 480 mg (1.6 mmol) of **2a** in 5 mL of dry DMF were added 488 mg (7.5 mmol) of NaN_3 and 0.95 mL (7.5 mmol) of Me_3SiCl. The resulting mixture was then heated for 14 h at 95 °C and then for 7.5 h at 150 °C. The DMF was removed under reduced pressure and the residue was treated with 2 mL of pyridine and 1 mL of acetic anhydride for 5 h at room temperature. The excess anhydride was destroyed by adding a few grams of ice and the mixture was extracted with CH_2Cl_2. After evaporation to dryness under reduced pressure, the residue was chromatographed on a 1.5 × 40 cm column of silica gel, eluting with 9:1 $CHCl_3$–EtOH (v/v), to give 226 mg (40%) of **3b** as a colorless syrup which was homogeneous on TLC: IR ($CHCl_3$) 2114 cm^{-1}; UV (MeOH) λ_{max} 259 nm (ϵ 9100) [lit.[3] (MeOH) λ_{max} 259 nm (ϵ 9200)]; NMR ($CDCl_3$) is identical with that previously reported.[3]

Method B. Procedure A was followed except for the addition of TMAC to the initial reaction mixture. A mixture of 480 mg (1.6 mmol) of **2a**, 0.95 mL (7.5 mmol) of Me_3SiCl, 488 mg (7.5 mmol) of NaN_3, and 821 mg (7.5 mmol) of TMAC in DMF with the reagents added to DMF in the order listed gave 385 mg (68%) of **3b**.[15]

Method C. Procedure B was followed, except for a change in the order of addition of the reagents to the solution of **2a** in DMF (NaN_3, TMAC, and Me_3SiCl, in order), to give 446 mg (79%) of **3b**.[15]

Method D. To a magnetically stirred solution of 85.5 mg (0.25 mmol) of **2b** in 5 mL of dry DMF were added 81.3 mg (1.25 mmol) of NaN_3, 41 mg (0.374 mmol) of TMAC, and 0.15 mL (1.18 mmol) of Me_3SiCl, respectively. The mixture was heated for 0.5 h at 85 °C and then for 14 h at 100 °C. The DMF was removed under reduced pressure and the residue was chromatographed on a 1.5 × 40 cm column of silica gel, eluting with 9:1 $CHCl_3$–EtOH (v/v), to give 72 mg (81%) of **3b**.[15]

Method E. A magnetically stirred solution of 347 mg (1 mmol) of **7b** and 325 mg (5 mmol) of NaN_3 in 5 mL of dry DMF was heated for 5 h at 95 °C and then for 5 h at 150 °C. Removal of the DMF under reduced pressure and chromatography of the residue on a 1.5 × 40 cm column of silica gel, eluting with 9:1 $CHCl_3$–EtOH (v/v), gave 177 mg (50%) of **3b**.[15]

Method F. Treatment of 155 mg (0.5 mmol) of the free base form of **6b** with 163 mg (2.5 mmol) of NaN_3 in 5-mL of dry DMF according to procedure E gave 177 mg (100%) of **3b**.[15]

3',5'-Di-*O*-acetyl-2'-chloro-2'-deoxyuridine (7b).[16] Acetylation of **7a**[11] with acetic anhydride and pyridine gave **7b** in quantitative yield as a chromatographically homogeneous syrup:[17] NMR ($CDCl_3$) δ 2.13 (s, 3, OAc), 2.16 (s, 3, OAc), 4.37 (br s, 2, H-5'), 4.37 (m, 1, H-4') 4.63 (t, 1, $J_{1',2'} = J_{2',3'} = 5$ Hz, H-2'), 5.24 (t, 1, $J_{3',4'} = 5$ Hz, H-3'), 5.80 (d, 1, $J_{5,6} = 8$ Hz, H-5), 6.07 (d, 1, $J_{1',2'} = 5$ Hz, H-1'), 7.56 (d, 1, H-6).

2,2'-Anhydro-1-(3,5-di-*O*-acetyl-β-D-arabinofuranosyl)uracil.[18] Acetylation of **6a**[11] with acetic anhydride and pyridine gave the free base form of **6b** in quantitative yield as a chromatographically homogeneous syrup: NMR ($CDCl_3$)[19] δ 1.98 (s, 3, OAc), 2.17 (s, 3, OAc), 3.99 (dd, 1, $J_{5'a,5'b} = 12$ Hz, $J_{4',5'a} = 4$ Hz, H-5'a), 4.24 (dd, 1, $J_{4',5'b} = 5$ Hz, H-5'b), 4.50 (m, 1, H-4'), 5.37 (d, 1, $J_{3',4'} = 1.5$ Hz, H-3'), 5.50 (d, 1, $J_{1',2'} = 6$ Hz, H-2'), 5.99 (d, 1, $J_{5,6} = 7.5$ Hz, H-5), 6.45 (d, 1, H-1'), 7.48 (d, 1, H-6). Crystallization from methanol gave colorless prisms, mp 184.6–185.7 °C (lit. mp 186–187 °C[18a] and 183–185 °C[18b]).

Acknowledgment. We thank the American Cancer Society (CH-72) for financial support.

Registry No. 1, 58-96-8; **2a**, 16667-57-5; **2b**, 75149-69-8; **3a**, 34407-68-6; **3b**, 26889-43-0; **6a**, 75149-70-1; **6b** (free base), 75149-71-2; **7a**, 42973-35-3; **7b**, 10190-39-3; NaN_3, 26628-22-8; $CH_3C(OMe)_3$, 1445-45-0.

(13) H. P. M. Fromageot, B. E. Griffin, C. B. Reese, and J. E. Sulston, *Tetrahedron*, **23**, 2315 (1967).

(14) **2b** has been prepared from 5'-*O*-acetyluridine as an intermediate without isolation.[13]

(15) Identical in all respects with **3b** prepared by method A.

(16) (a) I. L. Doerr and J. J. Fox, *J. Org. Chem.*, **32**, 1462 (1967); (b) S. Greenberg and J. G. Moffatt, *J. Am. Chem. Soc.*, **95**, 4016 (1973).

(17) **7b** has been reported as a difficulty obtained crystalline solid.[16] We were unable to obtain **7b** in crystalline form, but its NMR spectrum is essentially identical with that previously reported.[16b]

(18) (a) D. M. Brown, D. B. Parihar, and Sir A. Todd, *J. Chem. Soc.*, 4242 (1958); (b) J. P. Horwitz, A. J. Tomson, J. A. Urbanski, and J. Chua, *J. Org. Chem.*, **27**, 3045 (1962); (c) K. Kondo, T. Adachi, and I. Inoue, *ibid.*, **41**, 2995 (1976).

(19) This NMR spectrum is essentially identical with that reported in $(CD_3)_2SO$ at 60 MHz.[18c]

A Simple and Convenient Phenol Annelation

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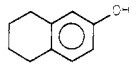
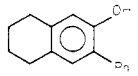
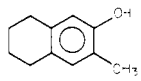
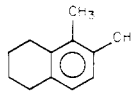
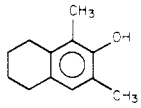
Conventional synthetic approaches to substances possessing a phenol ring(s) invariably start with the aromatic ring intact. Subsequent steps construct the remaining aliphatic molecular framework around this aromatic template or steps are taken to introduce the appropriately substituted intact aromatic ring at an early stage in the synthetic sequence. Though these approaches admirably serve most purposes, often they are plagued by serious shortcomings. Aside from the difficulties associated with the regiospecific preparation of substituted phenols, the adaptation of the synthetic work for the preparation of closely related natural products or synthetic analogues with even the simplest aromatic modification often necessitates an independent total synthesis.[2]

(1) National Institutes of Health (NIH) predoctoral trainee, NIH Trainee Grant No. GM-07775.

(2) For representative work and relevant discussions, see: (a) Leed, A. R.; Boettger, S. D.; Ganem, B. *J. Org. Chem.* **1980**, *45*, 1098; Kende, A. S.; Curran, D. P. *J. Am. Chem. Soc.* **1979**, *101*, 1857; McDonald, E.; Martin, R. T. *Tetrahedron Lett.* **1978**, 4723; (b) Gless, R. D.; Rapoport, H. *J. Org. Chem.* **1979**, *44*, 1324; Palmer, D. C.; Strauss, M. *J. Chem. Rev.* **1977**, *77*, 1.

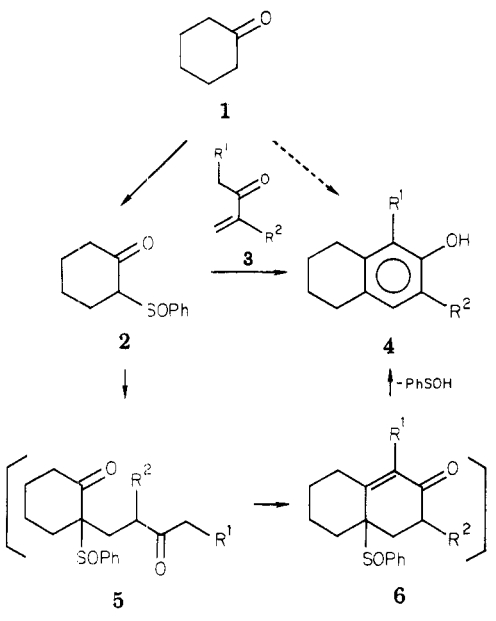
0022-3263/80/1945-5002$01.00/0

Table I. Preparation of Annelated Phenols from 2-(Phenylsulfinyl)cyclohexanone (2)

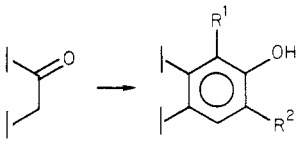
entry	enone 3 (equiv)	conditions,[a] temp, °C (time, h)	phenol 4	% yield[b]
a	CH_2=CHCOCH$_3$ (1.4)	0.1 equiv NaOMe, 0 (23.5); 1.2 equiv NaOMe, 25 (31)		58
b	CH_2=C(Ph)COCH$_3$ [c] (1.4)	0.1 equiv NaOMe, 0 (22.5); 1.2 equiv NaOMe, 25 (30.5)		48
c	CH_2=C(CH$_3$)COCH$_3$ (1.6)	0.1 equiv NaOMe, 0 (10.5); 1.2 equiv NaOMe, 25 (55)		43
d	CH_2=CHCOCH$_2$CH$_3$ (1.2)	0.1 equiv NaOMe, 0 (22.5); 1.2 equiv NaOMe, 25 (25)		46
e	CH_2=C(CH$_3$)COCH$_2$CH$_3$ [d] (1.4)	0.1 equiv NaOMe, 0 (23); 1.2 equiv NaOMe, 25 (43)		30[e]

[a] Reaction run under nitrogen in methanol (5–6 mL/mmol of 2); see experimental section. [b] Yield of purified product isolated by column chromatography (SiO_2). All products exhibited the reported or expected ^{1}H NMR, IR, and mass spectral characteristics and were identical in all respects with authentic material (when available). All new compounds gave satisfactory C, H analysis (±0.40%). [c] Gras, J.-L. *Tetrahedron Lett.* **1978**, 2111, 2955. [d] Gore, W. E.; Pearce, G. T.; Silverstein, R. M. *J. Org. Chem.* **1975**, *40*, 1705. [e] A major and persistent byproduct of the reaction is β-methoxy(β-alkoxy)-2-methyl-3-pentanone; see also ref 12.

Scheme I



Our current interest in developing versatile synthetic strategies for the total synthesis of naturally occurring substituted phenolic 9,10-dihydrophenanthrenes[2a,3] and naturally occurring and synthetic analgesics,[2b,4] as well as phenolic substituted isoquinolines,[5] has prompted us to investigate new methods for the introduction of substituted aromatic and phenolic rings. In addition, our interest has been guided by the desire to develop generalized synthetic routes which may be extended easily to the preparation of closely related natural products or synthetic analogues containing different or modified aromatic rings. For these purposes, it is apparent that a most efficient approach is to prepare the aliphatic portion of the molecule and subsequently introduce or construct the appropriately substituted phenol at a late stage in the synthetic scheme.[6] Useful for this purpose would be the controlled annelation of a substituted phenol onto a preexisting ketone, eq 1.[6d]



(1)

To this end, we have developed a mild, versatile phenol annelation capable of broad application, Scheme I. This process is based on the previously unrecognized but well-precedented (4 carbon + 2 carbon) Robinson annelation[7] of β-keto sulfoxides with vinyl ketones.[8]

(3) Typified by juncusol, a cytotoxic constituent of needle rush (*Juncus roemerianus*), cf.: Miles, D. H.; Bhattacharyya, J.; Mody, N. V.; Atwood, J. L.; Black, S.; Hedin, P. A. *J. Am. Chem. Soc.* **1977**, *99*, 618.

(4) Typified by the derivatives of morphine, morphinans, and benzomorphans, cf.: Lednicer, D.; Mitscher, L. A. "The Organic Chemistry of Drug Synthesis"; Wiley Interscience: New York, 1977; Vol. 1, Chapter 15, pp 286–298.

(5) For example, see: Cava, M. P.; Buck, K. T.; Noguchi, I.; Srinivasan, M.; Rao, M. G.; daRocha, A. I. *Tetrahedron* **1975**, *31*, 1667; Cava, M. P.; Buck, K. T.; daRocha, A. I. *J. Am. Chem. Soc.* **1972**, *94*, 5931.

(6) For representative and recent work on the use of aliphatic precursors for the preparation of aromatic rings, see: (a) (Diels–Alder cycloaddition) Barton, J. W.; Cheesman, D. W. H. In "Modern Reactions in Organic Synthesis"; Timmons, C. J., Ed.; Van Nostrand Reinhold Co.: London, 1970; (b) (Diels–Alder cycloaddition to form phenols) Danishefsky, S.; Kitahara, T.; Yan, C. F.; Morris, J. *J. Am. Chem. Soc.* **1979**, *101*, 6996; Danishefsky, S.; Yan, C. F.; Singh, R. K.; Gammill, R. B.; McCurry, P. M., Jr.; Fritsch, N.; Clardy, J. *Ibid.* **1979**, *101*, 7001; Danishefsky, S.; Harayama, T.; Singh, R. K. *Ibid.* **1979**, *101*, 7008; Danishefsky, S.; Etheredge, S. J. *J. Org. Chem.* **1979**, *44*, 4716; Danishefsky, S.; Singh, R. K.; Gammill, R. B. *Ibid.* **1978**, *43*, 379; Kraus, G. A.; Taschner, M. J. *J. Am. Chem. Soc.* **1980**, *102*, 1974; Kozikowski, A. P.; Schmiesing, R. *Tetrahedron Lett.* **1978**, 4241; (c) (benzo annelation) Paquette, L. A.; Melega, W. P.; Kramer, J. D. *Ibid.* **1976**, 4033; (d) (phenol annelation) Woodward, R. B.; Singh, T. *J. Am. Chem. Soc.* **1950**, *72*, 494; Cohen, N.; Lopresti, R. J.; Saucy, G. *Ibid.* **1979**, *101*, 6710; Prelog, V.; Metzler, O.; Jeger, O. *Helv. Chim. Acta* **1947**, *30*, 675; Prelog, V.; Wursch, J.; Konigsbacher, K. *Ibid.* **1951**, *34*, 258; (e) (resorcinol annelation) Chamiec, A. A. J.; Sammes, P. G.; Kennewell, P. D. *J. Chem. Soc., Chem. Commun.* **1978**, 118; (f) (cationic ring closure to give aromatics) Oikawa, Y.; Yonemitsu, O. *J. Org. Chem.* **1976**, *41*, 1118; Trost, B. M.; Reiffen, M.; Crimmin, M. *J. Am. Chem. Soc.* **1979**, *101*, 257; (g) (linear anthracene annelation) Wildeman, J.; Borgen, P. C.; Pluim, H.; Rouwette, P. H. F. M.; van Leusen, A. M. *Tetrahedron Lett.* **1978**, 2213; Kraus, G. A.; Sugimoto, H. *Ibid.* **1978**, 2263; Hauser, F. M.; Rhee, R. P. *J. Am. Chem. Soc.* **1977**, *99*, 4533; *Ibid.* **1979**, *101*, 1628; Hauser, F. M.; Prasanna, S. *J. Org. Chem.* **1979**, *44*, 2596.

(7) For recent reviews on the Robinson annelation, see: Jung, M. E. *Tetrahedron* **1976**, *32*, 3; Gawley, R. E. *Synthesis* **1976**, 777.

Treatment of 2-(phenylsulfinyl)cyclohexanone (**2**, prepared from cyclohexanone in 70–80% yield)[9] with a vinyl ketone **3** (e.g., methyl vinyl ketone) at 0–25 °C in absolute methanol in the presence of sodium methoxide affords initially the Michael adduct **5**, followed by the aldol condensation product **6**, and a mild, presumably thermal, elimination[10] of phenylsulfenic acid to give the annelated phenol **4**. The entire reaction sequence (**2** → **4**) proceeds under *surprisingly mild conditions* (0–25 °C), affording the annelated phenol directly without isolation and occasionally without detection of the reaction intermediates **5** and **6**.[11] A systematic examination of the reaction parameters[12] revealed that the overall yields are generally optimal (45–60%) if the reaction is run initially at 0 °C in the presence of a catalytic amount of sodium methoxide (0.10 equiv) to effect the Michael addition (**2** → **5**, ca. 24 h, 0 °C)[13] followed by the addition of a slight excess of sodium methoxide (1.2 equiv, 25 °C) to effect the aldol condensation (**5** → **6**). Subsequent elimination[10] of phenylsulfenic acid (0–25 °C is sufficient) affords the annelated phenol **4**. Table I summarizes typical conditions for effecting the successful phenol annelation.[14]

Evident from the examples illustrated in Table I is the versatility of this phenol annelation. Appropriate choice of the substituted vinyl ketone[15] allows the simple, regiocontrolled preparation of highly substituted phenols (compare **4c–e**). Moreover, implicit in the design of this phenol annelation is the ability to use methods[9] for the regiospecific preparation of β-keto sulfoxides from unsymmetrical ketones for additional control in the annelation of (substituted) phenols onto substituted, cyclic ketones. In addition, the mild conditions employed for the introduction of the phenol should be compatible with most functionality found in complex synthetic intermediates.

The simplicity of this sequence, the availability of the precursor agents (β-keto sulfoxides[9] and substituted vinyl ketones), and the generalized reaction conditions[14] indicate that this process is capable of broad application.

Experimental Section

Phenol Annelation. General Procedure Illustrated with 5,6,7,8-Tetrahydro-2-naphthol (4a). A solution containing 2-(phenylsulfinyl)cyclohexanone (**2**, 1.97 mmol, 439 mg) and sodium methoxide (0.21 mmol, 0.10 mL of 2.15 M methanolic $NaOCH_3$) in 10 mL of absolute methanol cooled to 0 °C under nitrogen was treated dropwise (20 min) with methyl vinyl ketone (2.76 mmol, 193 mg, 0.24 mL, 1.4 equiv) and the reaction mixture was stirred at 0 °C for 23.5 h. Additional sodium methoxide (2.36 mmol, 1.10 mL of 2.15 M methanolic $NaOCH_3$) was added and the mixture was allowed to warm to 25 °C where it was stirred for 31 h. The resulting reaction solution was poured onto 5% HCl (25 mL) and the aqueous phase was extracted thoroughly with ether (5 × 10 mL). The combined etheral layers were washed with saturated NaCl, dried ($MgSO_4$), and concentrated in vacuo. Chromatography (90 g of SiO_2, 36 × 3 cm, 10 to 25% ether–hexane gradient elution) afforded 168 mg (291 theoretical, 58%) of pure phenol **4a** as a white solid, mp 56–59 °C, identical in all respects with authentic material (Aldrich, mp 55–59 °C); ^1H NMR ($CDCl_3$) δ 6.95 (d, J = 9 Hz, 1 H), 6.60 (dd, J = 9, 2 Hz, 1 H), 6.55 (m, 1 H), 4.25 (br s, 1 H), 2.72 (m, 4 H), 1.78 (m, 4 H); IR (KBr) ν_{max} 3340, 3015, 2910, 1600, 1270, 800, 655 cm^{-1}; mass spectrum, m/e (relative intensity) 148 (M^+, 75), 147 (25), 121 (11), 120 (base), 107 (15), 91 (21).

Similar and identical reactions employing the conditions described above on 0.25–10.0-mmol scale afforded phenol **4a** in 45–60% yield.

3-Phenyl-5,6,7,8-tetrahydro-2-naphthol (4b): Table I, 48%; colorless oil; ^1H NMR ($CDCl_3$) δ 7.30 (s, 5 H), 6.78 (s, 1 H), 6.54 (s, 1 H), 4.92 (s, 1 H), 2.69 (m, 4 H), 1.74 (m, 4 H); IR (KBr) ν_{max} 3400, 3080, 3040, 2950, 1625, 750, 690 cm^{-1}; mass spectrum, m/e (relative intensity) 224 (M^+, base), 223 (13), 196 (50), 195 (5), 181 (5).

Anal. Calcd for $C_{16}H_{16}O$: C, 85.68; H, 7.19. Found: C, 85.30; H, 7.10.

3-Methyl-5,6,7,8-tetrahydro-2-naphthol (4c): Table I, 43%; mp 88–89 °C (lit.[16] mp 89.5–90.5 °C); ^1H NMR ($CDCl_3$) δ 6.82 (s, 1 H), 6.49 (s, 1 H), 4.98 (br s, 1 H), 2.68 (m, 4 H), 2.20 (s, 3 H), 1.77 (m, 4 H); IR (KBr) ν_{max} 3400, 2942, 2861, 1623, 1595, 1258, 1195, 850 cm^{-1}; mass spectrum, m/e (relative intensity) 162 (M^+, base), 161 (24), 147 (49), 134 (61), 121 (14), 91 (13).

Anal. Calcd for $C_{11}H_{14}O$: C, 81.44; H, 8.70. Found: C, 81.01; H, 8.78.

1-Methyl-5,6,7,8-tetrahydro-2-naphthol (4d): Table I, 46%; mp 109.5–110 °C (lit.[16b] mp 117–118 °C); ^1H NMR ($CDCl_3$) δ 6.83 (d, J = 8 Hz, 1 H), 6.59 (d, J = 8 Hz, 1 H), 5.11 (br s, 1 H), 2.69 (m, 4 H), 2.13 (s, 3 H), 1.81 (m, 4 H); IR (KBr) ν_{max} 3320, 3020, 2935, 2860, 1585, 1237, 780 cm^{-1}; mass spectrum, m/e (relative intensity) 162 (M^+, base), 161 (24), 147 (48), 134 (65), 121 (14), 91 (14).

Anal. Calcd for $C_{11}H_{14}O$: C, 81.44; H, 8.70. Found: C, 81.10; H, 8.75.

1,3-Dimethyl-5,6,7,8-tetrahydro-2-naphthol (4e): Table I, 30%; mp 94.5–95 °C (lit.[17] mp 95 °C); ^1H NMR ($CDCl_3$) δ 6.62 (s, 1 H), 4.40 (br s, 1 H), 2.58 (m, 4 H), 2.18 (s, 3 H), 2.08 (s, 3 H), 1.76 (m, 4 H); IR (KBr) ν_{max} 3440, 3015, 2940, 1575, 1470, 1275, 1215, 780 cm^{-1}; mass spectrum, m/e (relative intensity) 176 (M^+, base), 175 (17), 161 (30), 148 (53), 105 (14), 91 (10).

Anal. Calcd for $C_{12}H_{16}O$: C, 81.77; H, 9.15. Found: C, 81.85; H, 9.21.

Acknowledgment. This work was assisted financially by the American Cancer Society (Grant No. IN-115, administered by the Mid-America Cancer Center of the University of Kansas), a Biomedical Research Grant (RR 5606), and the University of Kansas General Research allocation (3605-X0-0038). We are grateful to the Research Corporation for funds used in the purchase of equipment.

Registry No. 2, 55705-17-4; **3a**, 78-94-4; **3b**, 32123-84-5; **3c**, 814-78-8; **3d**, 1629-58-9; **3e**, 25044-01-3; **4a**, 1125-78-6; **4b**, 75232-78-9; **4c**, 2969-53-1; **4d**, 56771-15-4; **4e**, 75232-79-0.

(8) This phenol annelation constitutes a 4 carbon + 2 carbon annelation procedure for constructing an aromatic ring. Though this complete process has not been previously reported, the individual steps of the annelative procedure are documented with literature precendent: (a) (Michael addition of β-keto sulfoxides to α,β-unsaturated carbonyl compounds) Vig, O. P.; Matta, K. L.; Sehgal, J. M.; Sharmag, S. D. *J. Indian Chem. Soc.* **1970**, *47*, 894; Russell, G. A.; Ochrymowycz, L. A. *J. Org. Chem.* **1969**, *34*, 3624; (b) (Michael addition and aldol condensation (Robinson annelation) of β-keto esters with vinyl ketones) ref 7; (c) (thermal elimination of phenylsulfenic acid) ref 6e, 9.

(9) Trost, B. M.; Salzmann, T. N.; Hiroi, K. *J. Am. Chem. Soc.* **1976**, *98*, 4887. Recent reviews include: Trost, B. M. *Chem. Rev.* **1978**, *78*, 363; *Acc. Chem. Res.* **1978**, *11*, 453.

(10) Though this process is presumably a thermal, syn elmination of phenylsulfenic acid (see ref 9), a base-catalyzed elimination cannot be ruled out.

(11) Occasional attempts to isolate the Robinson annelation adducts **6** prior to elimination of phenylsulfenic acid have been unsuccessful thus far.

(12) While the use of other bases (e.g., NaOEt/EtOH, *t*-BuOK/*t*-BuOH) had little effect on the overall yield, initial reaction temperatures of 25 °C or larger initial amounts of base (1.2 equiv) resulted in diminished yields.

(13) Generally, significant amounts of starting β-keto sulfoxide can be detected in the reaction mixture at this point.

(14) In constrast to many Robinson annelation procedures, see ref 7, the conditions detailed herein have been employed successfully on small as well as larger preparative scale reactions (0.1 mmol to greater than 10 mmol) with reproducible results.

(15) The β-substituted enone, *trans*-pent-3-en-2-one, does not react with β-keto sulfoxide **2** under the described conditions and is recovered unchanged. Attempts to induce Michael addition of **2** with this enone using other reaction conditions, e.g., higher reaction temperatures and/or the use of alternative solvents and bases, have not been investigated.

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