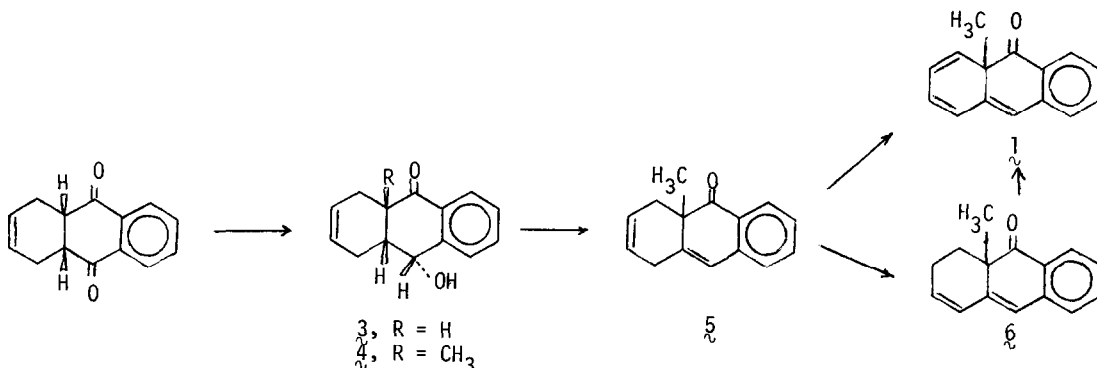


SYNTHESIS OF MOLECULES WITH FUSED BLOCKED AROMATIC RINGS

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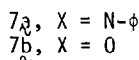
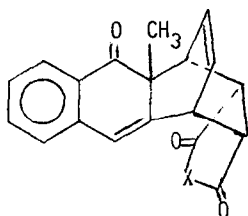
Methylenecyclohexadienes (semibenzenes) and cyclohexadienones can be defined as compounds with "blocked aromatic rings," since elimination or migration of a single substituent in each molecule would convert an alicyclic ring to an aromatic one. These types of compounds are well known, and have been found to undergo aromatization by a large variety of rearrangement and fragmentation processes.<sup>1,2</sup> In contrast, no example of a compound with two (or more) fused blocked aromatic rings has been reported. Since such compounds might, in principle, undergo rearrangement or fragmentation with simultaneous aromatization of several rings, their preparation should be of appreciable theoretical interest. In this paper, we report the synthesis of ketone **1**, which contains fused methylenecyclohexadiene and cyclohexadienone rings, and of cations (formed from derivatives of **1**) which contain fused blocked aromatic rings.

Reduction of diketone **2**<sup>3</sup> with one molar equivalent of sodium borohydride or of lithium tri-*sec*-butylborohydride gave mixtures of hydroxyketone **3** and its stereoisomers. However, slow



addition of **2** to an excess of sodium borohydride in ethanol at 0° yielded **3**, uncontaminated by its isomers, in 89% (isolated) yield. Conversion of **3** to its dianion by reaction with three molar equivalents of lithium diisopropylamide in THF at -75°, followed by reaction with excess methyl iodide at -75° (after which the temperature was allowed to rise to 23°) yielded the monomethylation product **4** in 100% yield as a viscous oil. Hydroxyketone **4** was characterized by conversion to its S-methyl dithiocarbonate, m.p. 92.5-94.0°. (The dithiocarbonate derivative was recovered unchanged from heating in refluxing DMF, supporting the *trans* assignment for the hydroxy and vicinal hydrogen in **4**.) Dehydration of **4** with p-toluenesulfonyl chloride in pyridine

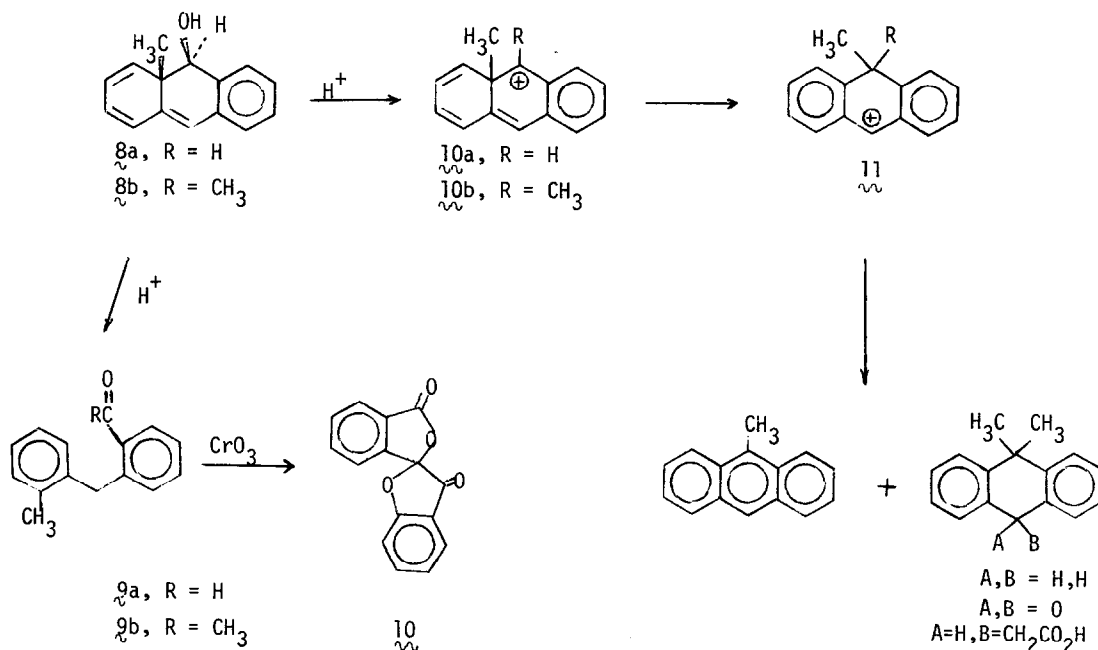
yielded ketone **5** ( $\lambda_{\max}$  333 nm,  $\epsilon=2520$ ) as a pale yellow oil in 79% yield. An attempt to carry out a Wittig reaction between **5** and methylenetriphenylphosphorane yielded none of the desired hydrocarbon product, but instead resulted in double bond migration to form **6** ( $\lambda_{\max}$  373 nm,  $\epsilon=3720$ ) in 55% yield. Reaction of **5** with one molar equivalent of bromine, followed by dehydrohalogenation of the product by reaction with DBU in benzene, yielded the fused blocked aromatic ketone **7** in 79% yield as a bright yellow oil. Similar treatment converted **6** to **7** in 53% yield. Ketone **7** was identified by its elemental analysis and spectra: IR,  $\nu_{\max}$  1680  $\text{cm}^{-1}$ ; UV,  $\lambda_{\max}$  428 nm (sh, = 3035), 407(4155), 342(7295), 329(7250), 315(sh, 5470), 282(9215), 272(11,040), 260(14575), 254 (15,600), 233(30,200);  $^1\text{H NMR}$  (60 MHz,  $\text{CDCl}_3$ ),  $\delta$  1.24(s, 3H), 6.00-6.50(m, 3H), 6.55(s, 1H), 6.70-7.00(m, 1H), 7.10-7.75(m, 3H) and 8.02(dd,  $J=8$  Hz, 1 Hz, 1H); Ms(50ev),  $m/e$  208( $\text{M}^+$ , 94.7), 193 (89.5), 178(42), 165(100). The structure was confirmed by formation of the Diels-Alder adducts **7a**(m.p. 221-222 $^\circ$ ) and **7b**(m.p. 207-208 $^\circ$ ) by reaction with N-phenylmaleimide in refluxing benzene and maleic anhydride in refluxing toluene, respectively. On standing in a solution of sulfuric acid



in acetic anhydride **7** was converted to a dimer (m.p. 177-179 $^\circ$ ) whose spectra resembled those of **7b** but whose structure is not yet firmly established. No products resulting from rearrangement of **7** were observed under those conditions.

Reduction of ketone **7** with lithium aluminum hydride in ether yielded alcohol **8a** (m.p. 62-66 $^\circ$ ) in 54-72% yield. Reaction of **7** with methyl lithium yielded **8b** (71%) as a yellow oil.

Alcohols **8a** and **8b** were both recovered unchanged after four hours in 1M hydrochloric acid in methanol. The unusual unreactivity of these tertiary, benzylic alcohols towards acid may be ascribed to the pseudoequatorial positions of the hydroxy groups (orthogonal to the  $\pi$ -orbitals of the aromatic rings) in both alcohols.<sup>5</sup> Reaction of **8b** with a 0.4 M solution of sulfuric acid in acetic acid did result in reaction, but formed the fragmentation product **9b** rather than one of the expected rearrangement products. Alcohol **8a** under the same conditions yielded equal amounts of aldehyde **9a** and 9-methylanthracene. The ortho-ortho' locations of the substituents in **9a** and **9b** were established by chromic acid oxidation of both compounds to yield the spiro-biphthalide **10**.<sup>6</sup> In addition, ketone **9b** was independently prepared by reaction of o-(o-methylbenzyl)benzoic acid<sup>7</sup> with methyl lithium.



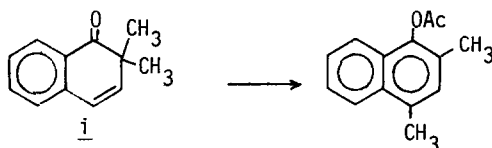
Reaction of **8b** with sulfuric acid in 1:1 acetic acid-acetic anhydride (rather than in acetic acid alone) yielded no **9b**. Instead, a mixture of 9,9-dimethylantrone (25% isolated yield) and 9,9-dimethyl-9,10-dihydroanthracene (53%) was obtained. Changing the solvent to acetic anhydride alone resulted in formation (75% by NMR analysis) of yet another product, 10,10-dimethyl-9,10-dihydro-9-anthranlylactic acid (m.p. 155-157°) accompanied by 9,9-dimethylantrone (10%) and 9,9-dimethyl-9,10-dihydroanthracene (15%). Alcohol **8a** yielded 9-methylantrone under both conditions.

The products resulting from methyl migrations in these reactions must have arisen from the fused blocked aromatic cation **11**. This represents the first evidence for formation of such cations. The fragmentation products, **9a** and **9b** on the other hand, were presumably formed directly from **8a** and **8b** by protonation of the double bond in the central ring. The unexpected solvent effects can be rationalized by assuming that formation of **11** is always more rapid than fragmentation, but that rearrangement of **11** is slower than reformation of **8** and subsequent fragmentation when water is present to reform **8**. In solutions containing acetic anhydride reformation of **8** is impossible, and rearrangement of **11** to form the 10,10-dimethyl-9-anthranlyl cation is the only process which occurs.

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## REFERENCES AND NOTES

- 1) For reviews of cyclohexadienone reactions, see S. J. Rhoads in "Molecular Rearrangements," Part 1, P. de Mayo, Ed., Interscience Publishers, New York, 1963, pp. 600-696; A. J. Waring in "Advances in Alicyclic Chemistry," Vol. 1, H. Hart and G. J. Karabatsos, Eds., Academic Press, New York, 1966, pp. 131-152; B. Miller in "Mechanisms of Molecular Migrations," Vol. 1, B. S. Thyagarajan, Ed., Interscience Publishers, New York, 1968; B. Miller, Accounts Chem. Res., **3**, 245 (1975).
- 2) For reactions of semibenzenes, see K. v. Auwers and W. Jühlicher, Chem. Ber., **55**, 2167 (1922); C. R. Bird and R. C. Cookson, J. Org. Chem., **24**, 441 (1969); M. S. Newman and R. M. Layton, ibid., **33**, 2338 (1968); H. Hart and J. D. DeVrieze, Tetrahedron Lett. 4257 (1968); B. Miller and K.-H. Lai, J. Am. Chem. Soc., **94**, 3472 (1972).
- 3) O. Diels and K. Alder, Liebigs Ann. Chem., **460**, 98 (1928).
- 4) Surprisingly, **5** was recovered unchanged from reaction with sulfuric acid in acetic anhydride, under conditions which resulted in complete rearrangement of naphthalenone **i**. [E. N. Marvell and A. O. Geiszler, J. Am. Chem. Soc., **76**, 5118 (1954)]



- 5) See B. Miller and E. C. Marhevka, Tetrahedron Lett., 895(1981) for similar effects on reactivities of other tertiary benzylic alcohols.
- 6) W. R. Vaughan, M. V. Anderson, Jr., and R. A. Little, Jr., J. Am. Chem. Soc., **76**, 1748(1954).

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