Convenient Method for the Reduction of *ortho*-Quinones to Dihydrodiols

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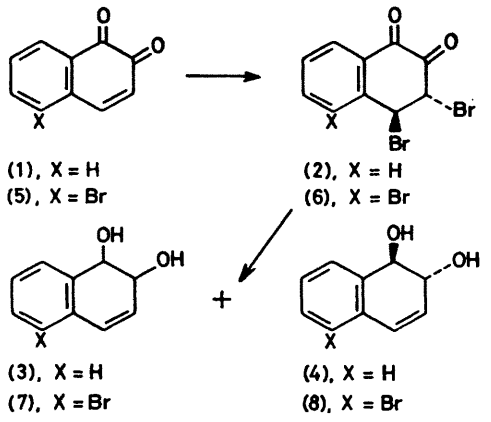
Summary A convenient method for the reduction of non-K-region *ortho*-quinones to the corresponding dihydrodiols is reported; the synthesis of 3,4-dihydroxy-3,4-dihydrodibenz[*a*,*h*]anthracene is also described.

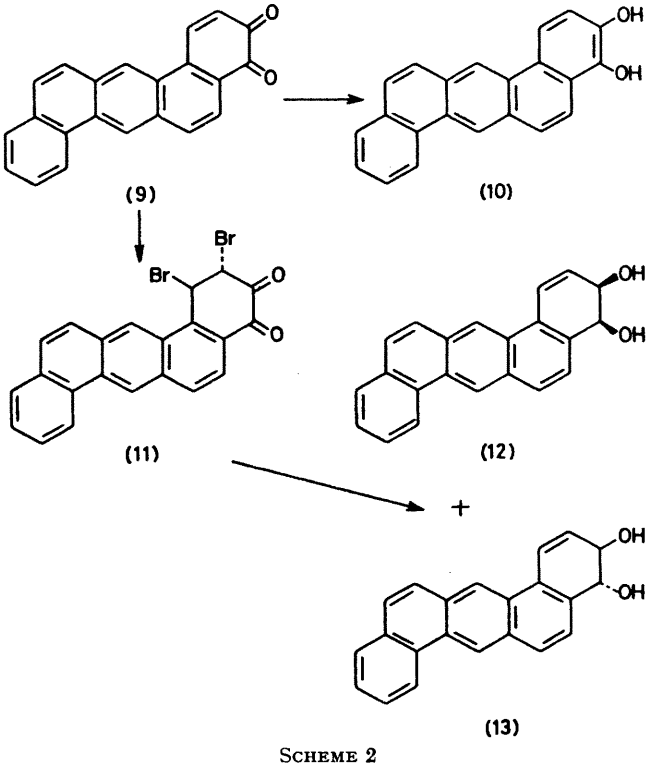
THE non-K-region† dihydrodiols of polycyclic aromatic hydrocarbons have been established to be the proximate carcinogens in the carcinogenesis due to these hydrocarbons.[1] Because of their importance in the carcinogenic and mutagenic processes, several of these dihydrodiols have been recently synthesized.[2,3]

Conventional reduction of non-K-region *ortho*-quinones with lithium aluminium hydride afforded only very small amounts of the corresponding dihydrodiols.[4] We report here a convenient method for the reduction of non-K-region *ortho*-quinones to dihydrodiols through a dibromo inter-

† The 9,10-carbons of phenanthrene constitute a K-region whereas the 1,2,3,4-region is a non-K-region.



SCHEME 1



SCHEME 2

mediate as shown in Schemes 1 and 2. Treatment of the model compound 1,2-naphthoquinone (**1**) with bromine in benzene yielded the dibromo compound (**2**) which was not isolated. Reduction of the dibromo compound with excess of sodium borohydride in ethanol afforded a mixture of *cis*- and *trans*-1,2-dihydroxy-1,2-dihydronaphthalene (**3**) and (**4**) in fair yield (34%). The dihydrodiols were found to be bromine-free. Mass spectral analyses of the neutral fractions confirmed the structure of the dihydrodiols. The *trans*-1,2-dihydroxy-1,2-dihydronaphthalene was crystallized out from the mixture as white needles, m.p. 105—106 °C (lit.[5] m.p. 103 °C) and was identical, from m.p. and spectral data, with an authentic sample.[5] Similar reduction of 5-bromo-1,2-naphthoquinone‡ (**5**) *via* the dibromo compound (**6**), with excess of sodium borohydride in ethanol, yielded a mixture of *cis*- and *trans*-5-bromo-1,2-dihydroxy-1,2-dihydronaphthalene (**7**) and (**8**) in 65% yield.

Conventional reduction of dibenz[*a*,*h*]anthra-3,4-quinone (**9**)‡ with lithium aluminium hydride led to the catechol derivative, 3,4-dihydroxydibenz[*a*,*h*]anthracene (**10**). The quinone (**9**) could, however, be converted into the dibromo compound (**11**) (m.p. 170—172 °C) which was reduced with excess of sodium borohydride in ethanol. The reduced mixture, in the form of acetates, was purified by column chromatography on neutral deactivated alumina. On ammonolysis of the acetates, although some fractions were seen as mixtures of two spots (*cis*- and *trans*-isomers) (**12**) and (**13**), the pure *trans*-isomer, *trans*-3,4-dihydroxy-3,4-dihydrodibenz[*a*,*h*]anthracene (**13**), m.p. 274—275 °C (decomp.), was isolated as a pure material.§ Boyland and Sims[6] have isolated a dihydroxydihydrodibenz[*a*,*h*]-anthracene from the metabolism of dibenz[*a*,*h*]anthracene which they identified as 3,4-dihydroxy-3,4-dihydrodibenz-[*a*,*h*]anthracene. Karle and his co-workers[3] have recently reported an alternative synthesis of 3,4-dihydroxy-3,4-dihydrodibenz[*a*,*h*]anthracene although details of synthesis and complete physical characteristics are not available. The *trans*-stereochemistry of compound (**13**) is evident from the failure of the compound to form an acetonide and from its n.m.r. spectra.¶ The yields of the dihydrodiols obtained by this new method from the *ortho*-quinones are much higher [34% for (**1**) and *ca.* 65% for (**5**) and (**9**)] than those (<10%) usually obtained by the action of conventional hydride reducing agents.

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‡ 5-Bromo-1,2-naphthoquinone (**5**) and dibenz[*a*,*h*]anthra-3,4-quinone (**9**) have been synthesized here. These syntheses are being reported elsewhere.

§ Satisfactory analytical data were obtained.

¶ N.m.r. spectra were recorded on a Bruker 90 MHz spectrometer in $(CD_3)_2SO$ relative to Me_4Si: δ 4·39 (H–3), 4·80 (H–4), 6·24 (H–2), 7·46 (H–1), and 7·65–9·40 (ArH) ($J_{1,2}$ 10, $J_{1,3}$ 2, $J_{2,3}$ 2, and $J_{3,4}$ 11 Hz).

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