

Periodate Oxidation of Phenols

X. Structural and Steric Orientation in the Diels-Alder Dimerisation of *o*-Quinols

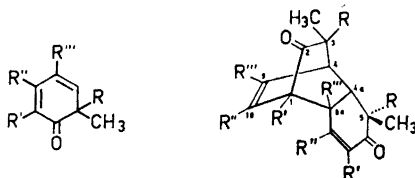
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The asymmetric 2,4-cyclohexadienones **1**¹ and **2–5**² ("o-quinols") as well as **7**³ and **8**⁴ are known to dimerise rapidly by Diels-Alder addition at room temperature to yield substituted 1,4-ethenonaphthalenes. *o*-Quinol acetates, such as **6**, are stable at room temperature, but dimerise readily on heating. In all cases, formation of only one of several possible dimers has been reported, indicating that these dimerisations are specific or at least highly selective with regard to both structural and steric orientation.

The structural orientation of the diene and the dienophile in the dimerisation of **1** has been established by degradation of the dimerisation product to 1,7-dimethyl-2-naphthol,¹ thus ascertaining the positions of the tertiary carbinol groups and the keto groups in the ring system to be as shown in formula **9** and excluding the alternative orientation represented by formula **9a**. The arrangement of the keto groups in **9** is in harmony with the principle of the lowest dipole moment of the transition state,⁵ and analogous structural orientation has been assumed for the *o*-quinol dimers **10–13**² obtained by periodate oxidation of the corresponding methyl substituted phenols. Although experimental proof was lacking, *endo* rather than *exo* configuration was preferred for dimers **9–13**.^{1,2} The configurations at the asymmetric carbon atoms **3** and **5** of these dimeric *o*-quinols remained unknown.

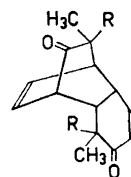
On the basis of chemical and spectral evidence, Kende and MacGregor³ later proposed that in dimer **15** the fluoro substituent at C-5 and the hydrogen at C-4a were in *trans* position. They also proposed the steric arrangement at C-3 and C-5 shown in **15**, which would reflect the sterically favoured positions of the bulky methyl groups in the transition state (cf. also Ref. 6). It should be noted, however, that in certain cases the stereochemistry of



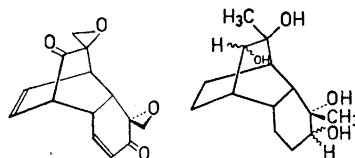
1–8

9–17

1	R = OH, R' = R'' = R''' = H	9
2	R = OH, R' = CH ₃ , R'' = R''' = H	10
3	R = OH, R'' = CH ₃ , R' = R''' = H	11
4	R = OH, R''' = CH ₃ , R' = R'' = H	12
5	R = OH, R' = R'' = CH ₃ , R''' = H	13
6	R = OAc, R' = R'' = R''' = H	14
7	R = F, R' = CH ₃ , R'' = R''' = H	15
8	R = Cl, R' = CH ₃ , R'' = R''' = H	16
	R = OH; CH ₂ Br instead of CH ₃ ;	17
	R' = R'' = R''' = H	



9a



18

19

Diels-Alder reactions has been found to be controlled by other factors than steric requirements.⁷ In their investigation of the chlorine containing dimer **16**, Lindgren and Ericsson⁴ came to the conclusion that the configuration at C-5 was analogous to that proposed for dimer **15**.

Recently, the structure and configuration of the bis(bromohydrin) **17** has been fully elucidated by chemical and spectral investigation⁸ and by X-ray diffraction analysis.⁹ This also clarified the structure and configuration of the precursor of **17**, i.e. the bis(spirooxiran) **18**, which was obtained by periodate oxidation of salicyl

alcohol, involving spontaneous dimerisation of the initially formed spiroepoxy-2,4-cyclohexadienone.⁶ In order to examine whether or not the configurational characteristics of the dimeric *o*-quinol 9 differed from those established for the bis(bromohydrin) 17, both compounds were reduced with Raney nickel in boiling ethanol. They were found to give the same tetrahydroxy compound 19. Hence, the dimeric *o*-quinol 9 is sterically analogous to 17 and 18, *i.e.*, it has *endo* configuration and steric arrangements at C-3 and C-5 analogous to those found for compounds 17 and 18.

The following experimental results indicate that the structural and steric orientation thus established for dimer 9 is also true for its homologues 10–13.

(a) The NMR spectrum (60 Mc, CDCl₃ + D₂O) of dimer 13 clearly shows the vicinal hydrogen atoms at positions 4a and 4 (H-4a, δ 2.84, d; H-4, δ 3.15, t; $J_{4,4a}$ and $J_{4,10}$ 2.0 cps), indicating that the structural orientation of the diene and the dienophile moieties in 13 is the same as in 9 and 18.

(b) Similar to the diacetate of dimer 9, the diacetates of 10 and 11 on treatment with ethanolic KOH eliminate acetic acid from the unbridged ring (C-4a, C-5) with concomitant aromatisation of this ring.^{2c,10} This elimination reaction indicates that the configuration at C-5 of dimers 10 and 11 is the same as that of dimer 9.

(c) Whereas dimers 9–11 were found to consume 1 mol of NaIO₄ with cleavage of the 2,3-ketol bridge, dimers 12 and 13 proved to be stable towards this oxidant. This striking difference can be understood by assuming that dimers 10–13 have the same configuration at C-3 as established for dimer 9, and that the bulky methyl group present at C-8a in 12 and 13 hinders the formation of the cyclic periodic ester – involving the hydroxyl group at C-3 and the (hydrated) keto group in position 2 – which precedes the cleavage reaction (*cf.* Ref. 11).

The diacetate 14 obtained by acetylation of dimer 9 is identical with that obtained by thermal dimerisation of the *o*-quinol acetate 6;¹ likewise, the diacetate of 10 is identical with the dimerisation product of the acetate of *o*-quinol 2.^{2c} Thus, the dimerisation of *o*-quinol acetates seems to follow the same rules as that of the free *o*-quinols.

Experimental details will be given in a forthcoming publication.

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Photoreaction Between Trisethylenediamine Cobalt(III) (Co(en)₃³⁺) and Ethylenediaminetetraacetate (H₂Y²⁻)

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Only few *photoanations* have been reported with coordination compounds.^{1,2} The common photosubstitution is the photosolvation and generally any photosubstitution is accompanied by a dark (thermal) reaction.¹ Therefore, the reaction



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