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Borontrifluoride-Etherate Induced Rearrangement of Bicyclo[2.2.2]octene-7,8-diones: An Efficient Synthesis of Bicyclo[3.2.1]octene-2,8-diones.

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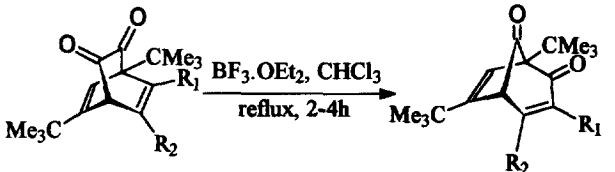
Abstract: A facile conversion of bicyclo[2.2.2]octene-7,8-diones to bicyclo[3.2.1]octene-2,8-diones mediated by BF_3-etherate in chloroform is described.

The bicyclo[3.2.1]octane skeleton is present in a number of important sesquiterpenes and neolignans. Consequently there has been interest in the construction of this ring system; among others,[1] the available methods consist of the acid catalyzed [4+2] cycloaddition[2] of *p*-benzoquinonoid compounds with styrenes and the anodic oxidation[3] of 3,4-dimethoxy phenols in presence of the latter.

Herein we report a facile method for the formation of bicyclo[3.2.1]octene-2,8-diones from bicyclo[2.2.2]octene-7,8-diones.[4] The strategy involves the BF_3-etherate induced rearrangement of the readily available Diels-Alder adducts of *o*-quinones[5,6] as illustrated in Scheme 1.

A solution of 3-phenyl-1,5-bis(1,1-dimethylethyl)bicyclo[2.2.2]oct-2,5-diene-7,8-dione **1a** in chloroform, when heated under reflux in the presence of BF_3-etherate smoothly rearranged to afford 4-phenyl-1,6-bis(1,1-dimethylethyl)bicyclo[3.2.1]oct-3,6-diene-2,8-dione **2a** in 92% yield.[7] The structure of the product was assigned on the basis of analytical and spectral data. Final proof for the structure of **2a** was obtained by single crystal X-ray determination. In a similar fashion **1b** and **1c** underwent rearrangement in presence of BF_3-etherate to **2b** and **2c** respectively (Scheme 1).



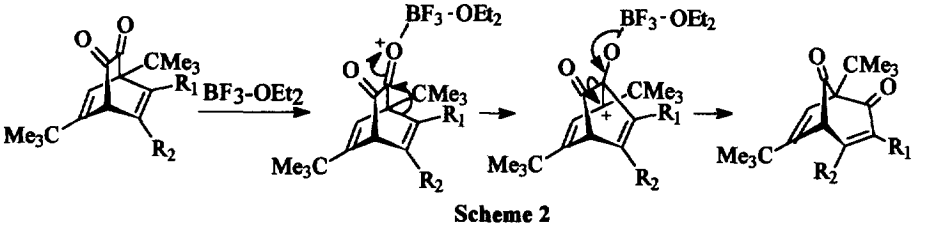
Scheme 1

a, R_1 = H, R_2 = Ph, 92%

b, R_1 = Ph, R_2 = H, 89%

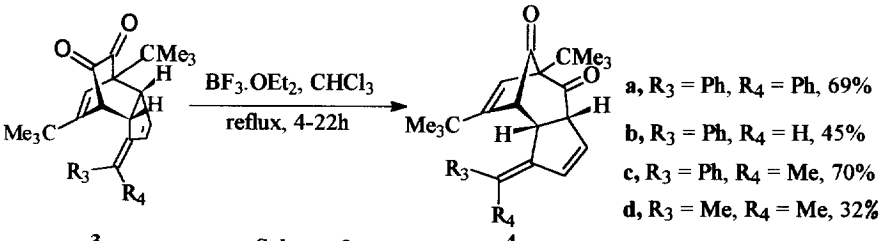
c, R_1 = H, R_2 = CH_2OH, 82%

While the mechanistic details of the rearrangement described here remain unclear, a rationalization along the following lines may be invoked (Scheme 2).



Scheme 2

A similar reaction of bicyclic adducts[5] **3a-d** afforded **4a-d**[8] in good yields (Scheme 3).



3 **Scheme 3** 4

In conclusion, we have developed a facile method for the generation of bicyclo[3.2.1]octene-2,8-diones which appear to be amenable to further synthetic transformation.

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7. Typical procedure for the synthesis of **2a:** To a solution of **1a** (0.5 g,1.55 mmol) in dry chloroform (20 ml) was added BF_3-etherate (0.22ml, 1.79 mmol) and the mixture was stirred under reflux in an atmosphere of argon for 2h. Aqueous work-up and extraction of the product with chloroform followed by chromatography on silica-gel afforded **2a** (0.46 g, 92%) as colourless crystalline solid. Recrystallized from hexane. mp. 151-152 °C. ^{1}H NMR ($CDCl_3$, 200 MHz) δ 0.97 (s, 9H), 1.26(s, 9H), 4.29 (s, 1H), 5.92 (s,1H), 6.24(s,1H), 7.49 (m, 5H); HRMS exact mass calcd. for $C_{22}H_{26}O_2$: (M^+) 322.19328; Found: 322.19270.
8. Selected spectral and analytical data for **4a**: mp. 218-220 °C; IR (KBr) 1752, 1699 cm^{-1}; ^{1}H NMR ($CDCl_3$, 270 MHz); δ 0.76 (s, 9H), 1.12 (s, 9H), 2.85 (d, J =1.75 Hz, 1H), 3.92 (m, 2H), 5.70 (s, 1H), 5.83 (dd, J = 5.4, 2.7 Hz, 1H), 6.49 (dd, J = 5.4, 2.7 Hz, 1H), 7.29 (m, 10H); HRMS exact mass calcd. for $C_{32}H_{34}O_2$: (M^+) 450.25589; Found: 450.25515. Anal. Calcd. for $C_{32}H_{34}O_2$: C, 85.28; H, 7.61 Found: C, 85.60; H, 7.68.

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