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Complementary Electrocyclic Reactions of <u>o</u>-Quinodimethanes. Highly Efficient Access to 4-Alkylideneisochroman-3-ones and 1-Carbomethoxy-3,4-dihydronaphthalenes

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Thermolysis of 1-alkenylbenzocyclobutenyl-1-carboxylic acid produced 4-alkylideneisochroman-3-ones in good yields via an unprecedented tandem electrocyclic-[1,5]sigmatropic process of \underline{o} -quinodimethane. Alternatively, thermolysis of the corresponding methyl ester afforded the dihydronaphthalenes via E-transition state in excellent yields.

During the course of our studies on the development of novel and synthetically useful methodologies using benzocyclobutenes¹⁾ we became interested in the question of competitive electrocyclic reactions between the hexatriene (Z-form) and the dienone (E-form) system in the transition state of <u>o</u>-quinodimethane, as illustrated in Scheme 1.



In this communication we describe the complementary electrocyclic reactions of \underline{o} -quinodimethanes, including <u>the first example</u> of tandem electrocyclic-[1,5]sigma-tropic reaction of Z- \underline{o} -quinodimethane.

The substrates used in this study, 1-alkenylbenzocyclobutenes (1a-e) were easily prepared by combination of standard procedures starting from the 1-cyanobenzocyclobutenes (2^{2}) and 3^{3}) as shown in Scheme 2.

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eagents: a, LDA, R⁻COCH₂R⁻, HMPA; b,SOCI₂, pyridine or Burgess reagent; c, KOH, aq.EtOH; d, LDA, EtCHO, HMPA; e, (COC1)₂, DMSO, NEt₃; f, Ph₃P=CH₂.

Scheme 2.

The thermolysis of a solution of the 1a-e in <u>o</u>-dichlorobenzene at 180 °C for 10 min proceeded cleanly, and very high yields of the products could generally be obtained as a chromatographically separable mixture of two isomers. The structure of the major products could be determined spectroscopically as 4-alkylideneisochroman-3-ones $(5a-e)^{4}$ which were formed from the Z-transition state, while the minor products were dihydronaphthalenecarboxylic acids (5a-e) produced via the E-isomer (Scheme 3).



The results of the thermolysis are presented in Table 1. The olefin geometry of **4b** and **4e**, obtained as single isomers, could be established as E by n.O.e. experiments of the isochromanone (6), derived from **4b** by the sequential reduction

	Yield/%			
Substrate	4	5		
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1a	92	6	a)	R' The second
b	87	6	a)	R ²
с	94	5		7
-	0.6	4		
a	96	4		
е	95	4	a)	

Table 1. Thermolysis of the benzocyclobutenes 1

 a) A trace amount of decarboxylated product 7 was obtained via [1,5]sigmatropic reaction.

with DIBAH and acetalisation, and 4e (irradiation at olefinic methyl, 14.6% enhancement of C-3 (H). irradiation C-2'(CH₂), 9.1% enhancement of C-5(H)⁵⁾) (Scheme 4).



The highly stereoselective formation of the isochromanones is explainable by the sequential electrocyclic reaction of the Z-o-quinodimethane and [1,5]sigmatropic reaction of the resulting dienol 8, as illustrated in Scheme 3. This mechanism is supported by the following experiment: The thermolysis of the deuterated carbo-xylic acid 1a-d₁ provided the deuterated isochromanone 4a-d [Found: m/z, 219.0969(M⁺). Calcd for $C_{13}H_{13}O_{3}D$: 219.1006] as a sole neutral product. The structure 4a-d was confirmed on the basis of the 90 MHz ¹HNMR spectrum.⁴) The deuterated methyl (δ 2.29) appears in lower field than the nondeuterated methyl (δ 2.14), indicating the cis relationship between the CH₂D and COO moieties (Scheme 5).



Scheme 5.

Alternatively, the thermolysis of a solution of the 1-alkenyl-1-methoxycarbonylbenzocyclobutenes(9a, 9b, and 9c), prepared from the corresponding carboxylic acids by treating with diazomethane, in <u>o</u>-dichlorobenzene at 180 °C for 20 min provided the dihydronaphthalenes 10 in excellent yields without any detectable contamination by the isochromanones (Scheme 6, Table 2).



Table 2. Thermolysis of the methyl esters 9

Substrate	Yield/% of 10
9a	100
b	97
С	99

The two kinds of product, 4 and 10, thus efficiently synthesized are generally less available, therefore the present complementary transformations seem to be valuable in organic synthesis.

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- No n.O.e. enhancement at C-5(H) is observed upon irradiation of olefinic methyl.

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