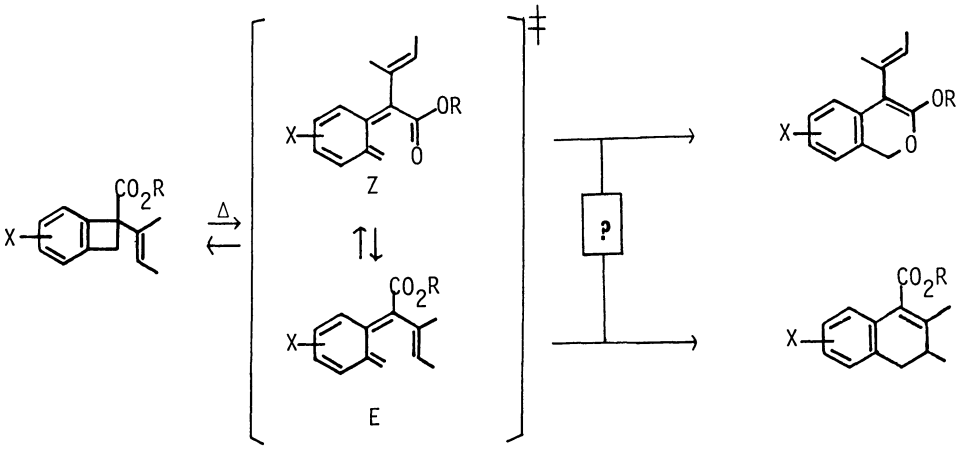
CHEMISTRY LETTERS, pp. 2117-2120, 1987.

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

Kozo SHISHIDO, Hironori KOMATSU, Keiichiro FUKUMOTO,* and
Tetsuji KAMETANI†
Pharmaceutical Institute, Tohoku University, Aobayama, Sendai 980
†Institute of Medicinal Chemistry, Hoshi University, Ebara 2-4-41,
Shinagawa-ku, Tokyo 142

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 o-quinodimethane. Alternatively, thermolysis of the corresponding methyl ester afforded the dihydronaphthalenes via E-transition state in excellent yields.

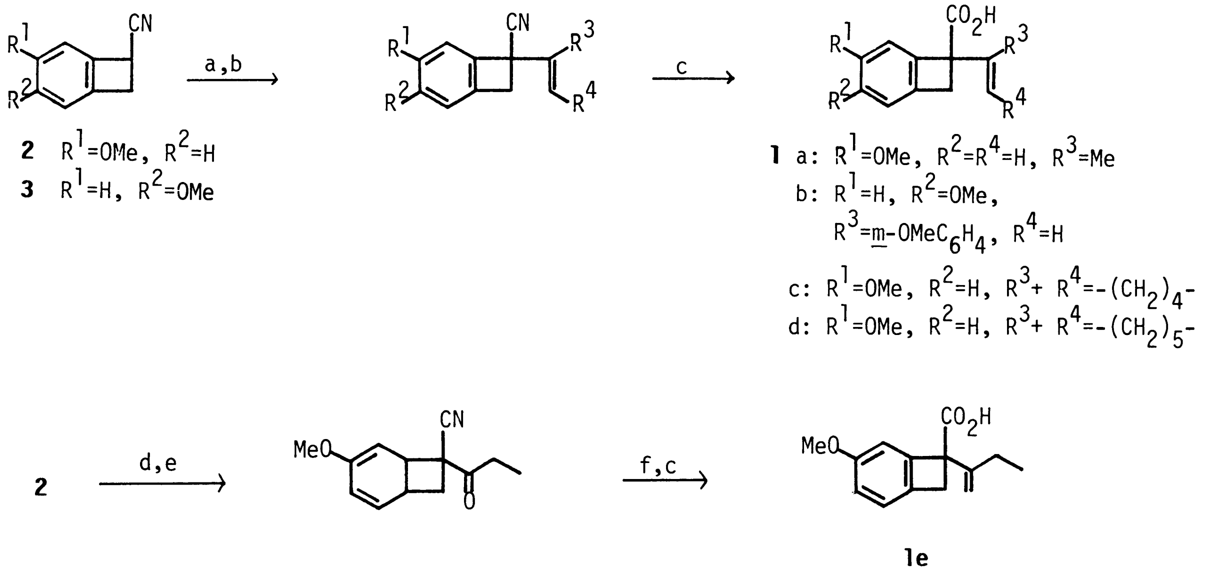
During the course of our studies on the development of novel and synthetically useful methodologies using benzocyclobutenes[1)] we became interested in the question of competitive electrocyclic reactions between the hexatriene (Z-form) and the dienone (E-form) system in the transition state of o-quinodimethane,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



Scheme 1.

In this communication we describe the complementary electrocyclic reactions of o-quinodimethanes, including the first example of tandem electrocyclic-[1,5]sigmatropic reaction of Z-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.



**2** $R^1$=OMe, $R^2$=H
**3** $R^1$=H, $R^2$=OMe

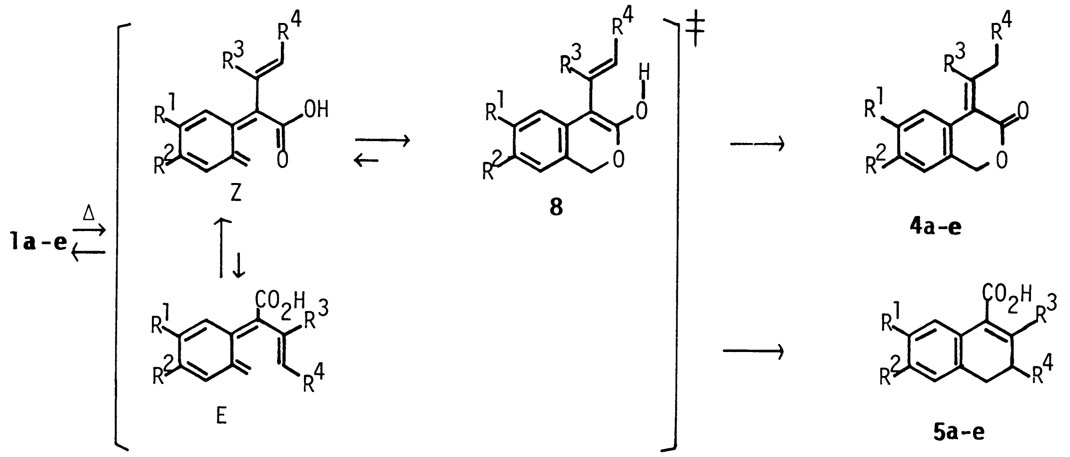
**1** a: $R^1$=OMe, $R^2$=$R^4$=H, $R^3$=Me
b: $R^1$=H, $R^2$=OMe, $R^3$=m-OMe$C_6H_4$, $R^4$=H
c: $R^1$=OMe, $R^2$=H, $R^3$+ $R^4$=-$(CH_2)_4$-
d: $R^1$=OMe, $R^2$=H, $R^3$+ $R^4$=-$(CH_2)_5$-

**1e**

Reagents: a, LDA, $R^3COCH_2R^4$, HMPA; b, $SOCl_2$, pyridine or Burgess reagent; c, KOH, aq.EtOH; d, LDA, EtCHO, HMPA; e, $(COCl)_2$, DMSO, $NEt_3$; f, $Ph_3P=CH_2$.

Scheme 2.

The thermolysis of a solution of the **1a-e** in o-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).

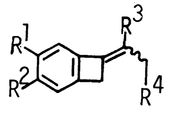


Scheme 3.

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

Table 1. Thermolysis of the benzocyclobutenes **1**

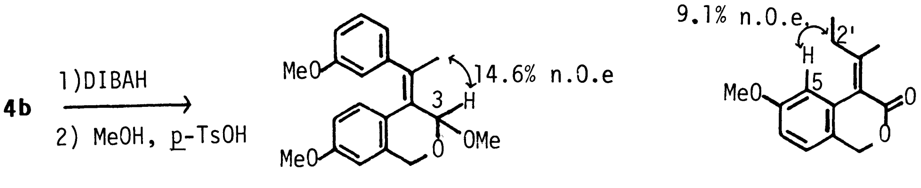
| Substrate | Yield/% **4** | Yield/% **5** | |
|---|---|---|---|
| **1a** | 92 | 6 | a) |
| **b** | 87 | 6 | a) |
| **c** | 94 | 5 | |
| **d** | 96 | 4 | |
| **e** | 95 | 4 | a) |



**7**

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

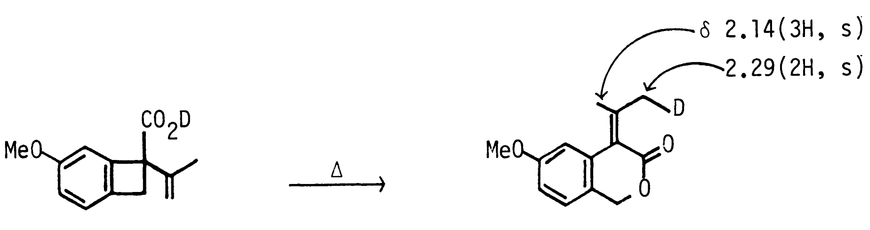
with DIBAH and acetalisation, and **4e** (irradiation at olefinic methyl, 14.6% enhancement of C-3 (H). irradiation C-2'($CH_2$), 9.1% enhancement of C-5(H)$^{5)}$) (Scheme 4).



**6**

Scheme 4.

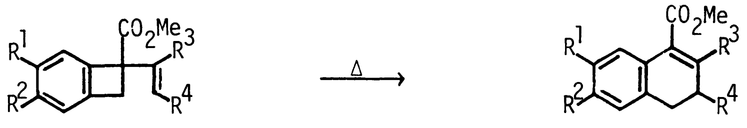
The highly stereoselective formation of the isochromanones is explainable by the sequential electrocyclic reaction of the Z-o-quinodimethane and [1,5]sigmatropic reaction of the resulting dienol **8**, as illustrated in Scheme 3. This mechanism is supported by the following experiment: The thermolysis of the deuterated carboxylic acid **1a-d$_1$** provided the deuterated isochromanone **4a-d** [Found: m/z, 219.0969($M^+$). Calcd for $C_{13}H_{13}O_3D$: 219.1006] as a sole neutral product. The structure **4a-d** was confirmed on the basis of the 90 MHz $^1$HNMR spectrum.$^{4)}$ The deuterated methyl ( $\delta$2.29) appears in lower field than the nondeuterated methyl ( $\delta$2.14), indicating the cis relationship between the $CH_2D$ and COO moieties (Scheme 5).



**1a-d$_1$** **4a-d**

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 *o*-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).



**9** **10**

a: $R^1$=OMe, $R^2$=$R^4$=H, $R^3$=Me
b: $R^1$=$R^4$=H, $R^2$=OMe, $R^3$=*m*-OMe$C_6H_4$
c: $R^1$=OMe, $R^2$=H, $R^3$+ $R^4$=-$(CH_2)_3$-

Scheme 6.

Table 2. Thermolysis of the methyl esters **9**

| Substrate | Yield/% of **10** |
|---|---|
| **9a** | 100 |
| **b** | 97 |
| **c** | 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.

We thank Dr. Yoshiteru Oshima of our Institute for the n.O.e. measurements.

## References

1) K. Shishido, M. Ito, S. Shimada, K. Fukumoto, and T. Kametani, Chem. Lett., 1984, 1943; K. Shishido, E. Shitara, K. Fukumoto, and T. Kametani, J. Am. Chem. Soc., 107, 5810 (1985); K. Shishido, K. Hiroya, K. Fukumoto, and T. Kametani, Tetrahedron Lett., 27, 971 (1986).
2) T. Kametani, M. Kajiwara, and K. Fukumoto, Tetrahedron, 30, 1053 (1974).
3) T. Kametani, Y. Kato, T. Honda, and K. Fukumoto, J. Am. Chem. Soc., 98, 8185 (1976).
4) M. Barbier, Heterocycles, 26, 421 (1987).
5) No n.O.e. enhancement at C-5(H) is observed upon irradiation of olefinic methyl.

(Received July 24, 1987)