Synthesis of 3-Bromo-1,5- and -1,7-Azulenequinones Having Some Alkyl or Phenyl Group by the Polybromination and Reductive Debromination of Their Bromo-Substituent[1]

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2-Methyl-, 2-phenyl-, 5- and 6-isopropylazulenes, and 5-isopropyl- and 6-isopropyl-2-methylazulenes were led to the corresponding 1,5- and 1,7-azulenequinones by polybromination in aqueous THF. 1-Carboxylic acid derivatives of these alkylazulenes also gave same products. Three isomeric 2-methyl derivatives of 3,3-biazulenequinones were produced from 2-methylazulene as minor products. Treatment of bromoazulenequinones with tin powder in acetic acid afforded the corresponding parent quinones.

Very recently we have reported[2] the synthesis of 3-bromo-1,5- and -1,7-azulenequinones by bromination of azulene in one-pot in aqueous solvent; these quinones could be used as convenient synthones.[3]

Now we wish to report application of our azulenequinone synthesis to 2-methyl-, 2-phenyl- and azulenes having an isopropyl group on the seven-membered moiety to clarify the substituent effect as well as scope and limitation of this method.

Bromination and isolation of the products were carried out in accordance with the previous report[2] and the results are summarized in Table 1.[4] Reaction of 2-methylazulene[5] (**1a**, 300 mg, 2.11 mmol) in aqueous THF (70 ml) with bromine (1.42 g, 8.86 mmol) in acetic acid (12 ml) at 0 °C followed by chromatographic isolation of the products gave 3-bromo-2-methyl-1,5-azulenequinone[6] (**2a**, 240 mg, 45% yield) and -1,7-azulenequinone[7] (**3a**, 80 mg, 15% yield) together with three 3,3-biazulenequinones (**5a**,[8] mp 210 °C; **5b**,[9] mp 190 °C; **5c**,[10] mp 210 °C) in 2% yield. A trace amount of 1,1,3-tribromoketone mixture[11] (**6a,b**) and 3-bromoazulenylazulenequinones (**7a**,[12] reddish violet needles, mp 127-129 °C and **7b**, reddish violet needles, mp 124-126 °C) were also isolated. 1,3-Dibromo-2-methylazulene (**8**) gave the same products on the bromination under the same conditions indicating intermediacy of this compound. Possible formation paths are shown in Scheme 1.

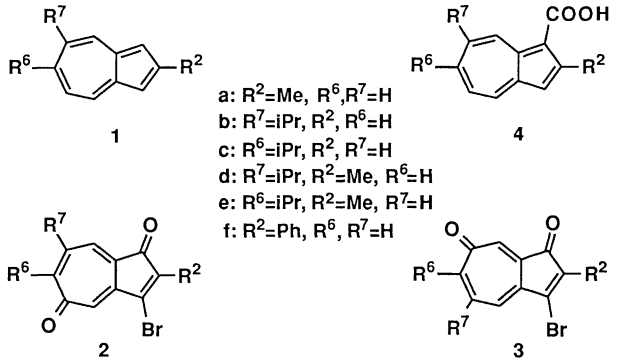
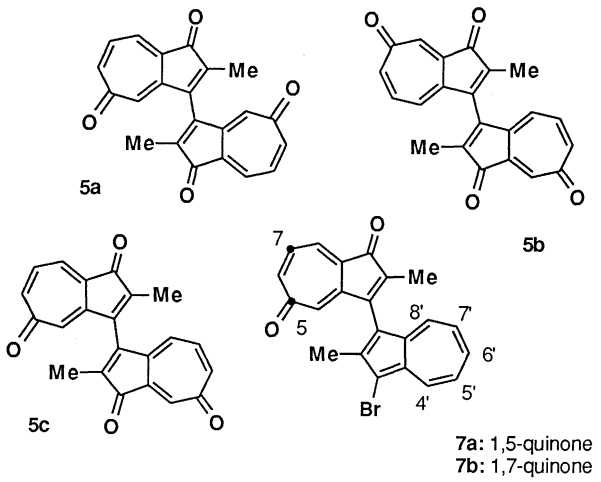


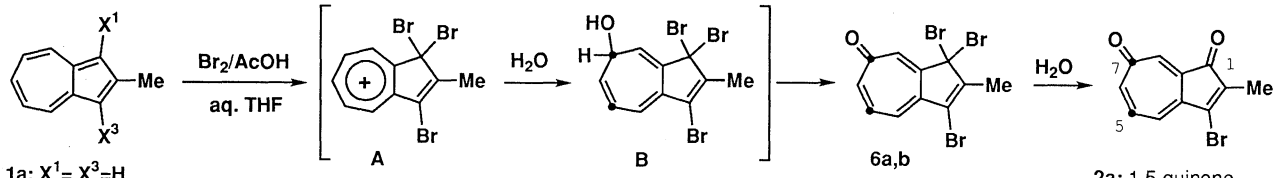
Table 1. Azulenequinones (**2** and **3**) obtained by the Bromination of Azulenes[4] (**1** and **4**)

Az	AQs	Color / Form	mp/ ℃	Yield/%*
1a	**2a**	light yellow needles	147-149	45
	3a	pale yellow needles	128 (dec)	15
4a	**2a**			42
	3a			12
1b	**2b**	light yellow needles	90 (dec)	43
	3b	pale yellow needles	100 (dec)	15
4b	**2b**			60
	3b			20
1c	**2c**	light yellow needles	120 (dec)	45
	3c	pale yellow needles	120 (dec)	15
4c	**2c**			50
	3c			15
1d	**2d**	light yellow needles	108-110	48
	3d	pale yellow needles	122-124	11
4d	**2d**			60
	3d			14
1e	**2e**	light yellow needles	91-93	50
	3e	pale yellow needles	60 (dec)	10
1f	**2f**	yellow needles	115-117	35
	3f	yellow needles	192-194	10

* Isolated yields.



Alkylazulenes having an alkyl group at the 5(7)- or 6-position are interested in terms of direct or sterically blocking the carbonylation position. The reaction of 5-isopropylazulene (**1b**) under the same conditions gave 3-bromo-7-isopropyl-1,5-azulenequinone (**2b**) as major product together with isomeric

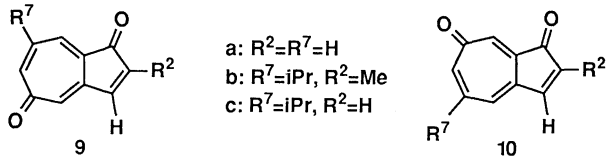


Scheme 1.

1,7-azulenequinone (**3b**). 6-Isopropylazulene (**1c**) also gave two azulenequinones (**2c**, **3c**) in substantial yields. 2-Methyl-6- isopropyl- (**1d**) and 2-phenylazulene (**1e**) gave corresponding azulenequinone derivatives.

Bromination of alkylazulene-1-carboxylic acids (**4a-d**) under the similar conditions gave same azulenequinones obtained above through initial bromination and decarboxylation followed by second bromination.

Reductive debromination of the bromo-substituent at the 3-position of the 3-bromo-1,5- and -1,7-azulenequinones were achieved by the treatment with tin powder in acetic acid; thus, 1,5-(**9a**, 30%),[13] 1,7-(**10a**, 30%),[13] and their alkyl derivatives **9b**[14] (light yellow needles, mp 117-119 °C, 50%), **9c** (light yellow needles, mp 105-107 °C, 25%) were synthesized, respectively.



These results indicate applicability of our synthetic method of azulenequinones to various alkyl- or arylazulenes. The bromination reaction of 1-alkyl- or 1-arylazulenes are now in progress. The results will be reported elsewhere.

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References and Notes

1 Partly presented at: T. Nozoe, H. Wakabayashi, K. Shindo, and M. Kageyama, The 65th Symposium on Organic Synthesis, Tokyo, June 1994, Abstr.1-6; T. Nozoe, 4th Towa University International Symposium, Fukuoka, Nov. 1994, Abstr. pp.13-18; H. Wakabayashi, K. Shindo, S. Ishikawa, M. Yasunami, and T. Nozoe, 24th Symposium on Structural Organic Chemistry, Oct. 1994, Fukuoka, Abstr. 2P65.

2 T. Nozoe, H. Wakabayashi, K. Shindo, T. Kurihara, S. Ishikawa, and M. Kageyama, *Chem. Lett.*, **1995**, 25.

3 T. Nozoe, H. Wakabayashi, K. Shindo, and S. Ishikawa, *Chem. Lett.*, **1995**, 27.

4 Satisfactory spectral (NMR, IR, MS, UV/Vis) data were obtained for these new compounds. Experimental details will be published elsewhere.

5 P. W. Yang, M. Yasunami, and K. Takase, *Tetrahedron Lett.*, **1971**, 4275; M. Yasunami, Alice Chen, P. W. Yang, and K. Takase, *Chem. Lett.*, **1980**, 579; M. Yasunami, S. Miyoshi, N. Kanegae, and K. Takase, *Bull. Chem. Soc. Jpn.*, **66**, 892 (1993).

6 **2a**: ^{1}H NMR (270 MHz, $CDCl_3$) δ 2.09 (3H, s, CH_3), 6.96 (1H, ddd, J=12.1, 2.5, 1.0 Hz, H-6), 7.05 (1H, dd, J=2.5, 0.5 Hz, H-4), 7.12 (1H, dd, J=12.1, 7.8 Hz, H-7), 7.27 (1H, ddd, J=7.8, 1.0, 0.5 Hz, H-8).

7 **3a**: ^{1}H NMR (270 MHz, $CDCl_3$) δ 2.09 (3H, s, CH_3), 6.84 (1H, ddd, J=12.1, 2.6, 0.8 Hz, H-6), 6.95 (1H, ddd, J=8.1, 0.8, 0.5 Hz, H-4), 7.14 (1H, dd, J=12.1, 8.1 Hz, H-5), 7.22 (1H, dd, J=2.6, 0.5 Hz, H-8).

8 **5a**: ^{1}H NMR (500 MHz, $CDCl_3$) δ 1.96 (6H, s, CH_3), 6.45 (2H, dd, J=2.4, 0.5 Hz, H-4,4'), 6.96 (2H, ddd, J=12.2, 2.4, 1.0 Hz, H-6,6'), 7.18 (2H, dd, J=12.2, 8.0 Hz, H-7,7'), 7.46 (2H, ddd, J=8.0, 1.0, 0.5 Hz, H-8,8').

9 **5b**: ^{1}H NMR (500 MHz, $CDCl_3$) δ 1.97 (6H, s, CH_3), 6.43 (2H, ddd, J=8.2, 0.8, 0.5 Hz, H-4,4'), 6.85 (2H, ddd, J=12.5, 2.7, 0.8 Hz, H-6,6'), 7.01 (2H, dd, J=12.5, 8.2 Hz, H-5,5'), 7.40 (2H, dd, J=2.7, 0.5 Hz, H-8,8').

10 **5c**: ^{1}H NMR (500 MHz, $CDCl_3$) δ 1.94 (3H, s, CH_3), 1.97 (3H, s, CH_3), 6.38 (1H, dd, J=8.2, 0.5 Hz, H-4'), 6.50 (1H, dd, J=2.5, 0.5 Hz, H-4), 6.84 (1H, ddd, J=12.2, 2.6, 0.5 Hz, H-6'), 6.96 (1H, ddd, J=12.2, 2.5, 1.0 Hz, H-6), 6.97 (1H, dd, J=12.2, 8.2 Hz, H-5'), 7.18 (1H, dd, J=12.2, 8.0 Hz, H-7), 7.39 (1H, d, J=2.6 Hz, H-8'), 7.47 (1H, ddd, J=8.0, 1.0, 0.5 Hz, H-8).

11 **6a**: ^{1}H NMR (500 MHz, $CDCl_3$) δ 2.37 (3H, s, CH_3), 6.98 (1H, ddd, J=12.2, 2.7, 1.0 Hz, H-6), 7.05 (1H, dd, J=2.7, 1.0 Hz, H-4), 7.17 (1H, dd, J=12.2, 8.5 Hz, H-7), 7.56 (1H, ddd, J=8.5, 1.0, 1.0 Hz, H-8);
6b: ^{1}H NMR (500 MHz, $CDCl_3$) δ 2.35 (3H, s, CH_3), 6.93 (1H, ddd, J=8.5, 1.0, 1.0 Hz, H-4), 6.94 (1H, ddd, J=12.2, 2.7, 1.0 Hz, H-6), 7.19 (1H, dd, J=12.2, 8.5 Hz, H-5), 7.67 (1H, dd, J=2.7, 1.0 Hz, H-8).

12 **7a**: ^{1}H NMR (500 MHz, $CDCl_3$) δ 1.87 (3H, s, CH_3), 2.47 (3H, s, CH_3), 6.33 (1H, d, J=2.7 Hz, H-4), 6.91 (1H, ddd, J=12.2, 2.7, 1.0 Hz, H-6), 7.15 (1H, dd, J=12.2, 7.9 Hz, H-7), 7.26 (1H, t, J=9.8 Hz, H-7'), 7.41 (1H, dd, J=7.9, 1.0 Hz, H-8), 7.42 (1H, t, J=9.8 Hz, H-5'), 7.69 (1H, t, J=9.8 Hz, H-6'), 7.80 (1H, d, J=9.8 Hz, H-8'), 8.43 (1H, d, J=9.8 Hz, H-4').

13 L. T. Scott and C. M. Adams, *J. Am. Chem. Soc.*, **106**, 4857 (1984).

14 **9b**: ^{1}H NMR (270 MHz, $CDCl_3$) δ 1.25 (6H, d, J=7.0 Hz, iPr-CH_3), 2.04 (3H, d, J=1.0 Hz, CH_3), 2.76 (1H, septet, J=7.0 Hz, iPr-CH), 6.69 (1H, dd, J=2.4, 0.5 Hz, H-4), 6.82 (1H, dd, J=2.4, 1.0 Hz, H-6), 7.25 (1H, dd, J=1.0, 0.8 Hz, H-8), 7.44 (1H, q, J=1.0 Hz, H-3).