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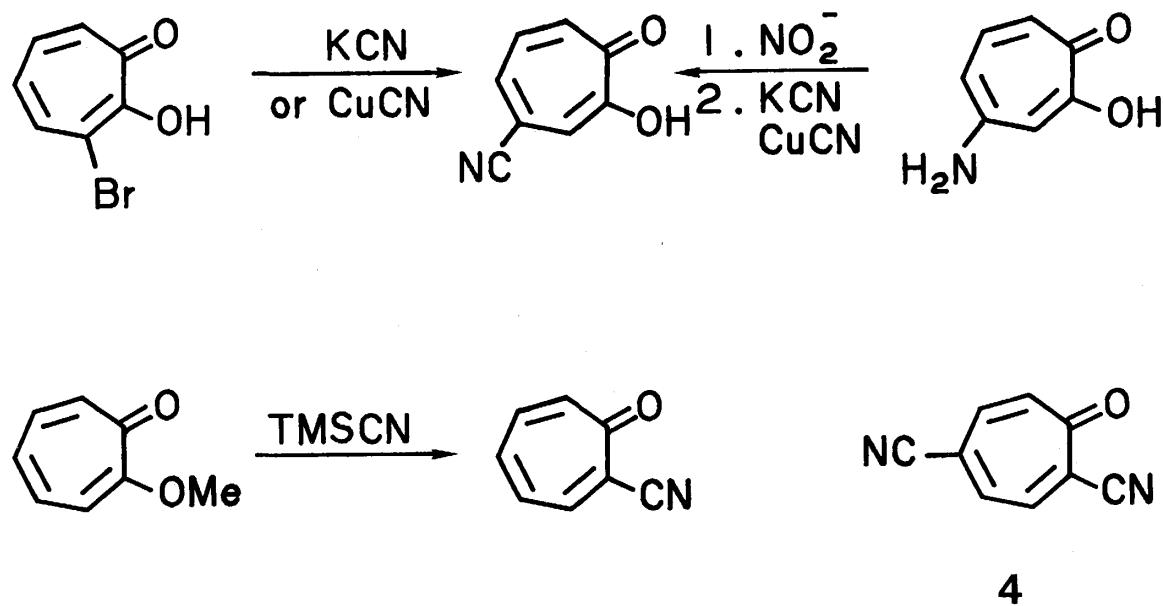


## Synthesis of 4, 6-Dicyano-2, 5-dimethoxytropone

Hitoshi TAKESHITA,\* Akira MORI, and Shun-ichi HIRAYAMA

4,6-Dicyano-2,5-dimethoxytropone, a potential dicyano-*p*-tropoquinone precursor, was prepared from 4,6-bis(formyloxymethyl)-2,5-dimethoxytropone. The other cyanotropones prepared by the reaction of 2,5-dimethoxytropone with trimethylsilyl cyanide were 2-cyano-5-methoxy- and 5-cyano-2-methoxytropones.

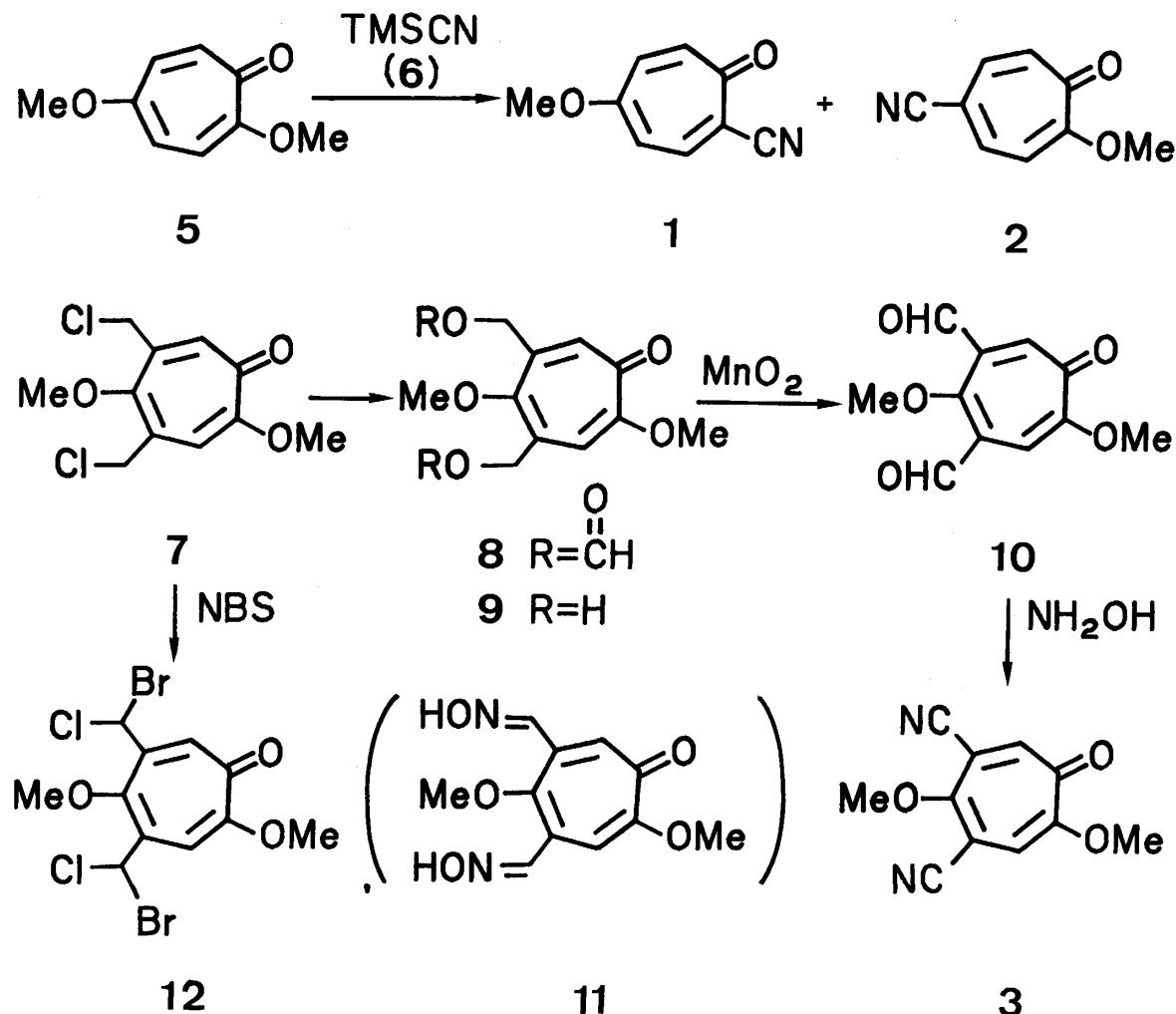
Previously, cyanotropolones were prepared by the substitution of 3-bromotropolone with potassium cyanide<sup>1)</sup> or copper (I) cyanide<sup>2)</sup> and by the Sandmeyer reaction of 4- and 5-aminotropolones,<sup>3)</sup> but the yields were not always satisfactory. Recently, Saito has prepared 2-cyanotropone from trimethylsilyl cyanide and 2-methoxytropone under mild conditions.<sup>4)</sup> In this paper, we will describe the synthesis of several cyanotropones, such as 2-cyano-5-methoxy- (1) and 5-cyano-2-methoxytropones (2) as well as 4,6-dicyano-2,5-dimethoxytropone (3), possible precursors for cyano-*p*-tropoquinones.



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Synthesis of Cyanotropone

First of all, in a hope of preparing 2,5-dicyanotropone (4), we attempted the reaction of 2,5-dimethoxytropone (5) with trimethylsilyl cyanide (6) under Saito's conditions,<sup>4)</sup> two monocyanotropones (1 and 2) were obtained in 28% and 22% yields. Since less-polar product, 2, exhibited two pairs of *AB*-type signals and a methoxy signal being long-range-coupled to the broad doublet signal at 7.03, which was the highest signal among the ring protons, the structure of 2 is shown to be 5-cyano-2-methoxytropone. On the other hand, the <sup>1</sup>H NMR spectrum of 1 exhibited a methoxy signal which long-range-coupled to an aromatic proton signal at 6.55; its structure must be 2-cyano-5-methoxytropone. The results were parallel to the Saito's mechanism;<sup>4)</sup> the attack of 6 occurred at the carbon bearing the substituent. Since it failed to give dicyanotropone directly, we attempted to convert 4,6-bis(chloromethyl)-2,5-dimethoxytropone (7)<sup>5)</sup> to the dicyano derivative.



When a hexamethylphosphoric triamide solution of 7 and sodium formate was heated at 50 °C for 2 h, 4,6-bis(formyloxymethyl)-2,5-dimethoxytropone (8) was obtained in 89% yield. An acid hydrolysis of 8 gave a bis(hydroxymethyl) derivative (9) in 81% yield. The

manganese (IV) oxide oxidation of **9** afforded a bisaldehyde (**10**) in 40% yield. Treatment of **10** with hydroxylamine gave a dicyano derivative (**3**) in 6% but no dioxime (**11**); the yield of **3**, however, could not be improved inspite of intensive survey of reaction conditions. This poor yield might be due to the nucleophilic attack of hydroxylamine into C-7 position, whose electron density decreased by the introduction of two cyano groups. Similar reaction has occurred when a 2-benzoyltropone derivative was treated with 1,2-diaminobenzene to give a benzodiazepinone derivative instead of 1,2-diazaazulene derivative.<sup>6)</sup> Alternatively, by refluxing benzene solution of **7** with *N*-bromosuccinimide and 2,2'-azobis(isobutyronitrile), an unstable dibromodichloro derivative (**12**) was obtained in 25% yield.

The further transformation of **3** to *p*-tropoquinone derivatives is under going and will be published elsewhere.

### Experimental

The elemental analyses were performed by Miss S. Hirashima, of This Institute. The NMR spectra were measured by a JEOL FX 100 Spectrometer in  $\text{CDCl}_3$  solution, unless otherwise specified, and the chemical shifts expressed were in  $\delta$  unit. The mass spectra were measured with a JEOL OISG-2 Spectrometer. The IR spectra were taken as KBr disks or as a liquid film inserted between NaCl plates using a Jasco IR-A 102 Spectrometer. The UV spectra were measured by a Hitachi U-3200 Spectrophotometer.

**Reaction of 6 and 2,5-Dimethoxytropone (5).** An anhydrous  $\text{CH}_2\text{Cl}_2$  solution (1 cm<sup>3</sup>) of **5** (211 mg) and **6** (253 mg) was stirred at room temperature for 5.5 d in the presence of  $\text{ZnI}_2$  (14 mg). The volatile materials were evaporated in vacuo and the residue was chromatographed on a silica-gel column to give **2** [yellow crystals, mp 154–156 °C, 35.3 mg; 22%. Found:  $m/z$ , 161.0482; Calcd for  $\text{C}_9\text{H}_7\text{NO}_2$ : 161.0476.  $^1\text{H}$  NMR  $\delta$ ( $\text{CD}_3\text{OD}$ ) = 3.99 (3H, s), 7.03 (1H, d,  $J$  = 10.5 Hz), 7.13 (1H, dd,  $J$  = 12.5, 0.7 Hz), 7.46 (1H, dd,  $J$  = 12.5, 1.6 Hz), and 7.70 (1H, ddd,  $J$  = 10.5, 1.6, 0.7 Hz).  $^{13}\text{C}$  NMR  $\delta$ ( $\text{CF}_3\text{COOD}$ ) = 59.7, 113.2, 116.5, 119.1, 136.8, 144.1, 146.4, 171.4, and 183.0. IR  $\nu$ : 2220, 1620, and 1580 cm<sup>-1</sup>. UV  $\lambda_{\text{max}}^{\text{MeOH}}$ : 222 nm ( $\epsilon$  = 13000), 249 (14000), 318 (7500, sh), 330 (8800), 353 (6600, sh), and 370 (4700, sh)] and **1** [yellow needles, mp > 300 °C, 45.8 mg; 28%. Found: 161.0475.  $^1\text{H}$  NMR  $\delta$ ( $\text{CD}_3\text{OD}$ ) = 3.91 (3H, s) 6.55 (1H, ddd,  $J$  = 10.4, 2.5, 1.2 Hz), 7.08 (1H, dd,  $J$  = 13.3, 1.2 Hz), 7.25 (1H, dd,  $J$  = 13.3, 2.5 Hz), and 7.87 (1H, d,  $J$  = 10.4 Hz).  $^{13}\text{C}$  NMR  $\delta$ ( $\text{CF}_3\text{COOD}$ ) = 59.2, 114.5, 116.1, 117.5, 141.4, 143.2, 152.8, 176.6, and 187.1. IR  $\nu$ : 2230, 1640, 1595, and 1570 cm<sup>-1</sup>. UV  $\lambda_{\text{max}}^{\text{MeOH}}$ : 218 nm ( $\epsilon$  = 13000, sh), 243 (13000), 247 (13000, sh), 328 (9200), 353 (8400), 369 (7200, sh), and 388 (3800, sh)].

**Reaction of 7 with HCOONa.** An HMPA solution (2 cm<sup>3</sup>) of **7** (29 mg) and HCOONa (17.5 mg) was stirred at 50 °C for 2 h under  $\text{N}_2$  atmosphere. The reaction mixture was diluted with water and extracted with AcOEt. The extract was washed with water, dried on  $\text{MgSO}_4$ , and heated in vacuo to leave **8** [pale yellow needles, mp 96–98 °C, 27.6 mg; 89%. Found: C,

Synthesis of Cyanotropone

55.15 ; H, 5.05%. Calcd for  $C_{13}H_{14}O_7$  : C, 55.32 ; H, 5.00%.  $^1H$  NMR  $\delta$  = 3.76 (3H, s) 3.90 (3H, d,  $J$  = 0.5 Hz), 5.18 (2H, t,  $J$  = 1 Hz), 5.25 (2H, d,  $J$  = 1 Hz), 6.73 (1H, s), 7.33 (1H, br s), 8.14 (1H, t,  $J$  = 1 Hz), and 8.15 (1H, t,  $J$  = 1 Hz).  $^{13}C$  NMR  $\delta$  = 56.4, 62.5, 63.0, 63.1, 112.9, 130.2, 135.5, 141.4, 155.6, 160.2, 160.7, 162.0, and 178.8. IR  $\nu$  : 1705, 1625, 1605, and  $1580\text{cm}^{-1}$ . UV  $\lambda_{\text{max}}^{\text{MeOH}}$  : 243 nm ( $\epsilon$  = 24000), 312 (6300, sh), 326 (7200), 353 (6400, sh), and 368 (5200, sh) ] .

**Acid Hydrolysis of 8.** A 50% aqueous AcOH solution (2  $\text{cm}^3$ ) of 8 (29.2 mg) in the presence of concd HCl (0.1  $\text{cm}^3$ ) was stirred at room temperature for 1.5 h. The mixture was then heated in vacuo to leave 9 [light brown needles, mp 75-77  $^{\circ}\text{C}$ , 18.9 mg ; 81%. Found : C, 58.22 ; H, 6.24%. Calcd for  $C_{11}H_{14}O_5$  : C, 58.40 ; H, 6.24%.  $^1H$  NMR  $\delta$ ( $\text{CD}_3\text{OD}$ ) = 3.71 (3H, br s), 3.98 (3H, s), 4.66 (2H d,  $J$  = 1 Hz), 4.72 (2H, s), 7.53 (1H, s), and 7.69 (1H, s).  $^{13}C$  NMR  $\delta$ ( $\text{CD}_3\text{OD}$ ) = 57.0, 61.5, 62.1, 62.7, 116.5, 132.9, 141.5, 152.6, 157.2, 163.2, and 179.6. IR  $\nu$  : 3400-3200 and  $1575\text{cm}^{-1}$ . UV  $\lambda_{\text{max}}^{\text{MeOH}}$  : 244 nm ( $\epsilon$  = 23000), 325 (7200, sh), 337 (7500), 350 (7100, sh), and 362 (5600, sh) ] .

**The  $\text{MnO}_2$ -Oxidation of 9.** An acetone solution (3  $\text{cm}^3$ ) of 9 (26.8 mg) was refluxed for 7 h with  $\text{MnO}_2$  (130 mg). The mixture was passed through a Celite column and the filtrate was chromatographed on a silica-gel column to give 10 [yellow crystals, mp 139-141  $^{\circ}\text{C}$ , 8.9 mg ; 40%. Found : C, 59.19 ; H, 4.63%. Calcd for  $C_{11}H_{10}O_5$  : C, 59.46 ; H, 4.54%.  $^1H$  NMR  $\delta$  = 3.96 (3H, s), 3.98 (3H, d,  $J$  = 0.5 Hz), 7.29 (1H, dd,  $J$  = 1, 0.5 Hz), 7.72 (1H, d,  $J$  = 0.6 Hz), 10.32 (1H, d,  $J$  = 1 Hz), and 10.45 (1H, d,  $J$  = 0.6 Hz).  $^{13}C$  NMR  $\delta$  = 56.7, 66.2, 107.4, 129.7, 137.4, 141.0, 162.6, 163.9, 179.4, 189.2, and 189.8. IR  $\nu$  : 2970, 2840, 1710, 1675, 1605, 1600, and  $1575\text{cm}^{-1}$ . UV  $\lambda_{\text{max}}^{\text{MeOH}}$  : 232 nm ( $\epsilon$  = 16000, sh), 249 (19000), 328 (7100), 371 (7200), and 415 (3500, sh) ] .

**The Reaction of 10 with  $\text{NH}_2\text{OH}$ .** An MeOH solution (8  $\text{cm}^3$ ) of 10 (93 mg),  $\text{NH}_2\text{OH} \cdot \text{HCl}$  (118 mg), and  $\text{AcONa}$  (138 mg) was refluxed for 4 h. After removal of the solvent in vacuo, the residue was diluted with water and extracted with  $\text{BuOH}$ . The silica-gel column chromatography of the extract gave 3 [yellow crystals, mp 242-247  $^{\circ}\text{C}$ , 4.8 mg ; 6%. Found :  $m/z$ , 216.0551. Calcd for  $C_{11}H_8O_3N_2$  : 216.0534.  $^1H$  NMR  $\delta$ ( $\text{CD}_3\text{OD}$ ) = 3.83 (3H, s), 3.90 (3H, s), 7.46 (1H, s), and 8.33 (1H, s). IR  $\nu$  :  $2230\text{cm}^{-1}$  ] .

**The Reaction of 7 with NBS.** An anhydrous benzene solution (2  $\text{cm}^3$ ) of 7 (50.3 mg), NBS (76.2 mg), and AIBN (10 mg) was refluxed for 31 h. The reaction mixture was chromatographed on a silica-gel column to give 12 [reddish yellow oil, 20 mg ; 25%. Found :  $m/z$ , 418 : 420 : 422 : 424 = 100 : 346 : 330 : 94.2.  $^1H$  NMR  $\delta$  = 3.88 (3H, s), 4.03 (3H, br s), 7.00 (1H, d,  $J$  = 0.6 Hz), 7.12 (1H, br s), 7.27 (1H, d,  $J$  = 0.6 Hz), and 7.90 (1H, s) ] .

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