A New Synthesis of 7-Substituted 2,3-Bis(alkylthio)naphth[1,8-*bc*]-azepines Using the Tris(alkylthio)cyclopropenyl Cation

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7-Substituted 2,3-bis(isopropylthio)naphth[1,8-*bc*]azepines **3a-c** were synthesized in good yields by the reactions of 5-substituted 1-naphthylamines **2a-c** with tris(isopropylthio)cyclopropenylium perchlorate (**1**) in acetonitrile under reflux. This reaction proceeds through the facile ring opening of **1**, followed by the intermediary formation of iminium salts **5a-c** and then intramolecular cyclization.

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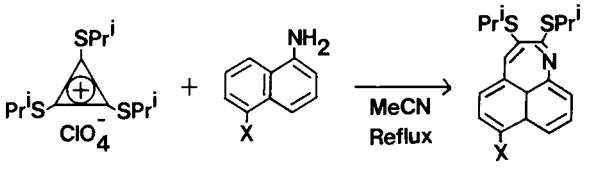
Recently, we have reported that tris(isopropylthio)cyclopropenylium perchlorate (**1**) reacts with pyrrole and indole in the presence of sodium hydride to give the pyrrolizine and fluorazene derivatives, respectively [1]. In this reaction, **1** serves as the reagent which prepares cyclic systems by the nucleophile-induced facile ring opening. On the basis of this reactivity of **1**, we now report the unique simple method for the preparation of 7-substituted 2,3-bis(isopropylthio)naphth[1,8-*bc*]azepines **3a-c** from 5-substituted 1-naphthylamines **2a-c** by the ring opening of **1**.

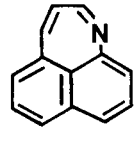


1 2 3

a: X=H
b: X=OH
c: X=NO$_2$

a: X=H
b: X=OH
c: X=NO$_2$

The reaction of **1** with two molar equivalents of 1-naphthylamine (**2a**) in dry acetonitrile was carried out under reflux for 25 hours. After chromatographic purification, 2,3-bis(isopropylthio)naphth[1,8-*bc*]azepine (**3a**) was obtained in 91% yield. The use of an equivalent of **2a** resulted in the formation of **3a** in 47% yield with the recovery of **1** in 53%. The desulfurization of **3a** by Raney nickel in ethanol at room temperature for 24 hours gave naphth[1,8-*bc*]-azepine (**4**) [2] in 25% yield.



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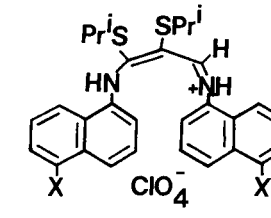
Under the similar conditions, 5-hydroxy- and 5-nitro-1-naphthylamines **2b** and **2c** were converted into the corresponding 7-hydroxy- and 7-nitro-2,3-bis(isopropylthio)-naphth[1,8-*bc*]azepines **3b** and **3c** in 96 and 43% yields, respectively. When the reaction of **1** with two molar equivalents of **2a** in dry acetonitrile was carried out at room temperature for 25 hours, however, it was found that an iminium salt **5a** [3] was formed in 52% yield as a mixture with **3a** (48%). Compound **5a** was converted quantitatively into **3a** by refluxing a solution of the mixture of **3a** and **5a** in dry acetonitrile for 25 hours. Similarly, the formation of **5b,c** was confirmed in the reactions of **2b,c** with **1**. These results indicate that the azepine derivatives **3a-c** are produced through the formation of **5a-c**.



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a: X=H
b: X=OH
c: X=NO$_2$

As described above, it was found that the reactions of **2a-c** with **1** proceed through the intermediary formation of **5a-c** to give **3a-c** in good yields. Thus, **1** is a useful reagent for the preparation of azepine derivatives **3a-c** from 5-substituted 1-naphthylamines **2a-c**.

EXPERIMENTAL

Melting points were determined with a Yanaco MP-S3 melting point apparatus and are uncorrected. All ^{1}H (270 MHz) and ^{13}C nmr (68 MHz) spectra were determined on a JEOL JNM-GX 270 FT nmr spectrometer using deuteriochloroform as a solvent and chemical shifts are reported in parts per million downfield from tetramethylsilane as an internal standard. Infrared spectra were obtained on a Hitachi 215 spectrophotometer. Mass spectra were obtained on a Shimadzu LKB-9000 spectrometer (70 eV).

Elemental analyses were performed by a Yanaco CHN CORDER MT-3. Column chromatography was performed on silica gel (Wakogel C-300).

General Procedure for the Synthesis of **3a-c**.

To a hot solution of 5-substituted 1-naphthylamines (1.0 mmole, 2 equivalents) in 20 ml of dry acetonitrile was added 181 mg (0.5 mmole) of tris(isopropylthio)cyclopropenylium perchlorate (**1**) in one portion. The mixture was refluxed under nitrogen for 25 hours. After cooling to room temperature, the solvent was evaporated under reduced pressure. The residue was chromatographed on silica gel using hexane-dichloromethane (3:1) as an eluent to yield 7-substituted 2,3-bis(isopropylthio)-naphth[1,8-*bc*]azepines **3a-c**.

2,3-Bis(isopropylthio)naphth[1,8-*bc*]azepine (**3a**).

This compound was obtained as colorless crystals, mp 86-87°, yield 91%; ir (potassium bromide): 3040, 2950, 2915, 2850, 1620, 1600, 1570, 1550, 1495, 1470, 1435, 1385, 1360, 1240, 1150, 1130, 1050, 935, and 810 cm^{-1}; ^1H nmr (deuteriochloroform): δ 9.19 (m, 1H), 8.02 (s, 1H), 7.87 (m, 1H), 7.72-7.65 (m, 3H), 7.58 (d, J = 9.2 Hz, 1H), 4.41 (sep, J = 6.7 Hz, 1H), 3.59 (sep, J = 6.7 Hz, 1H), 1.61 (d, J = 6.7 Hz, 6H), and 1.36 (d, J = 6.7 Hz, 6H); ^{13}C nmr (deuteriochloroform): δ 161.3, 144.8, 139.0, 133.9, 130.9, 128.3, 128.1, 127.8, 126.9, 126.4, 124.8, 124.4, 123.3, 38.18, 35.89, 23.10, and 22.89; ms: (m/e) 327 (M^+).

Anal. Calcd. for $C_{19}H_{21}NS_2$: C, 69.72; H, 6.42; N, 4.28. Found: C, 69.55; H, 6.50; N, 4.14.

7-Hydroxy-2,3-bis(isopropylthio)naphth[1,8-*bc*]azepine (**3b**).

This compound was obtained as colorless crystals, mp 159-160°, yield 96%; ir (potassium bromide): 3325, 1610, 1575, 1555, 1425, 1390, 1355, 1255, 1135, 910, and 755 cm^{-1}; ^1H nmr (deuteriochloroform): δ 8.77 (d, J = 8.6 Hz, 1H), 8.09 (d, J = 9.2 Hz, 1H), 8.01 (s, 1H), 7.57 (d, J = 9.1 Hz, 1H), 7.51 (t, J = 7.9 Hz, 1H), 7.03 (m, 1H), 5.76 (br s, 1H), 4.38 (sep, J = 6.7 Hz, 1H), 3.59 (sep, J = 6.7 Hz, 1H), 1.59 (d, J = 6.7 Hz, 6H), and 1.37 (d, J = 6.7 Hz, 6H); ^{13}C nmr (deuteriochloroform): δ 161.2, 151.5, 144.6, 138.8, 132.4, 128.6, 126.9, 124.0, 123.9, 123.5, 119.8, 117.1, 111.9, 38.14, 35.91; 23.10, and 22.87; ms: (m/e) 343 (M^+).

Anal. Calcd. for $C_{19}H_{21}NOS_2$: C, 66.47; H, 6.12; N, 4.08. Found: C, 66.35; H, 6.34; N, 3.97.

2,3-Bis(isopropylthio)-7-nitronaphth[1,8-*bc*]azepine (**3c**).

This compound was obtained as yellowish crystals, mp 128-129°, yield 43%; ir (potassium bromide): 2940, 2900, 2850, 1575, 1515, 1365, 1320, 1125, 765, and 725 cm^{-1}; ^1H nmr (deuteriochloroform): δ 9.53 (m, 1H), 8.35 (d, J = 10.4 Hz, 1H), 8.31 (m, 1H), 8.00 (s, 1H), 7.81 (d, J = 9.2 Hz, 1H), 7.74 (t, J = 7.9 Hz, 1H), 4.37 (sep, J = 6.7 Hz, 1H), 3.64 (sep, J = 6.7 Hz, 1H), 1.61 (d, J = 6.7 Hz, 6H), and 1.40 (d, J = 6.7 Hz, 6H); ^{13}C nmr (deuteriochloroform): δ 162.2, 147.0, 143.2, 137.0, 132.3, 130.8, 130.2, 128.4, 125.7, 125.4, 125.0, 123.1, 120.1, 38.00, 36.12, 23.03, and 22.80; ms: (m/e) 372 (M^+).

Anal. Calcd. for $C_{19}H_{20}N_2O_2S_2$: C, 61.29; H, 5.38; N, 7.53. Found: C, 61.28; H, 5.37; N, 7.36.

REFERENCES AND NOTES

[1] H. Kojima, K. Ozaki, N. Matsumura and H. Inoue, *Chem. Letters*, 1499 (1989).

[2] The ^1H nmr (deuteriochloroform) of **4** is: δ 9.30 (m, 1H), 9.00 (dd, J = 4.3, 1.8 Hz, 1H), 8.16 (dd, J = 8.2, 1.5 Hz, 1H), 7.90 (m, 1H), 7.81 (d, J = 8.9 Hz, 1H), 7.72 (m, 2H), 7.67 (d, J = 8.9 Hz, 1H) and 7.51 (m, 1H).

[3] The ^1H nmr (deuteriochloroform) of **5a** is: δ 9.15 (s, 1H), 8.58 (br s, 2H), 8.02-7.45 (m, 14H), 3.30 (sep, J = 6.7 Hz, 1H), 3.11 (sep, J = 6.7 Hz, 1H), 1.35 (d, J = 6.7 Hz, 6H) and 1.12 (d, J = 6.7 Hz, 6H).