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Synthesis of 1-Amino-2-naphthalenecarboxylic Acid Derivatives via the Intramolecular Cyclization of 4-(2-Cyanophenyl)-2-butenoic Acid Derivatives and Its Application to the One-Pot Preparation of Benzo[*h*]quinazoline-2,4(1*H*,3*H*)-diones

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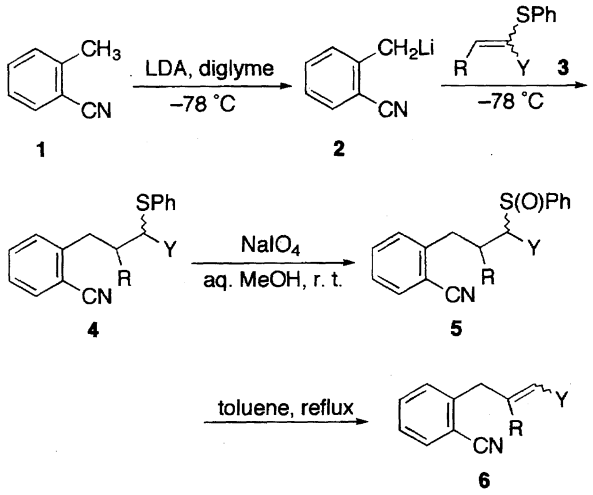
(Received November 2, 1998)

The reaction of 2-(lithiomethyl)benzonitrile with 2-phenylthio-2-alkenoic acid derivatives in diglyme at −78 °C, followed by oxidation with sodium metaperiodate in aqueous MeOH at room temperature and the subsequent elimination reaction in refluxing toluene, gave 4-(2-cyanophenyl)-2-butenoic acid derivatives in moderate-to-fair overall yields. Intramolecular cyclization of these products using NaH in DMF at 0 °C gave 1-amino-2-naphthalenecarboxylic acid derivatives almost quantitatively. Successive treatments with an isocyanate without isolation of the aminonaphthalenecarboxylates under reflux afforded benzo[*h*]quinazoline-2,4(1*H*,3*H*)-diones in moderate-to-good yields.

We have recently reported that 1-amino-2-naphthalenecarboxylic acid derivatives can be synthesized via a sequential Michael addition/enolate–nitrile coupling reaction between 2-(α-lithioalkyl)benzonitriles and α,β-unsaturated carboxylic acid derivatives, and that the method is applicable to a facile preparation of 9-amino analogues of arylnaphthofuranone lignans.[1,2] In this paper, we wish to report on an alternative general method for constructing this aminonaphthalecarboxylic acid system. The method is based on the intramolecular cyclization of 4-(2-cyanophenyl)-2-butenoic acid derivatives, which are easily prepared from 2-methylbenzonitrile and α-(phenylthio)acrylic acid derivatives, and can be applied to the one-pot preparation of benzo[*h*]quinazoline-2,4(1*H*,3*H*)-diones.

Synthesis of 1-Amino-2-naphthalenecarboxylic Acid Derivatives (9)

The starting material for the cyclization reaction, 4-(2-cyanophenyl)-2-butenoates (**6a**, **6b**, and **6c**) were prepared from 2-methylbenzonitrile (**1**) and α-(phenylthio)acrylates (**3a**, **3b**, and **3c**),[3] as illustrated in Scheme 1. Thus, 2-(lithiomethyl)benzonitrile (**2**) was generated by the treatment of **1** with LDA at −78 °C in diglyme, as described previously,[1] and treated with **3** at the same temperature to give 4-(2-cyanophenyl)-2-(phenylthio)butanoates (**4a**, **4b**, and **4c**) as diastereomeric mixtures in fair-to-good yields (Table 1, Entries 1, 2, and 3). Oxidation of these compounds with sodium metaperiodate in aqueous methanol at room temperature afforded the corresponding 4-(2-cyanophenyl)-2-(phenylsulfinyl)-butanoic acid derivatives **5** quantitatively, as judged by the ^{1}H NMR spectra of the crude products. These sulfoxides were then heated in refluxing toluene without any purification to give the butenoates **6** as *E* and *Z* mixtures in good overall yields from **4**. A similar sequence using an α-(phenylthio)acrylonitrile, such as **3d**, was also



Scheme 1.

uneventfully carried out to afford the corresponding butenenitrile **6d** in good overall yield (Table 1, Entry 4). In each case, the corresponding 3-butenoic acid derivative was not observed in the reaction mixture. The stereoisomeric mixtures were used in the next cyclization reaction. The specimen of each stereoisomer could be separated from the product mixtures and the stereochemical assignments were made on the basis of the ^{1}H NMR data. For example, the spectrum of (*E*)-**6a** exhibited a signal at δ = 2.18 attributable to the 3-methyl group, while that of (*Z*)-**6a** showed the 3-methyl signal at δ = 1.80. Moreover, the signal due to the 4-methylene of (*Z*)-**6a** appeared at a much lower field (δ = 4.30) than that of (*E*)-**6a** (δ = 3.67). These downfield shifts of the signals for 3-methyl of (*E*)-**6a** and 4-methylene of (*Z*)-**6a** are ascribed to the deshielding effect by the ethoxycarbonyl group (see Experimental Section).

The next intramolecular cyclization reaction of the (2-cyanophenyl)butenoic acid derivatives **6** producing 1-amino-2-naphtha-

Table 1. Preparation of 4-(2-Cyanophenyl)-2-butenoic Acid Derivatives **6**

Entry	3	4 (yield/%)[a,b]	6 (yield/%)[a,b]
1	**3a** (R = Me, Y = CO_2Et)	**4a** (84)	**6a** (79)
2	**3b** (R = Ph, Y = CO_2Et)	**4b** (70)	**6b** (87)
3	**3c** (R = 2-Furyl, Y = CO_2Et)	**4c** (62)	**6c** (75)
4	**3d** (R = Ph, Y = CN)	**4d** (71)	**6d** (88)

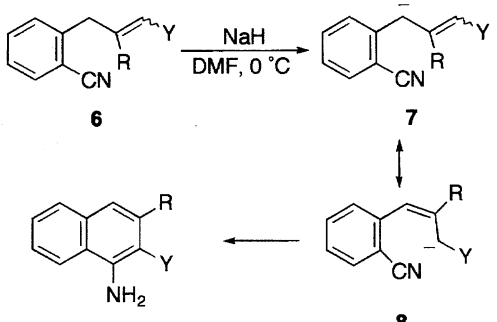
a) Isolated yields. b) Inseparable mixtures of diastereomers. Ratios were determined by ^{1}H NMR spectra (see Experimental Section). The stereochemistry of each diastereomer was not determined. c) Used as mixtures of stereoisomers in the next step. Ratios were determined by ^{1}H NMR spectra and the stereochemistry of each isomer was determined by the ^{1}H NMR spectrum of the specimen obtained by fractional preparative TLC on silica gel (see Experimental Section).

lenecarboxylic acid derivatives **9** could be accomplished by simply treating with sodium hydride in DMF at 0 °C, as illustrated in Scheme 2. The sequence is thought to proceed via deprotonation of a proton at the 4-position of **6**, affording the corresponding anionic intermediate **7**, followed by an intramolecular attack of its resonance structure **8** to the nitrile moiety. After an aqueous workup the expected products **9** was obtained in excellent yields.

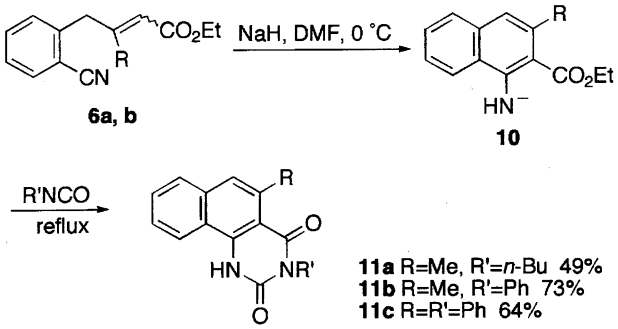
Preparation of Benzo[*h*]quinazoline-2,4-(1*H*,3*H*)-diones (11)

These benzoquinazolinedione derivatives are potentially of biological usefulness,[4] and their preparation has been accomplished by starting from 1-aminonaphthalene derivatives.[5] The methods, however, which require several reaction steps, involve tedious reaction conditions (high reaction temperature and/or high CO_2 pressure) and/or incomplete generality, and produce low yields. We therefore decided to extend the scope of the present intramolecular cyclization to a one-pot preparation of benzo[*h*]quinazolinedione derivatives **11** from the 4-(2-cyanophenyl)-2-butenoates **6a** and **6b**.

As shown in Scheme 3, an isocyanate, such as butyl isocyanate or phenyl isocyanate, were added to the amide anion intermediates **10**, which were generated in situ by the treatment of these starting esters **6a** and **6b** with sodium hydride under the above-mentioned conditions. The resulting mixtures were then heated at reflux temperature to give, after an aqueous workup, the expected products **11** in moderate-to-good yields.



Scheme 2.



Scheme 3.

In conclusion, the above sequence of reactions provides a new method for the preparation of 1-amino-2-naphthalenecarboxylic acid derivatives. This method is useful because of its applicability to the one-pot synthesis of benzo[*h*]quinazoline-2,4(1*H*,3*H*)-diones.

Experimental

General Methods. The melting points were measured on a Laboratory Devices MEL-TEMP II melting apparatus and are uncorrected. IR spectra were determined with a Perkin–Elmer 1600 Series FT IR spectrometer. The ^{1}H NMR spectra were determined with either a JEOL JNX-PMX 60 NMR spectrometer operating at 60 MHz in CCl_4 (unless stated otherwise) or a JEOL JNM-GX270 FT NMR spectrometer operating at 270 MHz in $CDCl_3$. Chemical shifts were referenced relative to tetramethylsilane as an internal standard. Mass spectra were recorded with a JEOL AUTOMASS 20 spectrometer (Center for Joint Research and Development, this University). TLC was carried out on Merck Kieselgel 60 PF_{254}.

Starting Materials. Ethyl 2-(phenylthio)-2-butenoate (**3a**),[6] ethyl 3-phenyl-2-(phenylthio)propenoate (**3b**),[7] and 3-phenyl-2-(phenylthio)propenenitrile (**3d**)[8,9] were prepared by appropriate reported methods. Ethyl 3-(2-furyl)-2-(phenylthio)propenoate (**3c**) was prepared by the treatment of ethyl (phenylthio)acetate with 2-furancarbaldehyde in the presence of NaOEt in EtOH at 0 °C. **3c**: A pale-yellow liquid; bp 140 °C/80 Pa; IR (neat) 1713 and 1598 cm^{-1}; ^{1}H NMR (60 MHz) δ = 1.01 (3H, d, J = 7.0 Hz), 4.01 (2H, q, J = 7.0 Hz), 6.44 (1 H, dd, J = 4.0 and 2.0 Hz), 7.0—7.3 (6H, m), 7.47 (1H, d, J = 2.0 Hz), and 7.82 (1H, s). Found: C, 65.81; H, 5.13%. Calcd for $C_{15}H_{14}O_3S$: C, 65.67; H, 5.14%. All other organic chemicals were obtained from commercial suppliers and purified appropriately prior to use.

Ethyl 4-(2-Cyanophenyl)-3-methyl-2-(phenylthio)butanoate (4a). Typical Procedure. To a stirred solution of LDA (3.3 mmol), which was generated from *i*-Pr_2NH (0.33 g, 3.3 mmol) and

n-BuLi (1.6 M solution in hexane, 1 M = 1 mol dm^{-3}; 3.3 mmol) in diglyme (10 ml) at −78 °C, was added dropwise 2-methylbenzonitrile (**1**) (0.19 g, 1.65 mmol). After stirring for 15 min, ethyl 2-(phenylthio)-2-butenoate (**3a**) (0.73 g, 3.3 mmol) was added. After an additional 2 h of stirring, the resulting mixture was quenched with aq NH_4Cl and extracted with Et_2O three times (20 ml each). The combined extracts were first washed with water and then brine, and dried over anhydrous $MgSO_4$. After evaporation of the solvent, the residue was purified by preparative TLC on SiO_2 to give **4a** (0.47 g, 84%) as a pale-yellow oil: A mixture of diastereomers (ca. 1 : 1); R_f 0.14 (1 : 7 EtOAc–hexane); IR (neat) 2224 and 1730 cm^{-1}; ^{1}H NMR (270 MHz) δ = 1.01 (1.5H, d, J = 6.5 Hz), 1.11 (1.5H, d, J = 6.9 Hz), 1.20 and 1.22 (combined 3H, 2t, J = 7.3 and 6.9 Hz, respectively), 2.45—2.55 (1H, m), 2.65—2.9 (1H, m), 3.09 (0.5H, dd, J = 13.8 and 5.2 Hz), 3.44 (0.5H, dd, J = 13.8 and 5.2 Hz), 3.64 (1H, d, J = 7.3 Hz), 4.13 and 4.18 (combined 2H, 2q, J = 7.3 and 6.9 Hz, respectively), and 7.25—7.65 (9H, m); MS *m/z* (%) 339 (M^+; 17) and 196 (100). Found: C, 70.99; H, 6.46; N, 4.13; S, 9.58%. Calcd for $C_{20}H_{21}NO_2S$: C, 70.77; H, 6.24; N, 4.13; S, 9.45%.

Following the above-mentioned procedure, compounds **4b**, **4c**, and **4d** were prepared.

Ethyl 4-(2-Cyanophenyl)-3-phenyl-2-(phenylthio)butanoate (4b): A mixture of diastereomers (ca. 6 : 4); R_f 0.18 (1 : 7 EtOAc–hexane); IR (neat) 2224 and 1729 cm^{-1}; ^{1}H NMR (270 MHz) δ = 0.87 (1.2H, t, J = 7.3 Hz), 1.19 (1.8H, t, J = 7.3 Hz), 3.05—3.35 (2H, m), 3.39 (0.4H, td, J = 11.3 and 4.0 Hz), 3.52 (0.6H, td, J = 10.2 and 4.4 Hz), 3.82 (0.8H, q, J = 7.3 Hz), 3.95—4.20 (2.2H, m), and 7.0—7.6 (14H, m); MS *m/z* (%) 401 (M^+; 4.9) and 206 (100). Found: C, 74.76; H, 5.82; N, 3.39%. Calcd for $C_{25}H_{23}NO_2S$: C, 74.78; H, 5.77; N, 3.49%.

Ethyl 4-(2-Cyanophenyl)-3-(2-furyl)-2-(phenylthio)butanoate (4c): A mixture of diastereomers (ca. 3 : 1); R_f 0.36 (1 : 5 EtOAc–hexane); IR (neat) 2224 and 1731 cm^{-1}; ^{1}H NMR (270 MHz) δ = 1.05 (0.75H, t, J = 7.4 Hz), 1.22 (2.25H, t, J = 7.4 Hz), 3.15—3.3 (2H, m), 3.5—4.2 (4H, m), 5.87 (0.25H, d, J = 3.2 Hz), 5.92 (0.75H, J = 3.2 Hz), 6.15 (0.25H, dd, J = 3.2 and 1.6 Hz), 6.20 (0.75H, dd, J = 3.2 and 2.1 Hz), 7.0—7.5 (9H, m), and 7.5—7.6 (1H, m); MS *m/z* (%) 391 (M^+; 5.4), 196 (36), and 116 (100). Found: C, 70.81; H, 5.39; N, 3.60%. Calcd for $C_{23}H_{21}NO_3S$: C, 70.56; H, 5.41; N, 3.58%.

4-(2-Cyanophenyl)-3-phenyl-2-(phenylthio)butanenitrile (4d): A mixture of diastereomers (ca. 1 : 1); R_f 0.39 (1 : 3 EtOAc–hexane); IR (neat) 2223 cm^{-1}; ^{1}H NMR (270 MHz) δ = 3.3—3.55 (2H, m), 3.6—3.75 (1H, m), 4.02 and 4.05 (combined 1H, 2d, J = 5.6 Hz each), and 7.1—7.6 (14H, m); MS *m/z* (%) 354 (M^+; 5.1) and 206 (100). Found: C, 78.17; H, 5.31; N, 8.18%. Calcd for $C_{23}H_{18}N_2S$: C, 77.93; H, 5.12; N, 7.90%.

Ethyl (*E*)- and (*Z*)-4-(2-Cyanophenyl)-3-methyl-2-butenoate (6a). Typical Procedure. To a stirred solution of **4a** (0.47 g, 1.4 mmol) in MeOH (30 ml) at 0 °C was added dropwise a solution of $NaIO_4$ (1.4 g, 6.4 mmol) in H_2O (12 ml). The cold bath was removed and the mixture was stirred overnight. After filtration of the precipitate, most of MeOH of the filtrate was evaporated, and the residue was extracted with Et_2O three times (20 ml each). The combined organic fractions were washed with brine and dried over anhydrous $MgSO_4$. After evaporation of the solvent, the oily crude product (0.48 g) was subjected to the next reaction without any purification procedure. The sulfoxide was dissolved in 12 ml of toluene and the solution was heated under reflux for 1.5 h. After cooling to room temperature, the toluene solution was first washed with 2% aq NaOH and then brine, and dried over anhydrous $MgSO_4$. After evaporation of the solvent, purification of the residue by preparative TLC on SiO_2 gave **6a** (a pale-yellow oil; 0.25 g, 79% from **4a**) as a mixture of *E*- and *Z*-isomers (*E* : *Z* = ca. 7 : 3). The specimen for analyses of each product was obtained by fractional preparative TLC on SiO_2.

(*E*)-**6a**: R_f 0.21 (1 : 3 EtOAc–hexane); IR (neat) 2225, 1714, and 1650 cm^{-1}; ^{1}H NMR (270 MHz) δ = 1.27 (3H, t, J = 7.1 Hz), 2.18 (3H, s), 3.67 (2H, s), 4.15 (2H, q, J = 7.1 Hz), 5.60 (1H, s), 7.3—7.45 (2H, t), 7.54 (1H, t, J = 7.9 Hz), and 7.66 (1H, d, J = 8.7 Hz); MS *m/z* (%) 229 (M^+; 7.3) and 183 (100). Found: C, 73.08; H, 5.50; N, 6.10%. Calcd for $C_{14}H_{15}NO_2$: C, 73.34; H, 6.59; N, 6.11%.

(*Z*)-**6a**: R_f 0.15 (1 : 20 EtOAc–hexane); IR (neat) 2224, 1715, and 1649 cm^{-1}; ^{1}H NMR (60 MHz, $CDCl_3$) δ = 1.28 (3H, t, J = 7.0 Hz), 1.80 (3H, s), 4.15 (2H, q, J = 7.0 Hz), 4.30 (2H, s), 5.80 (1H, s), and 7.1—7.65 (4H, m); MS *m/z* (%) 229 (M^+; 7.6) and 183 (100). Found: C, 73.43; H, 6.56; N, 6.06%. Calcd for $C_{14}H_{15}NO_2$: C, 73.34; H, 6.59; N, 6.11%.

Following the above-mentioned procedure, compounds **6b**, **6c**, and **6d** were prepared.

Ethyl (*E*)- and (*Z*)-4-(2-Cyanophenyl)-3-phenyl-2-butenoate (6b): (*E* : *Z* = ca. 8 : 2).

(*E*)-**6b**: R_f 0.50 (1 : 3 EtOAc–hexane); mp 85—87 °C (hexane–Et_2O); IR (KBr disk) 2227, 1725, and 1600 cm^{-1}; ^{1}H NMR (60 MHz) δ = 1.12 (3H, t, J = 7.2 Hz), 4.18 (2H, q, J = 7.2 Hz), 4.74 (2H, s), 6.25 (1H, s), and 7.1—7.55 (9H, m); MS *m/z* (%) 291 (M^+; 49) and 218 (100). Found: C, 78.10; H, 5.93; N, 4.78%. Calcd for $C_{19}H_{17}NO_2$: C, 78.33; H, 5.88; N, 4.81%.

(*Z*)-**6b**: R_f 0.42 (1 : 3 EtOAc–hexane); mp 77—80 °C (hexane–Et_2O); IR (KBr disk) 2223, 1708, and 1627 cm^{-1}; ^{1}H NMR (60 MHz) δ = 1.01 (3H, t, J = 7.2 Hz), 3.88 and 3.94 (combined 4H, q, J = 7.2 Hz and s, respectively), 5.64 (1H, s), and 7.05—7.6 (9H, m); MS *m/z* (%) 291 (M^+; 78) and 218 (100). Found: C, 78.50; H, 5.95; N, 4.68%. Calcd for $C_{19}H_{17}NO_2$: C, 78.33; H, 5.88; N, 4.81%.

Ethyl (*E*)- and (*Z*)-4-(2-Cyanophenyl)-3-(2-furyl)-2-butenoate (6c): (*E* : *Z* = ca. 9 : 1).

(*E*)-**6c**: R_f 0.59 (1 : 3 EtOAc–hexane); IR (neat) 2225, 1715, and 1614 cm^{-1}; ^{1}H NMR (60 MHz) δ = 1.29 (3H, t, J = 7.2 Hz), 4.21 (2H, q, J = 7.2 Hz), 4.59 (2H, s), 6.37 (1H, dd, J = 3.8 and 1.8 Hz), 6.57 (1H, s), 6.64 (1H, d, J = 3.8 Hz), and 7.1—7.65 (5H, m); MS *m/z* (%) 281 (M^+; 55) and 180 (100). Found: C, 72.60; H, 5.27; N, 4.88%. Calcd for $C_{17}H_{15}NO_3$: C, 72.58; H, 5.37; N, 4.98%.

(*Z*)-**6c**: R_f 0.50 (1 : 3 EtOAc–hexane); IR (neat) 2223, 1704, and 1621 cm^{-1}; ^{1}H NMR (60 MHz) δ = 1.27 (3H, t, J = 7.2 Hz), 4.10 and 4.21 (combined 4H, s and q, J = 7.2 Hz, respectively), 5.70 (1H, s), 6.37 (1H, dd, J = 3.6 and 1.8 Hz), 7.15—7.7 (6H, m); MS *m/z* (%) 281 (M^+; 55) and 180 (100). Found: C, 72.54; H, 5.36; N, 5.12%. Calcd for $C_{17}H_{15}NO_3$: C, 72.58; H, 5.37; N, 4.98%.

(*E*)- and (*Z*)-4-(2-Cyanophenyl)-3-phenyl-2-butenenitrile (6d): (*E* : *Z* = ca. 1 : 2).

(*E*)-**6d**: R_f 0.26 (1 : 3 EtOAc–hexane); IR (neat) 2220 and 1612 cm^{-1}; ^{1}H NMR (270 MHz) δ = 4.45 (2H, s), 5.84 (1H, s), 7.25—7.5 (8H, m), and 7.59 (1H, dd, J = 7.5 and 1.3 Hz); MS *m/z* (%) 244 (M^+; 100). Found: C, 83.80; H, 4.93; N, 11.19%. Calcd for $C_{17}H_{12}N_2$: C, 83.58; H, 4.95; N, 11.47%.

(*Z*)-**6d**: R_f 0.33 (1:3 EtOAc–hexane); IR (neat) 2216 and 1600 cm^{-1}; ^{1}H NMR (270 MHz) δ = 4.08 (2H, s), 5.21 (1H, s), 7.24 (1H, d, J = 7.0 Hz), 7.35—7.55 (7H, m), and 7.66 (1H, dd, J = 7.9 and 1.8 Hz); MS *m/z* (%) 244 (M^+; 100). Found: C, 83.21; H, 4.97; N, 11.33%. Calcd for $C_{17}H_{12}N_2$: C, 83.58; H, 4.95; N, 11.47%.

Ethyl 1-Amino-3-methylnaphthalene-2-carboxylate (9a).

Typical Procedure. To a stirred suspension of NaH (60%, 60 mg, 1.0 mmol; washed three times with anhydrous hexane) in DMF (4 ml) at 0 °C was added a solution of **6a** (0.18 g, 0.80 mmol) in DMF (4 ml). The mixture was stirred for 1 h at the same temperature before being worked up in the same way as described for the preparation of **4a**. Purification of the crude product by preparative TLC on silica gel gave the title compound **9a** (0.17 g, 93%) as a pale-yellow oil. The spectral data (IR and ^{1}H NMR) of this compound were consistent with those of the same compound prepared previously by us.[1)]

Following the above-mentioned procedure, compounds **9b**, **9c**, and **9d** were prepared.

Ethyl 1-Amino-3-phenylnaphthalene-2-carboxylate (9b) was identified by a comparison of its spectral data (IR and ^{1}H NMR) with those reported previously by us.[1)]

Ethyl 1-Amino-3-(2-furyl)naphthalene-2-carboxylate (9c): R_f 0.50 (1 : 3 EtOAc–hexane); IR (neat) 3487, 3377, and 1686 cm^{-1}; ^{1}H NMR (270 MHz) δ = 1.07 (3H, t, J = 7.4 Hz), 4.16 (2H, q, J = 7.4 Hz), 5.93 (2H, br. s), 6.45—6.55 (2H, m), 7.31 (1H, s), 7.45—7.55 (3H, m), 7.75 (1H, d, J = 7.9 Hz), and 7.85 (1H, d, J = 7.9 Hz); MS *m/z* (%) 281 (M^+; 34), and 235 (100). Found: C, 72.41; H, 5.37; N, 4.87%. Calcd for $C_{17}H_{15}NO_3$: C, 72.58; H, 5.37; N, 4.98%.

1-Amino-3-phenylnaphthalene-2-carbonitrile (9d): Mp 214 °C (CH_2Cl_2) (lit,[1)] 214 °C). Spectroscopic data of this product were identical with those reported previously by us.[1)]

3- Butyl- 5- methylbenzo[*h*]quinazoline- 2, 4(1*H*, 3*H*)- dione (11a). Typical Procedure. Compound **4a** (72 mg, 0.34 mmol) was treated with NaH (60%; 14 mg, 0.35 mmol) in DMF (4 ml) under the same conditions as described above for the preparation of **9a**. Butyl isocyanate (34 mg, 0.35 mmol) was added to the reaction mixture, and then it was heated at reflux temperature for 10 min. After cooling to room temperature, aq NH_4Cl (20 ml) was added. The precipitate appeared was collected by filtration and recrystallized from hexane–CH_2Cl_2 to give **11a** (47 mg, 49%) as a pale yellowish brown solid: Mp 269—273 °C; IR (KBr disk) 1706 and 1640 cm^{-1}; ^{1}H NMR (270 MHz) δ = 1.01 (3H, t, J = 7.3 Hz), 1.45—1.8 (4H, m), 2.89 (3H, s), 4.16 (2H, t, J = 7.6 Hz), 7.38 (1H, s), 7.55—7.7 (2H, m), 7.78 (1H, d, J = 7.3 Hz), 8.34 (1H, d, J = 8.1 Hz), and 9.91 (1H, br. s); MS *m/z* (%) 282 (M^+; 42), 226 (92), and 183 (100). Found: C, 72.19; H, 6.51; N, 9.92%. Calcd for $C_{17}H_{18}N_2O_2$: C, 72.32; H, 6.43; N, 9.92%.

Following the above-mentioned procedure, compounds **11b** and **11c** were prepared.

5- Methyl- 3- phenylbenzo[*h*]quinazoline- 2, 4(1*H*, 3*H*)- dione (11b): Mp 235—240 °C (hexane–$CHCl_3$); IR (KBr disk) 3180, 1711, and 1652 cm^{-1}; ^{1}H NMR (270 MHz) δ = 2.85 (3H, s), 7.35—7.7 (8H, m), 7.80 (1H, d, J = 7.9 Hz), 8.10 (1H, d, J = 7.9 Hz), and 9.89 (1H, br. s); MS *m/z* (%) 302 (M^+; 62), and 287 (100). Found: C, 75.19; H, 4.80; N, 9.30%. Calcd for $C_{19}H_{14}N_2O_2$: C, 75.48; H, 4.67; N, 9.27%.

3,5- Diphenylbenzo[*h*]quinazoline- 2,4(1*H*,3*H*)- dione (11c): Mp 352—355 °C (hexane–$CHCl_3$); IR (KBr disk) 3124, 1717, and 1656 cm^{-1}; ^{1}H NMR (270 MHz) δ = 7.3—7.55 (12H, m), 7.69 (1H, t, J = 8.0 Hz), 7.85 (1H, d, J = 7.3 Hz), 8.27 (1H, d, J = 8.7 Hz), and 10.05 (1H, br. s); MS *m/z* (%) 364 (M^+; 100). Found: C, 79.19; H, 4.29; N, 7.61%. Calcd for $C_{24}H_{16}N_2O_2$: C, 79.11; H, 4.43; N, 7.69%.

We thank Mrs. Miyuki Tanmatsu of this Department for obtaining mass spectra.

References

1) K. Kobayashi, K. Takada, H. Tanaka, T. Uneda, T. Kitamura, O. Morikawa, and H. Konishi, *Chem. Lett.*, **1996**, 25; K. Kobayashi, T. Uneda, K. Takada, H. Tanaka, T. Kitamura, O. Morikawa, and H. Konishi, *J. Org. Chem.*, **62**, 664 (1997).

2) For other reports on the synthesis of 1-amino-2-naphthalenecarboxylic acid derivatives, see: E. Campaigne, D. R. Maulding, and W. L. Roelofs, *J. Org. Chem.*, **29**, 1543 (1964); J. Wildeman, P. C. Borgen, H. Pluim, P. H. F. M. Rouwette, and A. M. van Leusen, *Tetrahedron Lett.*, **1978**, 2213; Y. Tomioka, K. Ohkubo, and M. Yamazaki, *Chem. Pharm. Bull.*, **33**, 1360 (1985); W. Zhang, R. Liu, and J. M. Cook, *Heterocycles*, **36**, 2229 (1993); A. Tyrala and M. Makosza, *Synthesis*, **1994**, 63; J. Wilamowski, D. Osman, A. Machaj, B. Kawalek, and J. J. Sepiol, *J. Prakt. Chem./Chem. Ztg.*, **337**, 234 (1995).

3) For recent reports on the synthesis utilizing 2-sulfenylacrylates, see: N. S. Barta, A. Brode, and J. R. Stille, *J. Am. Chem. Soc.*, **116**, 6201 (1994); C. Cave, D. Desmaele, and J. d'Angelo, *J. Org. Chem.*, **61**, 4361 (1996).

4) M. Banasik, H. Komura, M. Shimoyama, and K. Ueda, *J. Biol. Chem.*, **267**, 1569 (1992); S. Mignani, D. Damour, A. Doble, R. Labaudiniere, J. L. Malleron, O. Piot, and C. Gueremy, *Bioorg. Med. Chem. Lett.*, **3**, 1913 (1993); N. Shimazaki, H. Yamazaki, T. Yatabe, and H. Tanaka, Eur. Patent 481342 (1992); *Chem. Abstr.*, **117**, 131217h (1992); N. Shimazaki, H. Yamazaki, T. Yatabe, and H. Tanaka, Canada Patent 2503475 (1992); *Chem. Abstr.*, **118**, 22252r (1993); N. Shimazaki, H. Yamazaki, T. Yatabe, H. Tanaka, Y. Itoh, and M. Hashimoto, U. S. Patent 5296487 (1993); *Chem. Abstr.*, **121**, 50112a (1994); D. Dorsch, M. Mederski, M. Oswald, P. Schelling, N. Beier, I. Leus, and K.-O. Minck, Germany Patent 4300912 (1994); *Chem. Abstr.*, **121**, 179608w (1994).

5) A. I. Kizber and A. S. Glagoleva, *Dokl. Akad. Nauk SSSR*, **83**, 89 (1952); *Zh. Obshch. Khim.*, **23**, 1028 (1953); W. Dymek and D. Sybistowicz, *Monatsh. Chem.*, **96**, 542 (1965).

6) J. Durman, J. I. Grayson, P. G. Hunt, and S. Warren, *J. Chem. Soc., Perkin Trans. 1*, **1986**, 1939.

7) T. Agawa, M. Ishikawa, M. Komatsu, and Y. Ohshiro, *Bull. Chem. Soc. Jpn.*, **55**, 1205 (1982).

8) F. Pochet, *Synthesis*, **1980**, 379.

9) M. M. Baizer, *J. Org. Chem.*, **31**, 3847 (1996).