New General Synthesis of *tert*-Butyl 3-Amino-2-naphthalenecarboxylates by an Electrocyclic Reaction of *o*-Quinonedimethides generated from *tert*-Butyl (*Z*)-3-Amino-3-(bicyclo[4.2.0]octa-1,3,5-trien-7-yl)prop-2-enoates

Kazuhiro Kobayashi, Yoshikazu Kanno, Shinzo Seko and Hiroshi Suginome*

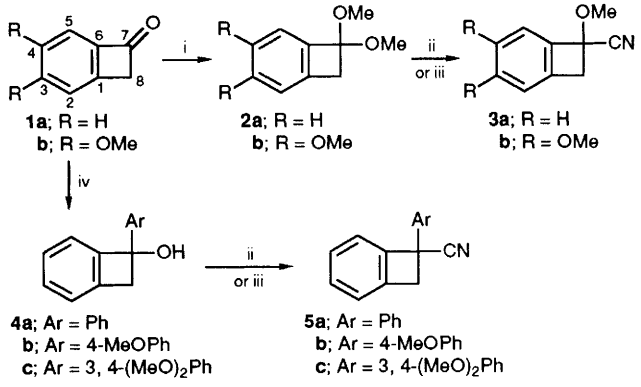
Organic Synthesis Division, Faculty of Engineering, Hokkaido University, Sapporo 060, Japan

A new general synthesis of *tert*-butyl 3-amino-2-naphthalenecarboxylates by an electrocyclic reaction of *o*-quinonedimethides thermally generated from *tert*-butyl (*Z*)-3-amino-3-(bicyclo[4.2.0]-octa-1,3,5-trien-7-yl)prop-2-enoates is described.

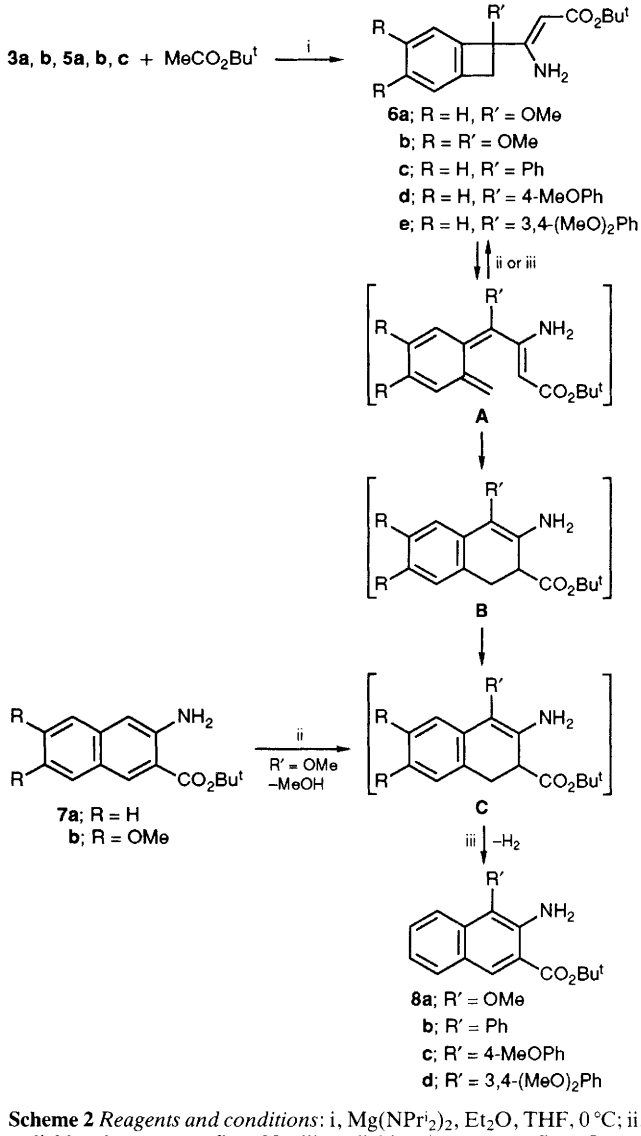
2-Aminobenzoic acids comprise a group of molecules which are very useful as precursors for the generation of benzynes.[1] Their benzo-analogues, 3-amino-2-naphthalenecarboxylic acids, are also useful and have been exploited as precursors for the synthesis of polyaromatic[2] and heterocyclic compounds.[3] There has been, however, little work[4] on the general method for preparing this group of molecules, particularly those having substituents which may have considerable potential in organic synthesis.

We report here on a new general synthesis of *tert*-butyl 3-amino-2-naphthalenecarboxylates by an electrocyclic reaction of *o*-quinonedimethides generated from *tert*-butyl (*Z*)-3-amino-3-(bicyclo[4.2.0]octa-1,3,5-trien-7-yl)prop-2-enoates. Although a number of syntheses by intramolecular electrocyclic reactions of *o*-quinonedimethides have been reported,[5] the synthesis reported here is the first case in which an enamino group is involved as an internal dienophile.

The substrates for thermolysis were synthesised as follows. Bicyclo[4.2.0]octa-1,3,5-trien-7-one **1a**,[6] or its 3,4-dimethoxy derivative **1b**,[6] was transformed into the 7,7-dimethylacetals, **2a**[7] and **b** [**b**; b.p. 114–115 °C (bath temp.)/0.2 Torr (1 Torr = 133.322 Pa)], with trimethyl orthoformate and toluene-*p*-sulfonic acid in refluxing methanol in 87 and 83% yields (Scheme 1). Dimethylacetals **2a** and **b** were converted into the corresponding 7-methoxy-7-carbonitriles, **3a** [b.p. 85–86 °C (bath temp.)/0.5 Torr] and **b**,† with either cyanotrimethylsilane and boron trifluoride etherate or zinc iodide in dichloromethane at 0 °C in 95 and 58% yields. On the other hand, the treatment of bicyclo[4.2.0]octa-1,3,5-trien-7-one **1a** with phenylmagnesium bromide in tetrahydrofuran (THF) at −78 °C gave 7-phenylbicyclo[4.2.0]octa-1,3,5-trien-7-ol **4a**[8] in 77% yield. Similar reactions of benzocyclobutanone **1a** with *p*-methoxyphenyl magnesium bromide and with 3,4-dimethoxyphenylmagnesium bromide gave the corresponding 7-arylalcohols, **4b** and **c**,† in 93 and 59% yields. These 7-aryl-7-ols **4a**, **b** and **c** were then transformed into the corresponding 7-carbonitriles **5a**, **b**† and **c** [**c**; m.p. 126–127 °C (from hexane–diethyl ether)] in 57–73% yields according to the procedure described for the transformation of 7,7-dimethylacetals, **2a** and **b**, into 7-carbonitriles, **3a** and **b**. The 7-carbonitriles **3a**, **b**, **5a**, **b** and **c** were next transformed into the corresponding *tert*-butyl (*Z*)-3-amino-3-(bicyclo[4.2.0]-octa-1,3,5-trien-7-yl)prop-2-enoates **6a–e** with magnesium



Scheme 1 *Reagents and conditions*: i, $CH(OMe)_3$, *p*-TsOH, MeOH, reflux; ii, Me_3SiCN, $BF_3{\cdot}OEt_2$, CH_2Cl_2, 0 °C; iii, Me_3SiCN, ZnI_2, CH_2Cl_2, 0 °C; iv, ArMgBr, THF, −78 °C



Scheme 2 *Reagents and conditions*: i, $Mg(NPr^i_2)_2$, Et_2O, THF, 0 °C; ii, *o*-dichlorobenzene, reflux, N_2; iii, *o*-dichlorobenzene, reflux, O_2

† *NMR data* for **3b**: (90 MHz) δ 3.41 (1H, d, *J* 13.6 Hz, 8-H), 3.60 (3H, s, 7-OMe), 3.73 (1H, d, *J* 13.6 Hz, 8-H), 3.87 (6H, s, 3- and 4-OMe), 6.76 (1H, s) and 6.87 (1H, s). For **4b**: (90 MHz) δ 3.58 (2H, s, 8-H), 3.78 (3H, s, OMe), 6.84 (2H, d, *J* 8.57 Hz, 3′- and 5′-H) and 7.1–7.5 (6H, m). For **4c**: (90 MHz) δ 3.59 (2H, s, 8-H), 3.86 (6H, s, OMe) and 6.7–7.4 (7H, m). For **5a**: (90 MHz) δ 3.54 (1H, d, *J* 14.07 Hz, 8-H), 4.15 (1H, d, *J* 14.07 Hz, 8-H) and 7.2–7.5 (9H, m). For **5b**: (90 MHz) δ 3.50 (1H, d, *J* 14.06 Hz, 8-H), 3.80 (3H, s, OMe), 4.12 (1H, d, *J* 14.06 Hz, 8-H), 6.88 (2H, d, *J* 8.79 Hz, 3′- and 5′-H) and 7.1–7.5 (6H, m).

bis(diisopropylamide) and *tert*-butyl acetate.[9] Typically, to a solution of diisopropylamine (11 mmol) and ethylmagnesium bromide (5 mmol) in diethyl ether at 0 °C were added the 7-carbonitrile **3a** (2.7 mmol) and *tert*-butyl acetate (2.7 mmol) in THF. The solution was stirred for 1.5 h to give 3-aminopropenoate **6a**‡ in 75% yield. Analogous reactions of 7-carbonitriles **3b**, **5a**, **b** and **c** under the same conditions as for 7-carbonitrile **3a** gave 3-aminopropenoates **6b–e**‡ in 53–72% yields.

The thermal generation of *o*-quinonedimethides (**A** in Scheme 2) from propenoates **6a** and **b** with an exclusion of molecular oxygen in solution gave protected 3-amino-2-naphthalenecarboxylic acids **7a** and **b**, while thermolysis of a solution saturated with molecular oxygen gave their 4-methoxy derivatives, **8a** and **b**; a solution of *tert*-butyl-(*Z*)-3-amino-3-(7-methoxybicyclo[4.2.0]octa-1.3.5-trien-7-yl)prop-2-enoate **6a** or its 3′,4′-dimethoxy derivative **6b** in *o*-dichlorobenzene was heated under reflux for 30 min in an atmosphere of nitrogen to give *tert*-butyl 3-aminonaphthlene-2-carboxylate **7a** (m.p. 105–106 °C) or its 6,7-dimethoxy derivative **7b** (m.p. 187–189 °C) through intermediates **A**, **B** and **C** in 58 and 64%, respectively, as outlined in Scheme 2. The analogous thermolysis of 3-aminopropenoates **6a**, **c**, **d** and **e** in *o*-dichlorobenzene saturated with oxygen gave 3-aminonaphthalene-2-carboxylates **8a** (m.p. 131–132 °C), **b** (m.p. 151–152 °C), **c** (m.p. 158–159 °C) and **d** (m.p. 131–132 °C) in 31–66% yields.§

‡ **6a–e** m.p.s 135–136, 122–144, 150–151, 142–143, 158–159 °C, respectively.

§ Satisfactory spectral and analytical results were obtained for all of the new compounds described in this paper.

The full experimental details described in this paper, together with applications of the present method to syntheses of various natural products, will be published in due course.

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References

1 For review, see T. L. Gilchrist in *The Chemistry of Triple-bonded Functional Groups*, ed. S. Patai and Z. Rappoport, J. Wiley & Sons, New York, 1983, p. 383.

2 G. S. Marx and E. D. Bergmann, *J. Org. Chem.*, 1972, **37**, 1807; N. C. Yang, R. V. Carr, E. Li, J. K. McVey and S. A. Rice, *J. Am. Chem. Soc.*, 1974, **96**, 2297; W. Amrein and K. Schaffner, *Helv. Chim. Acta*, 1975, **58**, 380; T. Nakayama, E. Seki and M. Hoshino, *J. Chem. Soc., Perkin Trans. 1*, 1978, 468; R. P. Thummel, W. E. Cravey and W. Nutakul, *J. Org. Chem.*, 1978, **43**, 2473; O. Abou-Tein, M. C. Goodland and J. F. McOmie, *J. Chem. Soc., Perkin Trans. 1*, 1983, 2659.

3 G. W. Rewcastle and W. A. Denney, *Synth. Commun.*, 1987, **17**, 309; B. Gaux and P. L. Henaff, *Bull. Soc. Chim. Fr.*, 1974, 900; M. E. Peek, C. W. Rees and R. C. Storr, *J. Chem. Soc., Perkin Trans. 1*, 1974, 1260; A. J. Barker, T. McC. Paterson, R. K. Smalley and H. Suschitzky, *J. Chem. Soc., Perkin Trans. 1*, 1979, 2203; C. Wentrup, H. Bender and G. Gross, *J. Org. Chem.*, 1987, **52**, 3838.

4 L. A. Levy, *Synth. Commun.*, 1983, **13**, 639; S. Wawzonek and M. C. Chen, *Org. Prep. Proced. Int.*, 1985, **17**, 65.

5 For example K. Kobayashi, M. Itoh and H. Suginome, *J. Chem. Soc., Perkin Trans. 1*, 1991, 2135; K. Shishido, A. Yamashita, K. Fukumoto and T. Kametani, *J. Chem. Soc., Perkin Trans. 1*, 1990, 469, and references cited therein.

6 M. P. Cava and K. Muth, *J. Am. Chem. Soc.*, 1960, **82**, 652; H. Dürr, H. Nickels, L. A. Pacala and M. J. Jones, Jr., *J. Org. Chem.*, 1980, **45**, 973.

7 R. V. Stevens and G. B. Bisacchi, *J. Org. Chem.*, 1982, **47**, 2393.

8 L. Horner, P. V. Subramanian and K. Eiber, *Liebigs Ann. Chem.*, 1968, **714**, 91.

9 T. Hiyama and K. Kobayashi, *Tetrahedron Lett.*, 1982, **23**, 1597.