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Cleavage of 7- and 8-nitropyrido[1,2-*a*]benzimidazoles on treatment with dimethyl acetylenedicarboxylate

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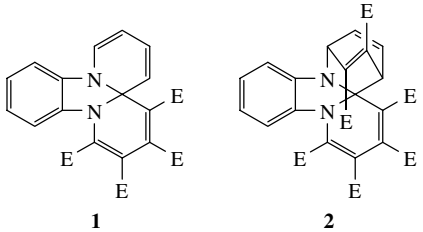
7-Nitropyrido[1,2-*a*]benzimidazole and 8-nitropyrido[1,2-*a*]benzimidazole undergo cleavage–recyclization under the action of an excess of dimethyl acetylenedicarboxylate.

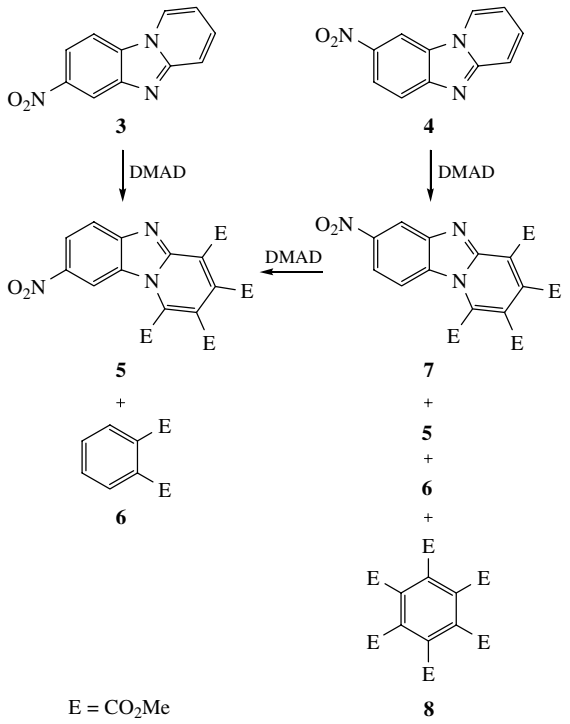
Dimethyl acetylenedicarboxylate (DMAD) is widely used in organic synthesis for the annelation of five- and six-membered rings.[1] Reactions of benzimidazole and its 1,2-substituted derivatives result in the annelation of a 1,2,3,4-tetramethoxycarbonylpyridine fragment.[2–4] Pyrido[1,2-*a*]benzimidazole forms adducts **1** and **2** with two or three DMAD molecules, respectively.[5]

We found that the reactions of 7- and 8-nitropyrido[1,2-*a*]-benzimidazoles **3** and **4** with an excess of DMAD in benzene occur in a different way. Compound **3** is converted[6] to 8-nitro-1,2,3,4-tetramethoxycarbonylpyrido[1,2-*a*]benzimidazole **5** and dimethyl *o*-phthalate **6**. Under the same conditions, 8-nitropyrido[1,2-*a*]benzimidazole **4** gives[7,8] a mixture of 7-nitro compound **7**, 8-nitro-substituted compound **5**, dimethyl phthalate **6** and hexamethyl benzenehexacarboxylate. The formation of compounds **6** and **8** was confirmed by chromatography–mass spectrometry† based on the presence of M^+ ions with *m*/*z* 194 and 426, respectively.

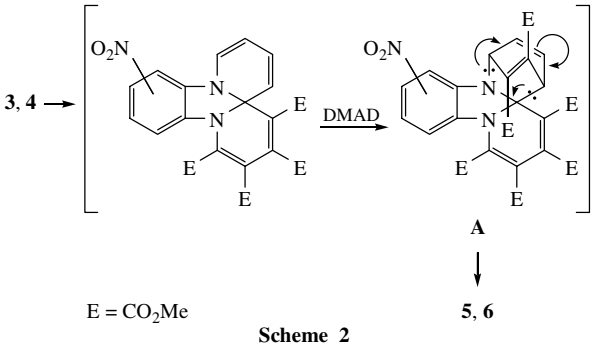


1 **2**

E = CO_2Me



Scheme 1



Scheme 2

We found by TLC that the concentration of compound **5** in the reaction mixture increases with the time of reaction with DMAD. This allowed us to assume that compound **5** was formed due to the recyclization of initial product **7**. In fact, the reaction of compound **7** with an excess of DMAD results in compound **5**.

We believe that, as in the case of pyridobenzimidazole,[5] the reaction occurs *via* the formation of 1:3 adduct **A**. Owing to the strong electron-withdrawing effect of the nitro group, this is followed by the elimination of a bicyclic fragment.

The electron-withdrawing effect of the nitro group in compound **5** dramatically decreases the nucleophilicity of the *para* N(5) atom and makes its reaction with DMAD impossible. On the contrary, the N(5) atom in compound **7** is located at the *meta*-position to the NO_2 group, and it remains capable of reacting with DMAD to form pyridobenzimidazole **5**.

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† A Kratos MS-25 RF mass spectrometer was used.

Experimental procedure. A mixture of compound **3** or **4** (1 mmol) and DMAD (30 mmol) was kept at 20 °C until the disappearance of the starting nitropyridobenzimidazole according to TLC (Silufol, ethyl acetate) and treated with 10 ml of water. The organic layer was separated. The residue after the distillation of benzene *in vacuo* was chromatographed on silica gel using ethyl acetate–heptane (2:1) as an eluent. The reaction of compound **3** gave 0.05 g (10%) of 8-nitro-1,2,3,4-tetramethoxycarbonylpyrido[1,2-*a*]benzimidazole **5**, mp 196–197 °C (benzene). R_f 0.42 (Silufol; ethyl acetate–hexane, 2:1). ^{1}H NMR (200 MHz, $CDCl_3$) δ: 3.97, 3.99, 4.10, 4.30 (s, CO_2Me), 8.16 (d, 1H, H-6, $J_{6,7}$ 8 Hz), 8.54 (dd, 1H, H-7, $J_{7,6}$ 8 Hz, $J_{7,9}$ 2 Hz), 8.66 (d, 1H, H-9, $J_{9,7}$ 2 Hz). MS, *m/z* (%): 445 (M^+, 100), 414 (35, M – MeOH), 387 (12, M – CO_2CH_2), 329 (70, M – $2CO_2CH_2$), 271 (49, M – $3CO_2CH_2$), 213 (21, M – $4CO_2CH_2$). Found (%): C, 50.94; H, 3.15; N, 9.32. Calc. for $C_{19}H_{15}N_3O_{10}$ (%): C, 51.23; H, 3.25; N, 9.42.

The reaction of compound **4** gave (i) 0.04 g (9%) of compound **7** or (ii) 0.16 g (32%) of a mixture of compounds **5** and **7**.

For **7**: mp 202–203 °C (benzene). R_f 0.47 (Silufol; ethyl acetate–hexane, 2:1). ^{1}H NMR (200 MHz, $CDCl_3$) δ: 3.95, 3.97, 4.10, 4.22 (s, CO_2Me), 8.97 (dd, 1H, H-6, $J_{6,8}$ 2.1 Hz, $J_{6,9}$ 0.6 Hz), 8.34 (dd, 1H, H-8, $J_{8,6}$ 2.1 Hz, $J_{8,9}$ 9.2 Hz), 7.77 (dd, 1H, H-9, $J_{9,8}$ 9.2 Hz, $J_{9,6}$ 0.6 Hz). MS, *m/z*: 445 (M^+). Found (%): C, 51.50; H, 3.40; N, 9.25. Calc. for $C_{19}H_{15}N_3O_{10}$ (%): C, 51.23; H, 3.25; N, 9.42.