Thermolyzed Products of Naphth[1,2-*d*]imidazo[2,1-*b*]-thiazole-2,3-dione

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Themolysis of naphth[1,2-*d*]imidazo[2,1-*b*]thiazole-2,3-dione (**1**) in dimethylformamide gave an intermediate 2-isocyanatonaphtho[1,2-*d*]thiazole (**2**), which underwent [4 + 4] cyclodimerization to yield dinaphtho-[1″,2″:4,5;1′″,2′″:4′,5′]dithiazolo[3,2-*a*:3′,2′-*e*]-1,3,5,7-tetrazocine-9,19-dione (**3**). The possible [4 + 2] cycloadduct, 3-(2-naphtho-[1,2-*d*]-thiazolyl)naphtho[1′,2′:4,5]thiazolo[3,2-*a*]-1,3,5-triazine-2,4-dione (**4**), an usual dimer type of heterocyclic isocyanates was not produced. Discrimination between the two isomers was established on the basis of spectral analyses.

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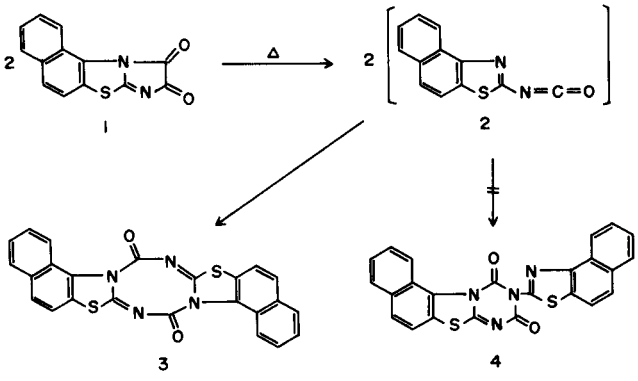
In continuing our studies on the biological activities of compounds in the fused naphtho[1,2-*d*]thiazole series [1-3], we reported the synthesis of a number of 3*H*-naphth[1,2-*d*]-imidazo[2,1-*b*]thiazol-2-ones [4] and naphtho[1′,2′:4,5]thiazolo[3,2-*b*]-1,2,4-triazole [5]. One of these derivatives, namely naphth[1,2-*d*]imidazo[2,1-*b*]thiazole-2,3-dione (**1**) was found to be unstable and it decomposed rapidly in dimethylformamide on heating to boiling. A yellow crystalline product with a melting point above 320° was isolated in 80% yield. The elemental analysis of this product indicated the empirical formula $C_{12}H_6N_2OS$ corresponding to the decarbonylated derivative **1**, 2-isocyanatonaphtho-[1,2-*d*]thiazole (**2**). However, mass fragmentation study revealed that it occurred as a dimer of **2** and showed the intensive molecular ion peak at m/z 452 followed by a prominent monomer ion peak at m/z 226. The subsequent cleavage just followed the pattern observed in case involved in compound **1** [4] and gave the homologous fragments of $C_{11}H_6N_2S$, $C_{10}H_6NS$, $C_{10}H_6N$ and C_9H_6 at m/z 198, 172, 140 and 114, respectively.



As illustrated in the reaction scheme, two pathways of the dimerization of compound **2** should be taken into consideration. It might proceed either *via* a [4 + 4] cycloaddition to yield dinaphtho[1″,2″:4,5;1′″,2′″:4′,5′]dithiazolo-[3,2-*a*:3′,2′-*e*]-1,3,5,7-tetrazocine-9,19-dione (**3**) or *via* a [4 + 2] cycloaddition to produce 3-(2-naphtho[1,2-*d*]thiazolyl)naphtho[1′,2′:4,5]thiazolo[3,2-*a*]-1,3,5-triazine-2,4-dione (**4**). Gizycki and Oertel [6] showed that some heterocyclic isocyanates, such as 2-isocyanatothiazole and 2-isocyanatobenzothiazole underwent [4 + 2] cyclodimerization to give the corresponding annelated 1,3,5-triazine-2,4-diones of a dimer type coincident with structure **4** of our postulation. However, it was claimed that these dimers showed characteristic double carbonyl absorption bands at 1750-1730 and 1705-1680 cm^{-1} in the ir spectra and two multiple-lined signals at δ 7.15-7.80 and 7.82-7.92 ppm in the ^{1}H-nmr spectra. It reflected that these identical functional groups occupied different positions in the asymmetrical dimerized molecules, which restricted the corresponding aromatic protons within two chemical environments to show anisochronous property.

In contrast with these properties, we found that our product exhibited only the single carbonyl absorption band at 1690 cm^{-1} in the ir region and one four-line system of aromatic protons at δ 7.67, 7.92, 8.12 and 8.62 ppm with the integrated intensity ratio of 2:1:2:1 in the ^{1}H-nmr spectrum. These data demonstrated the symmetrical existence of the dimerized molecule, which should be resulted from [4 + 4] cycloaddition and rationally assigned as [*a*,*e*]-bifused 1,3,5,7-tetrazocinedione **3** as shown in the reaction scheme. A ^{13}C-nmr spectral study confirmed furthermore our assignment. The heteroaromatic carbon atoms of the dithiazolo[3,2-*a*:3′,2′-*e*]1,3,5,7-tetrazocinedione component appeared at δ 158.59 (C-9, 19), 156.75 (C-6a, 16a), 143.80 (C-7a, 17a) and 131.51 (C-10a, 20a) ppm. The other nonprotonated and protonated aromatic carbon of the fused naphthalene nuclei occurred at δ 127.80, 127.52, 126.60, 126.24, 125.54, 124.21, 122.46 and 118.91 ppm, respectivley.

The unfused 1,3,5,7-tetrazocine molecule was first prepared by Gompper and Schwarzensteiner [7], who assigned this novel ring skeleton in boat form conformation on the basis of X-ray diffraction analysis. As a symmetrically bifused ring system, it is reasonably to assume that the tetrazocine ring skeleton of compound **3** existed in the chair form conformation, though a crystallographic study showed that it is not suitable for X-ray analysis.

EXPERMENTAL

Melting points were determined with Tottoli apparatus and are uncorrected. The ultraviolet and infrared spectra were measured with Shimadzu 210 A and Perkin Elmer M 577 spectrophotometer, respectively. ^{1}H-and ^{13}C-nulcear magnetic resonance spectra were recorded on Brucker HX-90 R spectrometer. The mass spectrum was recorded on a Hitachi RMS 4 spectrometer. Elemental analysis was performed in the Chungshan Institute of Science and Technology, Taoyuan, Taiwan, China.

Naphth[1,2-*d*]imidazo[2,1-*b*]thiazole-2,3-dione (**1**).

Compound **1** was prepraed from 2.0 g (0.01 mole) of 2-aminonaphtho-[1,2-*d*]thiazole and 1.3 g (0.01 mole) of oxalyl dichloride according to the procedure described in the previous communication [4], yield, 2.5 g (94%), mp 300°.

Dinaphtho[1″,2″:4,5:1′″,2′″:4′,5′]dithiazolo[3,2-*a*:3′,2′-*e*]-1,3,5,7-tetrazocine-9,19-dione (**3**).

A solution of 1.3 g (0.005 mole) of **1** in 30 ml of dimethylformamide was heated under reflux for 30 minutes. After cooling the crystalline precipitate was collected and recrystallized from dimethyl sulfoxide to yield 0.9 g (80%) of yellow needle crystals, mp > 320°; uv (methanol): λ max (log ε) 267 (4.00), 340 (3.66), 375 (3.76) nm; λ min (log ε) 321 (3.26), 358 (3.36) nm; ir (potassium bromide): 3050 (=C-H), 1690 (C=O), 1858, 1525 (C=N/C=C), 1275 (C-N), 645 (C-S) cm^{-1}; ^{1}H-nmr (DMSO-d$_6$): δ (ppm) 7.67 (m, 4H, H-2,3,12,13), 7.92 (m, 2H, H-4, 14), 8.12 (m, 4H, H-1, 11, 5, 15), 8.62 (d, 2H, H-6, 16, J = 6.0 Hz); ^{13}C-nmr (DMSO-d$_6$): δ (ppm) 158.59 (C-9, 19), 156.75 (C-6a, 16a), 143.80 (C-7a, 17a), 131.51 (C-10a, 20a), 127.80, 127.52 (C-4a, 14a, 10b, 20b), 126.60, 126.24, 125.54, 124.21, 122.46, 118.91 (C-1-4a, 5, 6, 11-14a, 15, 16); ms (70 eV): m/z 452 (M$^+$, 20), 226 (M$^+$/2, 100), 198 (M/2-CO, 96), 172 (198-CN, 40), 140 ($C_{10}H_6N$, 32), 114 (C_9H_6, 12).

Anal. Calcd. for $C_{24}H_{12}N_4O_2S_2$: C, 63.70; H, 2.67; N, 12.38; S, 14.17. Found: C, 63.35; H, 3.06; N, 11.99; S, 14.35.

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