Condensed 1,3-Benzothiazinones 3. Synthesis of 3-Substituted 1,2,4-Triazolo[3,4-*b*][1,3]benzothiazin-5-ones [1,2]

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Refluxing 2-hydrazono-3,4-dihydro-2*H*-1,3-benzothiazin-4-one **3** with triethyl orthoformate neat or with trimethyl orthoformate **4a**, triethyl orthoacetate, orthopropionate, orthobenzoate **4b-d** in xylene gave 1,2,4-triazolo[3,4-*b*][1,3]benzothiazin-5-one **2a** and its 3-substituted derivatives **2b-d** in 56-95% yields. On the other hand, when **3** was treated with trifluoro-, trichloroacetic anhydride **4e,f**, dichloro-, chloroacetyl chloride **4g,h**, 2-chloropropionyl and ethoxyoxalyl chloride **4i,j**, the corresponding open-chain condensates were produced, together with the title compounds **2g-i**, or the Dimroth rearrangement isomers **1e,g,i,j** each depending on the reaction conditions. Nevertheless efficient preparation of **2h** and 3-hydroxy-derivative **2k** to get rid of such rearrangement was developed.

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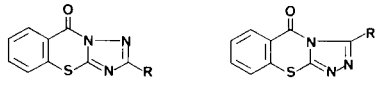
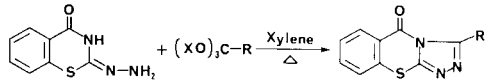
In the foregoing communication of this series [1], we reported the synthesis of a number of 2-substituted 1,2,4-triazolo[5,1-*b*][1,3]benzothiazin-9-ones **1**. Since the union of a 1,2,4-triazole component across the C^2–N^3 bond of 1,3-benzothiazin-4-one might also give rise to a second fusion of the [3,4-*b*] type, we wish to describe the synthesis of 3-substituted 1,2,4-triazolo[3,4-*b*][1,3]benzothiazin-5-ones **2**.



1 2

The starting 2-hydrazono-3,4-dihydro-2*H*-1,3-benzothiazin-4-one **3** was prepared by careful hydrolysis of 2-methylthio-4*H*-1,3-benzothiazin-4-one with hydrazine hydrate in 96% yield according to a procedure described recently [3]. Refluxing compound **3** with triethyl orthoformate neatly or with its trimethyl ester **4a** in xylene gave 1,2,4-triazolo-[3,4-*b*][1,3]benzothiazin-5-one **2a** in 93 and 89% yield, respectively. Similar reactions of **3** with triethyl orthoacetate **4b**, triethyl orthopropionate **4c** and triethyl orthobenzoate **4d** afforded the corresponding 3-methyl-, 3-ethyl- and 3-phenyl-1,2,4-triazolo[3,4-*b*][1,3]benzothiazin-5-ones **2b-d** in 56-95% yields (Scheme 1).

Scheme 1

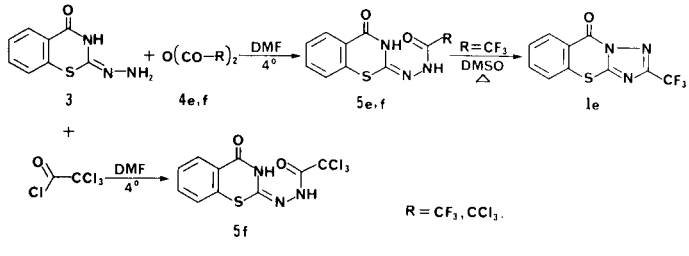


3 4a–d 2a–d

X=Me, Et; R=H, Me, Et, Ph.

Treating compound **3** with trifluoroacetic anhydride **4e** or trichloroacetic anhydride **4f** by stirring in dimethylformamide at 4° for 12 hours gave only the open-chain condensates, 2-trifluoro- and 2-trichloroacetylhydrazono-3,4-dihydro-2*H*-1,3-benzothiazin-4-ones **5e** and **5f** in 75 and 86% yield, respectively. An attempt made to cyclize these two intermediates by heating encountered some difficulties. For example, refluxing **5e** in dimethylformamide or dimethyl sulfoxide for only 15 minutes afforded not the expected ring-closure product, 3-trifluoromethyl-1,2,4-triazolo[3,4-*b*][1,3]benzothiazin-5-one (**2e**), but its isomer, 2-trifluoromethyl-1,2,4-triazolo[5,1-*b*][1,3]benzothiazin-9-one (**1e**) in 63% yield [1]. This reaction proceeded reasonably *via* the Dimroth rearrangement at elevated temperature [4-6]. However, no reaction occurred in compound **5f** under such conditions. This relatively bulky trichloromethyl group of **5f** might exercise considerable influence to hinder the cyclization of forming both [3,4-*b*]- and [5,1-*b*]-isomers. The reaction stopped at the same open-chain intermediate step to give **5f**, when trichloroacetyl chloride was used in place of **4f** in the above process (Scheme 2).

Scheme 2

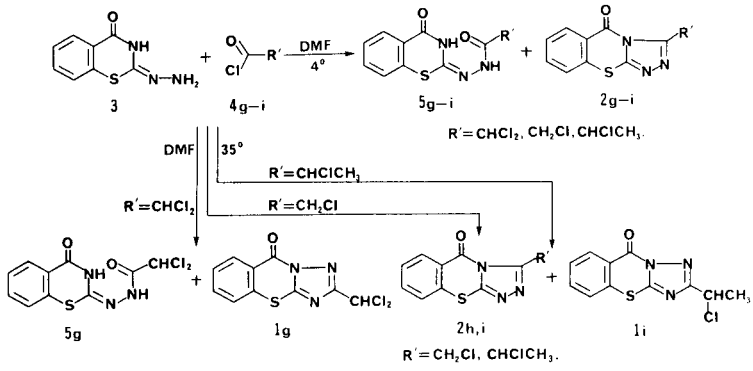


3 4e,f 5e,f 1e

5f

Similar treatment of compound **3** with other chlorocarboxylic acid chlorides, namely, dichloroacetyl chloride **4g**, chloroacetyl chloride **4h** or 2-chloropropionyl chloride **4i** by stirring in dimethylformamide at 4° afforded the expected title compounds, 3-dichloromethyl-, 3-chloromethyl- and 3-(1-chloroethyl)-1,2,4-triazolo[3,4-*b*][1,3]benzothiazin-5-ones **2g-i** in 12-24% yields. Though these yields were relatively low and a large amount of the corresponding open-chain intermediates, 2-dichloroacetyl-, 2-chloroacetyl- and 2-(2-chloropropionyl)hydrazono-3,4-dihydro-2*H*-1,3-benzothiazin-4-ones **5g-i** were still isolated, no rearrangement reaction was observed in all cases. However,

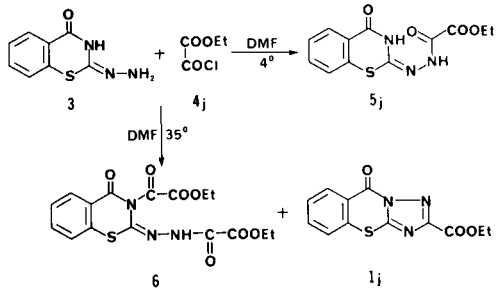
Scheme 3



when the above reactions were performed by heating at 35° for only 2 hours, the Dimroth rearrangement occurred, where 2-dichloromethyl- and 2-(1-chloroethyl)-1,2,4-triazolo[5,1-*b*][1,3]benzothiazin-9-ones **1g,i** were produced together with a major amount of **5g** and a minor amount of **2i**, respectively. Only in the case involving **3** and **4h**, the reaction proceeded by heating in dimethylformamide at 35° more favorably to give the expected **2h** as the unique product in 73% yield (Scheme 3).

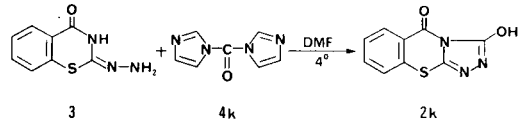
The reaction of **3** with ethoxyoxalyl chloride **4j** was found also to stop at the open-chain intermediate step. It gave 2-(ethoxyoxalylhydrazono)-3,4-dihydro-2*H*-1,3-benzothiazin-4-one (**5j**) by stirring at 4° in dimethylformamide, but a biacylated compound, 3-(ethoxyoxalyl)-2-(ethoxyoxalylhydrazono)-3,4-dihydro-2*H*-1,3-benzothiazin-4-one (**6**) together with a small amount of rearrangement product, 2-(ethoxycarbonyl)-1,2,4-triazolo[5,1-*b*][1,3]benzothiazin-9-one (**1j**) [1] after heating at 35° in the same medium (Scheme 4).

Scheme 4



Finally, the preparation of the corresponding 3-hydroxy-1,2,4-triazolo[3,4-*b*][1,3]benzothiazin-5-one **2k** was also performed by stirring **3** and *N,N'*-carbonyldiimidazole **4k** in dimethylformamide at room temperature. It then afforded the expected product in 58% yield, where no open-chain intermediate nor rearrangement isomer was found. Spectral analysis of **2k** showed that this compound, just like its type 1 isomer [1], existed also in the enol form. The hydroxyl function was recognized by the presence of an intensive broad absorption band at 3300-2700 cm^{-1} in the ir region and a prominent singlet at δ 12.27 ppm in the ^1H nmr spectrum (Scheme 5).

Scheme 5



So far as the above experimental results show, it might be understood that the synthesis of the title compounds are more difficult than that of the corresponding type 1 isomers. The reactions of the starting compound **3** with some representative carboxylic acid anhydrides or chlorides stopped mostly at the open-chain intermediate steps under cooling or at ambient temperature. On the other hand, when the experiments were performed by warming at relatively higher temperature up to 35°, Dimroth-type rearrangement occurred almost simutaneously with the ring-closure reaction. The Dimroth rearrangement of several ring-fused triazole systems induced by base, acid or by heating has been described in the literatures [6-11]. This seems to be more notable in the synthesis of condensed 1,3-benzothiazinones, since, in contrast with acid anhydrides and acid chlorides, the reaction of **3** with some ortho esters proceeded in aprotic solvent like xylene much favorably to provide the expected title compounds **2a-d** in satisfactory yields. Though the reaction of **3** with some acidic condensation agents failed to give the corresponding 3-substituted 1,2,4-triazolo[3,4-*b*][1,3]benzothiazin-5-ones, **2e,f** and **2j** by stirring at 4° or by gentle warming at 35° in dimethylformamide, the experiments in this medium were found to be rather accessible for generating the 3-dichloromethyl-, 3-chloromethyl-, 3-(1-chloroethyl)- and 3-hydroxy-derivatives, **2g,i** and **2k**, respectively.

For a number of heterocyclic compounds, it has been claimed that the Dimroth rearrangement proceeded *via* a ring-fission, and recyclization pathway [12-14]. It seems to

be interesting to go into more details of the rearrangement reaction in compounds of the condensed 1,3-benzothiazinone system. The results will be discussed in the subsequent communication of this series.

EXPERIMENTAL

All melting points were determined with Fisher Johns 5193-K 328 apparatus and are uncorrected. The thin-layer chromatography was done on silica gel G, Merck, using ethyl acetate/*n*-hexane (4:3) as developing system. The ultraviolet and infrared spectra were measured with Shimazu 210 A and Perkin Elmer 938 G spectrophotometer, respectively. The ^{1}H nuclear magnetic resonance and mass spectra were recorded on JEOL FX 100 or Bruker AM-300 WB and JEOL JMS-D 300 spectrometer, respectively. The elemental analyses were performed in the Instrument Center of National Science Council at National Taiwan University, Taipei and National Chengkung University, Tainan, Republic of China.

2-Hydrazono-3,4-dihydro-2*H*-1,3-benzothiazin-4-one (**3**).

Compound **3** was prepared from 20.9 g (0.1 mole) of 2-methylthio-4*H*-1,3-benzothiazin-4-one by treating with 6.0 g (0.1 mole) of hydrazine hydrate in methanol according to a known procedure [3], yield 19.1 g (98%), mp 232-234°.

1,2,4-Triazolo[3,4-*b*][1,3]benzothiazin-5-one (**2a**).

Procedure A.

A mixture of 0.97 g (0.005 mole) of **3** in 10 ml (0.06 mole) of triethyl orthoformate was refluxed under stirring for 4 hours. After cooling, the solid product was collected on a filter, washed with *n*-hexane and recrystallized from benzene to give 0.94 g (93%) of yellow crystals, mp 194-195°, Rf 0.34; uv (ethanol): λ max (log ε) 222 (4.27), 253 (3.90), 309 (3.52) nm; λ min (log ε) 234 (3.84), 278 (2.95) nm; ir (potassium bromide): 3055, 3015 (=C-H), 1712 (C=O), 1592, 1434 (C=N/C=C), 1347 (C-N), 739 (C-S) cm^{-1}; ^{1}H nmr (DMSO-d$_6$): δ (ppm) 7.52-7.93 (m, 3H, ArH), 8.42-8.51 (m, 1H, H-6), 9.57 (s, 1H, H-3); ms: (70 eV) m/z 203 (M$^+$, 100), 175 (M-CO, 30), 136 (C_6H_5COS, 8).

Anal. Calcd. for $C_9H_5N_3OS$: C, 53.19; H, 2.48; N, 20.68. Found: C, 53.29; H, 2.45; N, 20.69.

Procedure B.

A solution of 0.97 g (0.005 mole) of **3** and 1.06 g (0.01 mole) of trimethyl orthoformate (**2a**) in 150 ml of xylene was heated at reflux under stirring for 8 hours. After cooling, the trace amount of precipitate was filtered off and the filtrate was concentrated to about 10 ml under reduced pressure. The residue was added with 10 ml of *n*-hexane and allowed to stand at 4° overnight. The precipitate formed was collected and recrystallized from benzene to yield 0.9 g (89%) of yellow crystals, mp 194-195°.

3-Methyl-1,2,4-triazolo[3,4-*b*][1,3]benzothiazin-5-one (**2b**).

A solution of 0.97 g (0.005 mole) of **3** and 1.65 g (0.01 mole) of triethyl orthoacetate (**4b**) in 150 ml of xylene was treated and worked out as described above. After recrystallization from benzene, it afforded 1.04 g (95%) of crystals, mp 188-189°, Rf 0.21; uv (ethanol): λ max (log ε) 223 (4.24), 253 (3.90), 309 (3.53) nm; λ min (log ε) 234 (3.83), 278 (2.90) nm; ir (potassium bromide): 3057, 3024 (=C-H), 1703 (C=O), 1589, 1438 (C=N/C=C), 1329 (C-N), 743 (C-S) cm^{-1}; ^{1}H nmr (DMSO-d$_6$): δ (ppm) 2.80 (s, 3H, CH_3), 7.58-7.87 (m, 3H, ArH), 8.34-8.41 (m, 1H, H-6); ms: (70 eV) m/z 217 (M$^+$, 100), 189 (M-C_2H_4, 11), 136 (C_6H_4COS, 44).

Anal. Calcd. for $C_{10}H_7N_3OS$: C, 55.29; H, 3.25; N, 19.34. Found: C, 55.22; H, 3.26; N, 19.30.

3-Ethyl-1,2,4-triazolo[3,4-*b*][1,3]benzothiazin-5-one (**2c**).

A solution of 0.97 g (0.005 mole) of **3** and 1.7 g (0.01 mole) of triethyl orthopropionate (**4c**) in 150 ml of xylene was treated and worked out as described above. After recrystallization from ethanol, it provided 1.04 g (90%) of crystals, mp 133-134°, Rf 0.30; uv (ethanol): λ max (log ε) 223 (4.33), 250 (3.89), 309 (3.52) nm; λ min (log ε) 234 (3.83), 278 (2.90) nm; ir (potassium bromide): 3088, 3057, 3023 (=C-H), 1699 (C=O), 1592, 1435 (C=N/C=C), 1317 (C-N), 744 (C-S) cm^{-1}; ^{1}H nmr (DMSO-d$_6$): δ (ppm) 1.33 (t, 3H, CH_3, J = 7.4 Hz), 3.24 (q, 2H, CH_2, J = 7.4 Hz), 7.58-7.82 (m, 3H, ArH), 8.39-8.42 (m, 1H, H-6); ms: (70 eV) m/z 231 (M$^+$, 100), 188 (M-CH_3CO, 10), 136 (C_6H_4COS, 62).

Anal. Calcd. for $C_{11}H_9N_3OS$: C, 57.13; H, 3.92; N, 18.17. Found: C, 57.19; H, 3.92; N, 18.15.

3-Phenyl-1,2,4-triazolo[3,4-*b*][1,3]benzothiazin-5-one (**2d**).

A solution of 0.97 g (0.005 mole) of **3** and 2.24 g (0.01 mole) of triethyl orthobenzoate (**4d**) in 150 ml of xylene was treated and worked out as described above. After recrystallization from ethanol, it gave 0.75 g (56%) of crystals, mp 209-210°, Rf 0.43; uv (ethanol); λ max (log ε) 223 (4.33), 250 (4.34), 310 (3.58) nm; λ min (log ε) 231 (4.21), 288 (3.52) nm; ir (potassium bromide): 3091, 3059, 3011 (=C-H), 1709 (C=O), 1589, 1478 (C=N/C=C), 1332 (C-N), 745 (C-S) cm^{-1}; ^{1}H nmr (DMSO-d$_6$): δ (ppm) 7.54-7.59 (m, 3H, H-3', 4', 5'), 7.69-8.04 (m, 3H, H-7, 8, 9), 8.18 (m, 2H, H-2', 6'), 8.52-8.54 (m, 1H, H-6); ms: (70 eV) m/z 279 (M$^+$, 94), 251 (M-CO, 28).

Anal. Calcd. for $C_{15}H_9N_3OS$: C, 64.50; H, 3.25; N, 15.04. Found: C, 64.64; H, 3.19; N, 15.19.

2-Trifluoroacetylhydrazono-3,4-dihydro-2*H*-1,3-benzothiazin-4-one (**5e**).

A solution of 0.97 g (0.005 mole) of **3** in 20 ml of dimethylformamide was kept at 0-4° on an ice-bath and then treated dropwise with 2.1 g (0.01 mole) of trifluoroacetic anhydride (**4e**) and stirred at this temperature for 12 hours. The reaction mixture was poured into 200 ml of ice-water and the precipitate formed was collected and recrystallized from ethanol to give 1.1 g (75%) of crystals, mp 227-228°, Rf 0.38; uv (ethanol): λ max (log ε) 225 (4.44) nm; ir (potassium bromide): 3360 (N-H), 3015 (=C-H), 1725, 1673 (C=O), 1604, 1581 (C=N, C=C), 1366 (C-N), 1204, 1150 (C-F) cm^{-1}; ^{1}H nmr (DMSO-d$_6$): δ (ppm) 7.30-7.70 (m, 3H, ArH), 8.14-8.21 (m, 2H, H-5, NH), 11.90 (s, br, 1H, NH); ms: (70 eV) m/z 289 (M$^+$, 53), 220 (M-CF_3, 31), 192 (M-CF_3CO, 12), 136 (C_6H_4COS, 100).

Anal. Calcd. for $C_{10}H_6F_3N_3O_2S$: C, 41.53; H, 2.09; N, 14.53. Found: C, 41.44; H, 2.08; N, 14.52.

Trifluoromethyl-1,2,4-triazolo[5,1-*b*][1,3]benzothiazin-9-one (**1e**).

A solution of 1.0 g (0.0035 mole) of **5e** in 20 ml of dimethyl sulfoxide was heated under reflux for 15 minutes. After cooling, the reaction mixture was poured into 80 ml of ice-water. The precipitate was collected and recrystallized from ethanol to afford 0.8 g (85%) of fine crystals, mp 218-219°. This product gave all agreeable analytical data with those reported previously [1].

Trichloroacetylhydrazono-3,4-dihydro-2*H*-1,3-benzothiazin-4-one (**5f**).

A solution of 0.97 g (0.001 mole) of **3** in 20 ml of dimethylformamide was kept at 0-4° in an ice-bath and treated dropwise with 3.1 g (0.1 mole) of trichloroacetic anhydride (**4f**) and then worked out as described above. After recrystallization from ethanol, it provided 1.5 g (86%) of crystals, mp 218-219°, Rf 0.38; uv (ethanol): λ max (log ε) 225 (4.47) nm; ir (potassium bromide): 3300-2700 (N-H), 3062 (=C-H), 1702 (C=O), 1604, 1585 (C=N/C=C) 1349 (C-N), 818, 785 (C-Cl) cm^{-1}; ^1H nmr (DMSO-d_6): δ (ppm) 7.32-7.70 (m, 3H, ArH), 8.15-8.22 (m, 2H, H-5, NH), 11.56 (s, br, 1H, NH); ms (70 eV): m/z 337 (M^+, 18), 302 (M-Cl, 8), 222 (M-CCl_3, 100), 192 (M-CCl_3CO, 32), 136 (C_6H_4COS, 52).

Anal. Calcd. for $C_{10}H_6Cl_3N_3O_2S$: C, 35.47; H, 1.79; N, 12.41. Found: C, 35.53; H, 1.76; N, 12.40.

Repeating the above reaction but using 1.8 g (0.01 mole) of trichloroacetylchloride in place of **4f** under the same conditions gave 1.4 g (83%) of the same product, mp 218-219°.

3-Dichloromethyl-1,2,4-triazolo[3,4-*b*][1,3]benzothiazin-5-one (**2g**).

To a solution of 0.97 g (0.005 mole) of **3** in 25 ml of dimethylformamide was added dropwise 1.5 g (0.01 mole) of dichloroacetyl chloride (**4g**) under cooling at 5°. The reaction mixture was stirred at this temperature for 12 hours and then poured into 200 ml of ice-water. The precipitate formed was collected on a filter, washed with water and recrystallized from ethanol to yield 0.3 g (24%) of light yellow crystals, mp 184-185°, Rf 0.59; uv (ethanol): λ max (log ε) 221 (4.37), 238 (4.23), 310 (3.60) nm; λ min (log ε) 231 (4.23), 287 (3.50) nm; ir (potassium bromide); 3090, 3050 (=C-H), 1706 (C=O), 1595, 1433 (C=N/C=C), 1302 (C-N), 805, 762 (C-Cl) cm^{-1}; ^1H nmr (MDSO-d_6): δ (ppm) 7.50-7.95 (m, 3H, ArH), 7.95 (s, 1H, $CHCl_2$), 8.42-8.50 (m, 1H, H-6); ms: (70 eV) m/z 285 (M^+, 18), 250 (M-Cl, 100), 222 (M^+-ClCO, 23), 136 (C_6H_4COS, 31).

Anal. Calcd. for $C_{10}H_5Cl_2N_3OS$: C, 41.98; H, 1.76; N, 14.69. Found: C, 41.87; H, 1.76; N, 14.67.

2-Dichloroacetylhydrazono-3,4-dihydro-2*H*-1,3-benzothiazin-4-one (**5g**).

The mother liquid of **2g** was allowed to stand at 4° overnight. The white cloudy precipitate formed was collected on a filter, washed with ethanol and recrystallized from ethanol to give 0.4 g (26%) of crystals, mp 223-224°, Rf 0.06; uv (ethanol): λ max (log ε) 225 (4.42), 273 (4.20) nm; λ min (log ε) 260 (4.18) nm; ir (potassium bromide): 3300-2800 (N-H), 3011 (=C-H), 1686 (C=O), 1581, 1563 (C=N/C=C), 1365 (C-N), 808, 780 (C-Cl) cm^{-1}; ^1H nmr (DMSO-d_6): δ (ppm) 6.59 (s, 1H, $CHCl_2$), 7.34-7.70 (m, 3H, ArH), 8.14-8.21 (m, 1H, H-5), 10.97 (s, br, 1H, NH), 12.80 (s, br, 1H, NH); ms: (70 eV) m/z 303 (M^+, 28), 268 (M-Cl, 5), 229 (M-$CHCl_2$, 70), 192 (M-$COCHCl_2$, 25), 136 (C_6H_4COS, 100).

Anal. Calcd. for $C_{10}H_7Cl_2N_3O_2S$: C, 39.49; H, 2.32; N, 13.82. Found: C, 39.24; H, 2.33; N, 13.75.

2-Dichloromethyl-1,2,4-triaolo[5,1-*b*][1,3]benzothiazin-9-one (**1g**).

To a solution of 9.7 g (0.05 mole) of **3** in 20 ml of dimethylformamide was added dropwise 1.5 g (0.01 mole) of **4g** under stirring and cooling at 4°. The reaction mixture was then heated gently at 35° for 2 hours and after cooling poured into 100 ml of ice-water. The precipitate was collected and recrystallized twice from ethanol to afford 0.2 g (14%) of white crystals, mp 205-206°. This product gave all agreeable analytical data with those reported previously [1].

The combined mother liquid of **1g** was concentrated and then allowed to stand at 4° overnight. The precipitate formed was collected and recrystallized from ethanol to give 0.6 g (39%) of **5g**, mp 223-224°.

3-Chloromethyl-1,2,4-triazolo[3,4-*b*][1,3]benzothiazin-5-one (**2h**).

To a solution of 0.97 g (0.005 mole) of **3** in 20 ml of dimethylformamide was added dropwise 1.14 g (0.01 mole) of chloroacetyl chloride (**4h**) under cooling at 4°. The reaction mixture was stirred at room temperature, heated gently at 35° for 2 hours and then poured into 200 ml of ice-water. The precipitate was collected on a filter, washed with water and recrystallized from ethanol to afford 0.92 g (73%) of light yellow crystals, mp 160-161°, Rf 0.51; uv (ethanol): λ max (log ε) 223 (4.20), 240 (4.08), 311 (3.44) nm; λ min (log ε) 231 (4.00), 283 (3.00) nm; ir (potassium bromide): 3046, 3026 (=C-H), 1707 (C=O), 1588, 1465 (C=N/C=C), 1340 (C-N), 770 (C-Cl) cm^{-1}; ^1H nmr (DMSO-d_6): δ (ppm) 5.29 (s, 2H, CH_2Cl), 7.52-7.94 (m, 3H, ArH), 8.42-8.50 (m, 1H, H-6); ms: (70 eV) m/z 251 (M^+, 86), 216 (M-Cl, 100), 188 (M-ClCO, 30).

Anal. Calcd. for $C_{10}H_6ClN_3OS$: C, 47.72; H, 2.40; N, 16.70. Found: C, 47.75; H, 2.40; N, 16.72.

2-Chloroacetylhydrazono-3,4-dihydro-2*H*-1,3-benzothiazin-4-one (**5h**).

Repeating the above reaction but changing the conditions by stirring at 0-5° for 12 hours gave 0.3 g (22%) of yellow crystals, mp 205-206°, Rf 0.09; uv (ethanol): λ max (log ε) 225 (4.40), 269 (4.21) nm; λ min (log ε) 259 (4.20) nm; ir (potassium bromide): 3155 (N-H), 3011 (=C-H), 1691 (C=O), 1603, 1588 (C=N, C=C), 1345 (C-N) cm^{-1}; ^1H nmr (DMSO-d_6): δ (ppm) 4.19 (s, 2H, CH_2Cl), 7.33-7.70 (m, 3H, ArH), 8.06-8.14 (m, 1H, H-5), 10.58 (s, br, 1H, NH), 11.90 (s, br, 1H, NH); ms: (70 eV) m/z 269 (M^+, 38), 220 (M-CH_2Cl, 66), 192 (M-$COCH_2Cl$, 21), 136 (C_6H_4COS, 100).

Anal. Calcd. for $C_{10}H_8ClN_3O_2S$: C, 44.53; H, 2.99; N, 15.58. Found: C, 44.45; H, 2.87; N, 15.51.

The mother liquid of **5h** was concentrated and then allowed to stand at 4° overnight. The precipitate was collected and recrystallized from ethanol to give 0.2 g (18%) of **2h**, mp 160-161°.

2-(2-Chloropropionylhydrazono)-3,4-dihydro-2*H*-1,3-benzothiazin-4-one (**5i**).

To a solution of 0.97 g (0.05 mole) of **3** in 20 ml of dimethylformide was added dropwise 1.3 g (0.01 mole) of 2-chloropropionyl chloride (**4i**) under stirring at 5°. The reaction mixture was stirred at this temperature for 12 hours and then poured into 200 ml of ice-water. The precipitate was collected and recrystallized from ethanol to give 0.9 g (64%) of white needle crystals, mp 209-210°, Rf 0.24; uv (ethanol): λ max (log ε) 225 (4.45) nm; ir (potassium bromide): 3300-2800 (N-H), 3011 (=C-H), 1710, 1660 (C=O), 1610, 1590 (C=N/C=C), 1345 (C-N) cm^{-1}; ^1H nmr (DMSO-d_6): δ (ppm) 1.60 (d, 3H, CH_3, J = 6.6 Hz), 4.63 (q, 1H, CH, J = 6.6 Hz), 7.36-7.73 (m, 3H, ArH), 8.11-8.19 (m, 1H, H-5), 10.70 (s, 1H, NH), 11.90 (s, br, 1H, NH); ms: (70 eV) m/z 283 (M^+, 55), 248 (M-Cl, 10), 220 (M-$CHClCH_3$, 85), 192 (M-$COCHClCH_3$, 29), 136 (C_6H_4COS, 100).

Anal. Calcd. for $C_{11}H_{10}ClN_3O_2S$: C, 46.57; H, 3.55; N, 14.81. Found: C, 46.56; H, 3.55; N, 14.79.

3-(1-Chloroethyl)-1,2,4-triazolo[3,4-*b*][1,3]benzothiazin-5-one (**2i**).

The mother liquid of **5i** was concentrated under reduced pres-

sure to about 5 ml and the solid product was collected and recrystallized from ethanol to provide 0.15 g (12%) of white crystalline powder, mp 151-152°; Rf 0.55; uv (ethanol): λ max (log ε) 238 (4.46), 338 (3.63) nm; λ min (log ε), 288 (3.27) nm; ir (potassium bromide): 3097, 3057 (=C-H), 1700 (C=O), 1590, 1450 (C=N/-C=C), 1350 (C-N), 721 (C-Cl) cm^{-1}; ^1H nmr (DMSO-d_6): δ (ppm) 2.02 (d, 3H, CH_3, J = 7.0 Hz), 6.12 (q, 1H, CH, J = 7.0 Hz), 7.52-7.92 (m, 3H, ArH), 8.42-8.50 (m, 1H, H-8); ms: (70 eV) m/z 265 (M^+, 16), 230 (M-Cl, 100), 177 (M-CNCHClCH$_3$, 23), 136 (C_6H_4COS, 25).

Anal. Calcd. for $C_{11}H_8ClN_3OS$: C, 49.72; H, 3.03; N, 15.81. Found: C, 49.72; H, 3.04; N, 15.83.

2-(1-Chloroethyl)-1,2,4-triazolo[5,1-*b*][1,3]benzothiazin-9-one (**1i**).

Repeating the above reaction but heating the reaction mixture at 35° for 2 hours gave 0.4 g (31%) of **1i**, mp 179-180°. It gave all agreeable analytical data with those reported previously [1].

From the mother liquid, 0.15 g (12%) of **2i**, mp 151-152° was also isolated.

2-(Ethoxyoxalylhydrazono)-3,4-dihydro-2*H*-1,3-benzothiazin-4-one (**5j**).

To a solution of 0.97 g (0.005 mole) of **3** in 20 ml of dimethylformamide was added dropwise 1.4 g (0.01 mole) of ethyl oxalyl chloride (**4j**) under cooling at 4°. The reaction mixture was stirred at this temperature for 12 hours and then poured into 200 ml of ice-water. The precipitate formed was collected, washed with water and recrystallized from ethanol to afford 1.21 g (83%) of white crystals, mp 179-180°, Rf 0.10; uv (ethanol): λ max (log ε) 225 (4.41), 280 (4.08) nm; λ min (log ε) 267 (4.07) nm: ir (potassium bromide): 3358-3135 (N-H), 3060 (=C-H), 1695 (C=O), 1579, 1565 (C=N/C=C), 1255 (C-O) cm^{-1}; ^1H nmr (DMSO-d_6): δ (ppm) 1.31 (t, 3H, CH_3, J = 7.0 Hz), 4.36 (q, 2H, CH_2, J = 7.0 Hz), 7.40-7.67 (m, 3H, ArH), 8.13-8.20 (m, 1H, H-5), 12.80 (s, 1H, NH), 13.61 (s, 1H, NH); ms: (70 eV) m/z 293 (M^+, 18), 275 (M-H_2O, 25), 220 (M-$CO_2C_2H_5$, 45), 192 (M-$COCO_2C_2H_5$, 20), 136 (C_6H_4COS, 100).

Anal. Calcd. for $C_{12}H_{11}N_3O_4S$: C, 49.14; H, 3.78; N, 14.33. Found: C, 48.84; H, 3.73; N, 14.34.

3-(Ethoxyoxalyl)-2-(ethoxyoxalylhydrazono)-3,4-dihydro-2*H*-1,3-benzothiazin-4-one (**6**).

Repeating the above reaction by heating the reaction mixture at 35° for 2 hours gave 1.44 g of white crude product, which was recrystallized twice from ethanol to afford 0.43 g (22%) of white crystals, mp 184-185°, Rf 0.50; uv (ethanol): λ max (log ε) 225 (4.36) nm; ir (potassium bromide): 3370 (N-H), 3088 (=C-H), 1758, 1696 (C=O), 1580, 1565 (C=N/C=C), 1367 (C-N), 1235 (C-O) cm^{-1}; ^1H nmr (DMSO-d_6): δ (ppm) 1.24 (m, 6H, $2CH_3$), 4.30 (m, 4H, $2CH_2$), 7.38-7.80 (m, 3H, ArH), 8.08-8.18 (m, 1H, H-5), 9.57 (s, 1H, NH); ms: (70 eV) m/z 393 (M^+, 14), 320 (M-$CO_2C_2H_5$, 45), 247 (M-$2CO_2C_2H_5$, 20), 220 (M-$CO(CO_2C_2H_5)_2$, 100).

Anal. Calcd. for $C_{16}H_{15}N_3O_7S$: C, 48.85; H, 3.84; N, 10.68. Found: C, 48.75; H, 3.88; N, 10.57.

2-(Ethoxycarbonyl)-1,2,4-triazolo[5,1-*b*][1,3]benzothiazin-9-one (**1j**).

The combined mother liquid of **6** was concentrated and then allowed to stand at 4° overnight. The precipitate was collected and recrystallized from ethanol to give 0.2 g (14%) of faint yellow crystalline needles, mp 192-193°. This product gave all agreeable analytical data with those reported previously [1].

3-Hydroxy-1,2,4-triazolo[3,4-*b*][1,3]benzothiazin-5-one (**2k**).

To a solution of 0.97 g (0.005 mole) of **3** in 20 ml of dimethylformamide was added in small portions 1.62 g (0.01 mole) of *N,N'*-carbonyldiimidazole (**4k**) under cooling at 4°. The reaction mixture was stirred at room temperature overnight, then poured into 200 ml of ice-water and acidified with acetic acid. The precipitate was collected on a filter, washed with water and recrystallized from ethanol to produce 0.65 g (58%) of crystals, mp 242-243°, Rf 0.23; uv (ethanol): λ max (log ε) 221 (4.28), 239 (4.16), 304 (3.39) nm; λ min (log ε) 230 (4.14), 285 (3.26) nm; ir (potassium bromide): 3300-2700 (O-H), 1754 (C=O), 1534, 1440 (C=N/-C=C), 1295 (C-N) cm^{-1}; ^1H nmr (DMSO-d_6): δ (ppm) 7.42-7.80 (m, 3H, ArH), 8.22-8.30 (m, 1H, H-6), 12.27 (s, 1H, OH); ms: (70 eV) m/z 219 (M^+, 100), 190 (M-COH, 43), 162 (M-$CHON_2$, 16).

Anal. Calcd. for $C_9H_5N_3O_2S$: C, 49.30; H, 2.30; N, 19.16. Found: C, 49.38; H, 2.31; N, 19.19.

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