77153-05-0; **21c**, 77153-06-1; **22b**, 77153-07-2; **22c**, 77153-08-3; **22d**, 77153-09-4; **23b**, 77153-10-7; **23c**, 77153-11-8; **23d**, 77153-12-9; **24a**, 77153-13-0; **24b**, 77153-14-1; **25**, 77153-15-2; **26**, 77153-16-3; **27**, 77209-98-4; *N*-ethyl-*o*-toluamide, 57056-81-2; *N*-ethylacetamide, 625-50-3; *N*-ethylformamide, 627-45-2; acetamidine HCl, 124-42-5; propionamidine HCl, 3599-89-1; propionamidine, 39800-84-5; benzamidine HCl, 1670-14-0; benzoylbenzamidine, 16776-73-1; benzoylbenzamidine HCl, 38063-74-0; acetylbenzamidine HCl, 38063-68-2; benzoylacetamidine HCl, 38063-70-6; benzoylpropionamidine HCl, 77153-17-4; *N*-octadecanoylpropionamidine HCl, 77153-18-5; β-(*o*-toluoylamino)propionamidine HCl, 77172-39-5; β-amino-*N*-benzoylpropionamide, 77153-19-6; *N*-acetylbenzamide, 1575-95-7; β-(*p*-toluoylamino)propionamidine HCl, 20482-62-6; *N*-octanoyl-*N'*-ethylguanidine, 77153-20-9; 3-amino-*N*-acetylpropionamidine 2HCl, 77153-21-0; *N*-[3-[(*tert*-butoxycarbonyl)amino]-1,2,4-trimethyl-5-pyrroyl]propionamidine, 77153-22-1; 3-[(*tert*-butoxycarbonyl)amino]-5-carboxy-1,2,4-trimethylpyrrole hydroxybenzotriazolide derivative, 77153-23-2; *N*-octadecanoylpropionimide, 77153-24-3; propionitrile, 107-12-0; 2-methyl-2-imidazoline, 534-26-9; *N*-acetyl-*N'*-ethylguanidine HCl, 77153-25-4; *N*-benzoyl-*N'*-ethylguanidine, 77153-26-5; 3-aminopropionitrile fumarate, 1119-28-4; 3-(benzoylamino)propionitrile, 1131-83-5; dimethyl (tosylimino)dithiocarbonate, 2651-15-2; 4-[[[(aminoiminomethyl)amino]acetyl]amino]-*N*-[5-[[(3-amino-3-iminopropyl)amino]carbonyl]-1-methyl-1*H*-pyrrol-3-yl]-1-methyl-1*H*-pyrrole-2-carboramide 2HCl, 18133-22-7; ethylguanidine sulfate, 57989-90-9.

Thiocarbonyl Transfer Reagent Chemistry. 3. Selective Displacements with Formaldehyde Hydrazones and Other Nucleophiles[1]

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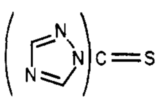
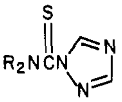
Formaldehyde hydrazones react with 1,1'-thiocarbonylbis(1,2,4-triazole) to effect C-thioacylation. The 1,2,4-triazole leaving group on these stable thioglyoxylic acid derivatives could in turn be displaced by hydrazones, sulfonohydrazides, thiosemicarbazides, and hydrazides.

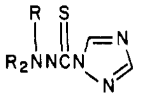
As part of a study on the reaction of amines and hydrazines with thiocarbonyl transfer reagent **1** (giving **2** and **3**, respectively), we wished to examine the analogous reaction with other nucleophiles. We now report that formaldehyde hydrazones (**4**) react cleanly with **1** to effect C-thioacylation giving **5**. The yields of these stable, novel derivatives of thioglyoxylic acid (CHOCSOH, **6**) averaged nearly 80%. Clearly, **4** reacts through carbon via intermediate **7** to displace 1,2,4-triazole as indicated in Scheme I. The reaction is somewhat analogous to an enamine acylation.[2] We have, however, found no literature example of acylations of formaldehyde hydrazones.[4]



1



2



3

The triazolyl leaving group in **1** appears to possess a unique reactivity in that when **4b** and **4c** were combined with 1,1'-thiocarbonylbisimidazole **8**, no reaction took place.[5]

Attempts to extend this reaction to other aldehyde hydrazones (e.g., acetaldehyde *N*,*N*-dimethylhydrazone (**9**)) failed; only starting materials were isolated. It was our expectation that the acetaldehyde derivative **9** might react more slowly than **4b**, but at this time we have no explanation regarding the complete lack of reactivity with reagent **1**.

Table I. Preparation of Hydrazones of Thioglyoxalyl-1,2,4-triazoles 5[a]

compd	mp, °C	% yield	^{1}H NMR, δ
$(i\text{-}C_3H_7)_2NN{=}CHCSTri$[b] (**5a**)	106-107	50	1.38 (d, 12 H, CH_3), 4.20 (sept, 2 H, CH), 8.02 (s, 1 H, triazole), 8.33 (s, 1 H, =CH), 9.27 (s, 1 H, triazole)
$(CH_3)_2NN{=}CHCSTri$ (**5b**)	134-135	96	3.40 (s, 6 H, CH_3), 8.13 (s, 1 H, triazole), 8.20 (s, 1 H, =CH), 9.33 (s, 1 H, triazole)
$(C_6H_5CH_2)_2NN{=}CHCSTri$ (**5c**)	108-109	82	4.83 (s, 4 H, CH_2), 7.33 (m, 10 H, C_6H_5), 8.00 (s, 1 H, triazole), 8.33 (s, 1 H, =CH), 9.23 (s, 1 H, triazole)

[a] Satisfactory analytical data (±0.3% for C, H, N) were reported for all compounds. [b] Tri = 1,2,4-triazoyl.

As expected from previous work,[5] **5a-c** (see Table I for physical data) are easily transformed by various amines and hydrazines to the corresponding thioamides and thiohydrazides (**10-13**, Table II). One reaction worthy of special note is that **5b** in its reaction with phenylhydrazine gives **14**. This product presumably arises by addition of a second molecule of phenylhydrazine to the C=N moiety followed by elimination of dimethylhydrazine. Finally, 1,2,4-triazole is displaced from **5b** and **5c** on treatment with

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[1] For Part 2 in this series, see: Larsen, C.; Harpp, D. N. *J. Org. Chem.* **1980**, *45*, 3713.

[2] House, H. O. "Modern Synthetic Reactions"; Breslow, R., Ed.; W. A. Benjamin: Menlo Park, CA, 1972; pp 766-772. Reagent 1 has been shown to react with enamines.[3]

[3] Larsen, C., unpublished results.

[4] One report has appeared concerning the reaction of formaldehyde hydrazones with acetic anhydride; however, the reactions were complex, and acylation did not take place on carbon. Lamberton, J. A.; Nelson, E. R; Triffett, A. C. K. *Aust. J. Chem.* **1974**, *27*, 1521.

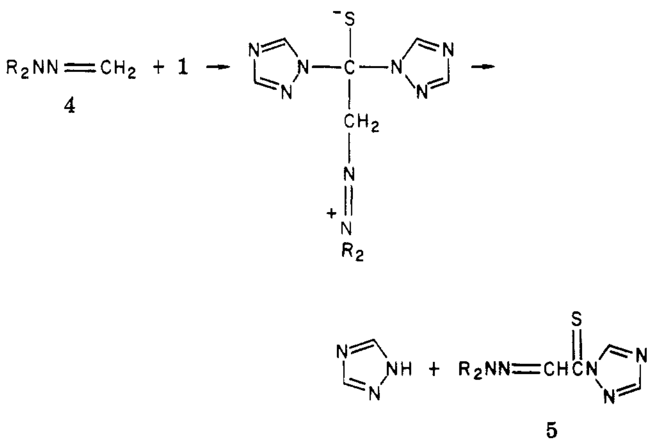
[5] Some of the special displacement reaction properties of reagent 1 have been published: Larsen, C.; Steliou, K.; Harpp, D. W. *J. Org. Chem.* **1978**, *43*, 337.

Table II. Reactions of 5 with Various Nucleophilic Reagents[a]

compd	mp, °C	% yield	^{1}H NMR, δ
$(CH_3)_2NN{=}CHCSNHCH_2C_6H_5$ (**10**)	111–112	81	3.08 (s, 6 H, CH_3), 5.03 (d, 2 H, CH_2), 7.07 (s, 2 H, CH), 7.47 (s, 5 H, arom), 8.58 (br s, 1 H, NH)
$(CH_3)_2NN{=}CHCSNHC_6H_5$ (**11**)	102–103	48	3.13 (s, 6 H, CH_3), 7.05 (s, 1 H, CH), 7.65 (m, 5 H, arom), 10.03 (br s, 1 H, NH)
$(CH_3)_2NN{=}CHCSNHNH_2$ (**12**)	165–166	72	3.10 (s, 6 H, CH_3), 4.77 (br s, 2 H, NH_2), 7.00 (s, 1 H, CH), 9.0 (br s, 1 H, NH)
$(C_6H_5CH_2)_2NN{=}CHCSNH_2$ (**13**)	141–142	90	4.70 (s, 4 H, CH_2), 7.16 (s, 1 H, CH), 7.38 (m, 10 H, arom), 8.03 (br s, 2 H, NH)
$C_6H_5NHNHCSCH{=}NNHC_6H_5$ (**14**)[b]	128–130	79	7.15 (m, 11 H, CH, arom), 8.08 (br s, 2 H, NH), 9.57 (br s, 1 H, NH)
$(CH_3)_2NN{=}CHCSNHN{=}C(C_6H_5)_2$ (**15**)	203–204	66	2.9 (s, 6 H, CH_3), 6.95 (s, 1 H, CH), 7.67 (m, 10 H, arom), 11.17 (br s, 1 H, NH)
$(CH_3)_2NN{=}CHCSNHNHO_2SC_6H_4CH_3$ (**16**)	156–157 dec	48	2.43 (s, 3 H, CH_3), 3.15 (s, 6 H, NCH_3), 6.8 (s, 1 H, CH), 7.62 (m, 4 H, arom), 8.9 (br s, 1 H, NH), 9.73 (br s, 1 H, NH)
$(CH_3)_2NN{=}CHCSNHNHCSNHC_2H_5$ (**17**)	141–142	47	1.27 (t, 3 H, CH_3), 3.13 (s, 6 H, CH_3), 3.67 (m, 2 H, CH_2), 6.9 (s, 1 H, CH), NH, baseline)
$(CH_3)_2NN{=}CHCSNHNHCOC_6H_5$ (**18**)	179–180	98	3.20 (s, 6 H, CH_3), 7.0 (s, 1 H, CH), 7.87 (m, 5 H, arom), 10.75 (s, 1 H, NH, NH, baseline)
$(i\text{-}C_3H_7)_2NN{=}CHCSNH_2$ (**19**)	76–78	89	1.23 (d, 6 H, CH_3), 3.93 (h, 1 H, CH), 7.00 (s, 1 H, =CH), 7.92 (br s, 2 H, NH)

[a] Satisfactory analyses were reported for all compounds. [b] Low-resolution mass spectrum gave a parent ion at *m/e* 270.

Scheme I



a, R = $(CH_3)_2CH$; b, R = CH_3; c, R = $C_6H_5CH_2$

less nucleophilic compounds such as hydrazones, sulfonohydrazides, thiosemicarbazides, and hydrazides to give **15–18**, respectively (Table II).

Experimental Section

Conditions and equipment used for the physical measurements were those described previously.[1]

***N,N*-Dimethylhydrazone of Thioglyoxalyl-1,2,4-triazole 5b.** To a stirred solution of formaldehyde, *N,N*-dimethylhydrazone (0.01 mol, 0.72 g) in CCl_4 (10 mL) was added a solution of **1** (0.01 mol, 1.8 g) in $CHCl_3$ (10 mL) dropwise over a 15-min period. After the addition was completed the stirring was continued for 1 h. The crystalline material was collected, suspended in ethanol, and filtered again to yield 1.75 g (96%) of red crystals which could be recrystallized from ethanol.

The same procedure was used for the preparation of **5a** and **5 c**.

General Procedure for Preparation of Compounds Listed in Table II. With the exception of the *N,N*-dimethylhydrazone of thioglyoxalic hydrazide, all the compounds could be prepared by adding the reagent to a hot solution of **5b** or **5c** in ethanol and heating the solution to the boiling point for 1 or 2 min (after which the red color had disappeared). After the mixture was cooled in ice–water the precipitated crystals could be collected. The products thus obtained were recrystallized from ethanol to give colorless or yellow crystals. In the case of the *N,N*-dimethylhydrazone of thioglyoxalic hydrazide the reagents were mixed in the cold, as heating caused evolution of hydrogen sulfide, resulting in the formation of a gum.

***N,N'*-Dibenzylhydrazone of Thioglyoxalyl-1,2,4-triazole 5c.** To a stirred solution of formaldehyde *N,N*-dibenzylhydrazone (0.01 mol, 2.24 g) in CCl_4 (15 mL) was added a solution of **1** (0.01 mol, 1.8 g) in CH_2Cl_2 (10 mL) dropwise. The strongly red-colored solution was filtered to give 0.60 g of triazole. The filtrate was evaporated in vacuo to give a red oil which crystallized upon standing. Addition of ethanol and filtration gave 2.75 g of red crystals.

Formaldehyde *N,N'*-Dibenzylhydrazone (4c).[6] To a stirred solution of *N,N*-dibenzylhydrazine (0.025 mol, 5.3 g) in methanol (15 mL) was added a solution of 37% formaldehyde in water (0.025 mol, 2.05 g). Ten minutes after addition was completed an exothermic reaction took place, and crystals separated. After 30 min the reaction mixture was cooled in ice–water and the crystals were filtered and dried (4.7 g). From the filtrate an additional 0.85 g was obtained by adding ca. 15 g of ice. Recrystallization from methanol gave 5.15 g (92%) colorless crystals with mp 47–47.5 °C.

Anal. Calcd for $C_{15}H_{16}N_2$: C, 80.32; H, 7.19; N, 12.49. Found: C, 80.34; H, 7.14; N, 12.53.

Acknowledgment. We thank the Natural Sciences and Engineering Research Council of Canada and the Danish Natural Science Research Council for financial support of this work.

Registry No. **1**, 63976-76-1; **4a**, 39837-46-2; **4b**, 2035-89-4; **4c**, 38663-41-1; **5a**, 77060-54-9; **5b**, 77060-55-0; **5c**, 77060-56-1; **10**, 77060-57-2; **11**, 77060-58-3; **12**, 77060-59-4; **13**, 77060-60-7; **14**, 77060-61-8; **15**, 77060-62-9; **16**, 77060-63-0; **17**, 77060-64-1; **18**, 77060-65-2; **19**, 77060-66-3; *N,N*-dibenzylhydrazine, 5802-60-8; formaldehyde, 50-00-0.

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(6) Norman, R. O. C.; Purchase, R.; Thomas, C. B.; Aylward, J. B. *J. Chem. Soc., Perkins Trans. 1* **1972**, 1692.