perature was allowed to rise to 0 °C and the mixture stirred for another 2 h. Enough dry benzene, saturated with hydrogen bromide, was added dropwise to bring the pH to 5 and stirring continued at 0 °C for 1 h. The mixture was poured into 100 mL of saturated sodium bicarbonate solution and extracted. Florisil chromatography and elution with 9:1 hexane–ethyl acetate yielded 82 mg (9%) of a mixture of cyanide **5** diastereomers and 250 mg (26%) of a colorless, crystalline **5** diastereomer: mp 238–240 °C (MeOH); UV λ_{max} 204 nm (log ϵ 4.25), 223 (4.46), 291 (4.51); IR [NH] 3460 (m), [C≡N] 2195 (w), [C=O] 1660 (s), 1610 (s), [C=C] 1585 (s) cm^{-1}; ^1H NMR δ 1.40 (t, 3 J = 7 Hz, Me), 2.84 (q, 2, J = 7 Hz, SCH_2), 3.14 (t, 1, J = 5 Hz, allyl H), 3.72 (s, 3, OMe), 4.29 (d, 1, J = 5 Hz, SCH), 5.06 (dd, 1, J = 11, 2 Hz, NCH), 7.13 (t, 1, J = 7 Hz, H-11), 7.20 (t, 1, J = 7 Hz, H-10), 7.36 (d, 1, J = 7 Hz, H-9), 7.49 (d, 1, J = 7 Hz, H-12), 7.74 (s, 1, olefinic H); exact mass, m/e 381.1510 (calcd for $C_{21}H_{23}O_2N_3S$ m/e 381.1509).

Ester 8b. A Raney nickel slurry in water (12 mL of 50%, pH 10) was washed three times with 60 mL of water each, 50 mL of methanol each, and 50 mL of acetone each and a suspension of the solid in 50 mL of acetone refluxed for 0.5 h. The solvent was decanted and a solution of 1.153 g (2.6 mmol) of ester **8a** in 35 mL of methanol and 35 mL of acetone added to the residue. The stirring suspension was refluxed for 1.5 h and filtered. The precipitate was washed exhaustively with methanol and the combined filtrate and washings evaporated to dryness. The residue was taken up with methylene chloride and washed with saturated ammonium chloride solution and brine. The organic solution was dried and evaporated, leaving 1.010 g (99%) of colorless, crystalline ester **8b**: mp 192–193 °C (MeOH); UV λ_{max} 224 nm (log ϵ 4.45), 356 (4.62); IR [NH] 3460 (m), [C=O] 1725 (s), 1680 (s), 1610 (s), [C=C] 1580 (s), 1560 (s) cm^{-1}; ^1H NMR δ 1.33 (t, 3, J = 7 Hz, Me), 1.82 (m, 1, ring D CH_2 α-H), 2.33 (dd, 1, J = 11, 4 Hz, $COCH_2$ H), 2.40 (br d, 1, J = 17 Hz, ring D CH_2 β-H), 2.81 (m, 1, $COCH_2$ H), 2.84 (m, 2, ring C CH_2), 3.13 (br d, 1, J = 6 Hz, allyl H), 3.55 (d, 2, J = 7 Hz, NCH_2), 3.72 (s, 3, OMe), 4.22 (q, 2, J = 7 Hz, OCH_2), 4.59 (br d, 1, J = 12 Hz, NCH), 5.46 (d, 1, J = 15 Hz, acrylic α-H), 6.61 (s, 1, olefinic NCH), 7.10 (t, 1, J = 7 Hz, H-11), 7.17 (t, 1, J = 7 Hz, H-10), 7.26 (d, 1, J = 15 Hz, acrylic β-H), 7.31 (d, 1, J = 7 Hz, H-9), 7.47 (d, 1, J = 7 Hz, H-12); exact mass, m/e 394.1879 (calcd for $C_{23}H_{26}O_4N_2$ m/e 394.1891).

Urethane Vinylogues 10,11, and 12. A solution of 40 mg (0.10 mmol) of cyanide **5** in 3 mL of freshly distilled trifluoroacetic acid (de-aired by argon) was stirred under nitrogen at room temperature for 2 h. It was diluted with 100 mL of methylene chloride, washed thoroughly with water, 10% sodium hydroxide solution, and brine, dried, and evaporated, yielding 39 mg (99%) of colorless, crystalline nitrile **10**: mp 106–108 °C (Et_2O); UV λ_{max} 223 nm (log ϵ 4.69), 292 (4.72); IR [NH] 3460 (m), [C=O] 1660 (s), 1610 (s) cm^{-1}; ^1H NMR δ 1.25 (t, 3, J = 7 Hz, Me), 1.90 (m, 1, ring D CH_2 α-H), 2.65 (m, 1, ring D CH_2 β-H), 2.69 (q, 2, J = 7 Hz, SCH_2), 3.10 (m, 1, allyl H), 3.62 (s, 3, OMe), 4.32 (br d, 1, J = 11 Hz, NCH), 5.01 (d, 1, J = 4 Hz, SCH), 7.12 (t, 1, J = 7 Hz, H-11), 7.19 (t, 1, J = 7 Hz, H-10), 7.34 (d, 1, J = 7 Hz, H-9), 7.48 (d, 1, J = 7 Hz, H-12), 7.68 (s, 1, olefinic H); exact mass, m/e 381.1531 (calcd for $C_{21}H_{23}O_2N_2S$ m/e 381.1509).

A solution of 110 mg (0.30 mmol) of ester **6** in 4 mL of freshly distilled trifluoroacetic acid (de-aired by argon) was stirred under nitrogen at room temperature for 2 h. Workup as above, chromatography of the crude product on silica gel and elution with 6:1 hexane–ethyl acetate gave 88 mg (80%) colorless, amorphous ester **11**: UV λ_{max} 223 nm (log ϵ 4.37), 292 (4.40); IR [NH] 3460 (m), [C=O] 1720 (s), 1690 (s), 1670 (s), 1610 (s) cm^{-1}; ^1H NMR δ 1.25 (t, 3, J = 7 Hz, Me), 1.69 (dd, 1, J = 15, 11 Hz, α-keto H), 2.20, 2.42 (m, 1 each, ring D CH_2), 2.94 (dd, 1, J = 15, 3 Hz, α-keto H), 3.08 (m, 1, allyl H), 3.67 (s, 3, OMe), 4.15 (q, 2, J = 7 Hz, OCH_2), 4.61 (br s, 1, NCH), 7.09 (t, 1, J = 7 Hz, H-11), 7.14 (t, 1, J = 7 Hz, H-10), 7.34 (d, 1, J = 7 Hz, H-9), 7.45 (d, 1, J = 7 Hz, H-12), 7.53 (s, 1, olefinic H); exact mass, m/e 368.1740 (calcd for $C_{21}H_{24}O_4N_2$ m/e 368.1733).

A mixture of 80 mg (0.21 mmol) of nitrile **10** and a Raney nickel slurry (1 mL of 50%, pH 10), pretreated as in the above preparation of ester **8b**, in 10 mL of methanol and 10 mL of acetone was stirred and refluxed for 1.5 h. The suspension was filtered through a Celite pad and the filtrate evaporated to dryness. Chromatography of the residue on Florisil and elution with 9:1 hexane–ethyl acetate yielded 43 mg (61%) of colorless, amorphous, solid cyanide **12**: IR [NH] 3460 (m), [C=O] 1675 (s), 1610 (s) cm^{-1}; ^1H NMR δ 2.00 (d, 2, J = 6 Hz, $NCCH_2$), 2.15, 2.60 (m, 1 each, ring D CH_2), 3.62 (s, 3, OMe), 4.57 (br s, 1, NCH), 7.12 (t, 1, J = 7 Hz, H-11), 7.20 (t, 1, J= 7 Hz, H-10), 7.38 (d, 1, J = 7 Hz, H-9), 7.47 (d, 1, J = 7 Hz, H-12), 7.57 (s, 1, olefinic H); exact mass, m/e 321.1475 (calcd for $C_{19}H_{19}O_2N_3$ m/e 321.1477).

Tetracycles 19, 20, 21, and 22. A stirring solution of 364 mg (0.99 mmol) of ester **6** in 8 mL of trifluoroacetic acid was exposed to a slow stream of air and the stirring continued at room temperature for 2 h. Workup as above gave 325 mg (90%) of colorless, foamy ester **19**: UV λ_{max} 209 nm (log ϵ 4.15), 262 (4.02), 310 (4.23); IR [NH] 3460 (m), [C=O] 1720 (s), 1670 (s), 1605 (s) cm^{-1}; ^1H NMR δ 1.21 (t, 3, J = 7 Hz, Me), 2.41 (dd, 1, J = 9, 5 Hz, α-keto H), 2.70 (dd, 1, J = 15, 4 Hz, α-keto H), 3.71 (s, 3, OMe), 3.96 (m, 1, allyl H), 4.11 (q, 2, J = 7 Hz, OCH_2), 5.32 (d, 1, J = 5 Hz, olefinic H), 7.04 (t, 1, J = 7 Hz, H-11), 7.13 (t, 1, J = 7 Hz, H-10), 7.26 (d, 1, J = 7 Hz, H-9), 7.31 (s, 1, olefinic NCH), 7.42 (d, 1, J = 7 Hz, H-12); exact mass (M^+ – H), m/e 365.1476 (calcd for $C_{21}H_{21}O_4N_2$ m/e 365.1451).

The same reaction with 140 mg (0.33 mmol) of chloride **7** in 10 mL of trifluoroacetic acid afforded 133 mg (96%) of yellow, amorphous chloride **20**: UV λ_{max} 210 nm (log ϵ 4.34), 258 (4.06), 311 (4.46), 369 (4.23); IR [NH] 3460 (m), [C=O] 1700 (s), 1660 (s), 1610 (s), [C=C] 1590 (s), 1570 (m), 1550 (s) cm^{-1}; ^1H NMR δ 3.65 (s, 3, OMe), 4.68 (d, 1, J = 6 Hz, allyl H), 5.74 (d, 1, J = 6 Hz, olefinic H), 5.97 (d, 1, J = 15 Hz, acryl α-H), 7.04 (t, 1, J = 7 Hz, H-11), 7.19 (t, 1, J = 7 Hz, H-10), 7.40 (d, 1, J = 7 Hz, H-9), 7.51 (d, 1, J = 15 Hz, acryl β-H), 7.53 (d, 1, J = 7 Hz, H-12), 7.58 (s, 1, olefinic NCH).

The same reaction with 34 mg (0.086 mmol) of ester **8b** in 4 mL of trifluoroacetic acid led to 31 mg (91%) of yellow, foamy ester **21**: UV λ_{max} 208 nm (log ϵ 4.33), 311 (4.42), 318 (4.44), 391 (4.09); IR [NH] 3460 (m), [C=O] 1720 (s), 1670 (s), 1600 (s), [C=C] 1560 (s) cm^{-1}; ^1H NMR δ 1.26 (t, 3, J = 7 Hz, Me), 2.38 (dd, 1, J = 16, 8 Hz, α-keto H), 2.74 (dd, 1, J = 16, 3 Hz, α-keto H), 3.74 (s, 3, OMe), 3.95 (m, 1, allyl H), 4.15 (q, 2, J = 7 Hz, OCH_2), 5.25 (d, 1, J = 5 Hz, olefinic H), 5.64 (d, 1, J = 15 Hz, acryl α-H), 6.52 (s, 1, olefinic NCH), 7.10 (t, 1, J = 7 Hz, H-11), 7.20 (t, 1, J = 7 Hz, H-10), 7.31 (d, 1, J = 15 Hz, acryl β-H), 7.32 (d, 1, J = 7 Hz, H-9), 7.48 (d, 1, J = 7 Hz, H-12); exact mass, m/e 392.1722 (calcd for $C_{23}H_{24}O_4N_2$ m/e 392.1736).

The same reaction with 375 mg (1.05 mmol) of cyanide **9** in 10 mL of trifluoroacetic acid yielded 317 mg (87%) of yellow, foamy cyanide **22**: UV λ_{max} 206 nm (log ϵ 4.35), 309 (4.31), 318 (4.30), 389 (3.98); IR [NH] 3460 (m), [C≡N] 2240 (w), [C=O] 1680 (s), 1660 (s), [C=C] 1580 (s), 1550 (m) cm^{-1}; ^1H NMR δ 1.31 (t, 3, J = 7 Hz, Me), 2.4–2.6 (m, 2, $NCCH_2$), 2.92 (t, 2, J = 6 Hz, benzyl Hs), 3.5–3.7 (m, 2, NCH_2), 3.85 (m, 1, allyl H), 4.22 (q, 2, J = 7 Hz, OCH_2), 5.20 (d, 1, J = 5 Hz, olefinic H), 5.54 (d, 1, J = 15 Hz, acryl α-H), 6.56 (s, 1, olefinic NCH), 7.10 (t, 1, J = 7 Hz, H-11), 7.20 (t, 1, J = 7 Hz, H-10), 7.32 (d, 1, J = 15 Hz, acryl β-H), 7.33 (d, 1, J = 7 Hz, H-9), 7.47 (d, 1, J = 7 Hz, H-12); exact mass (M^+ + H, by FAB), m/e 360.1706 (calcd for $C_{22}H_{22}O_2N_3$ m/e 360.1712).

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Synthesis of a Novel Thiadiazacyclazine

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Cyclazines, tricyclic compounds containing a central ring nitrogen and conjugated perimeter, continue to be the

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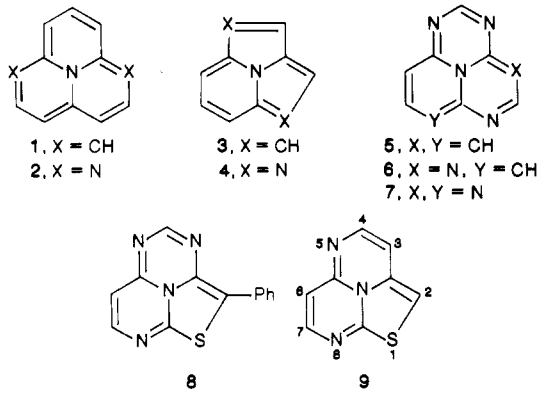
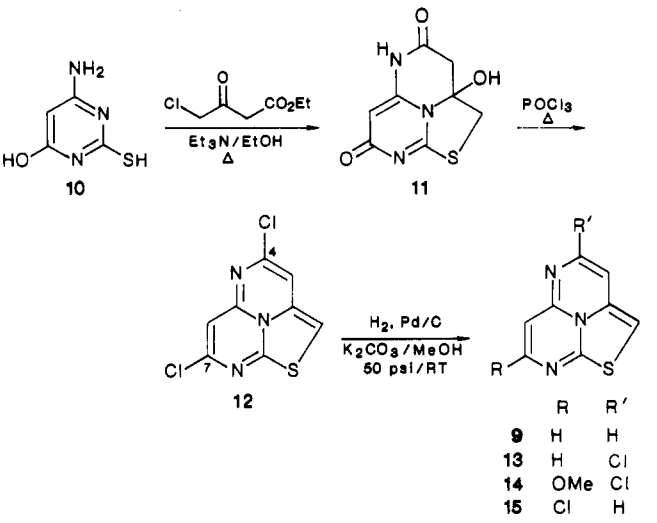
subject of a considerable amount of synthetic effort due to interest in their aromatic properties.[1] At this time, most reported cyclazines have either carbocyclic or nitrogen-containing perimeters.[2] Some examples of synthesized cyclazines are compounds 1–8. Cycl[3.3.3]azine (1)[3] and



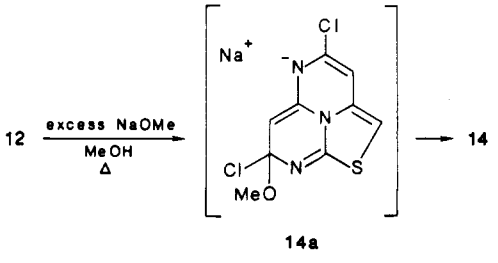
the corresponding diazacyclazine 2[1c] are unstable "anti-aromatic" ring systems which are highly reactive compounds exhibiting strong paramagnetic shifts in the ^1H NMR signals and very high susceptibility toward air-oxidation. On the other hand, cycl[3.2.2]azine (3)[4] and the azacyclazines 4–7[1a,2d] (having more than two perimeter ring nitrogens in the azacycl[3.3.3]azine series) are stable compounds having aromatic properties. Ceder and co-workers[5] previously synthesized the phenyl-substituted thiatriazacyclazine 8 and found it also to be a stable compound although in this case the unsubstituted ring system was not prepared.

Campaigne[6,7] et al. reported that heating 4-amino-6-hydroxy-2-mercaptopyrimidine (10) and ethyl 4-chloroacetoacetate in triethylamine/ethanol gave the tricyclic carbinolamine 11 (Scheme I) in 71% yield. Although tricyclic with a central ring nitrogen, no attempt was made at that point to convert 11 into a cyclazine. I have now found that heating this key intermediate (11) in excess phosphorus oxychloride results in both dehydration and chlorination in one step to give the maroon-colored dichlorothiadiazacyclazine 12 directly in 32% yield. Although zinc/acetic acid reduction was unsuccessful, catalytic hydrogenolysis of the chlorines, whereby excess palladium on carbon in potassium carbonate/methanol (50 psi, room temperature, 2 h) was used to overcome a certain amount of catalyst poisoning from the sulfur, did afford the unsubstituted maroon-colored thiadiazacyclazine ring system 9 in 35% yield. Two side products also obtained were a purple-colored monochlorothiadiazacyclazine (12% yield) and a brick red colored chloromethoxythiadiazacyclazine (3% yield), which were assigned structures 13 and 14, respectively. All of these were separated by silica gel column chromatography.

Scheme I



Compound 14 was also prepared in higher yield (61%) by heating 12 with excess sodium methoxide (~3 equiv) in methanol. The more easily displaced chlorine should be that at C-7, directly conjugated with a perimeter ring nitrogen, since the stabilized intermediate 14a would arise after initial attack of the ring by methoxide. Formation of such an intermediate would not be possible with attack of the other chlorinated position on 12 by methoxide. This chlorine would also be more susceptible to catalytic hydrogenolysis than the one at C-4, due again to its direct conjugation with a ring nitrogen, thus explaining the isolation of some 13 rather than 15. The structural assignment of 13 was also supported by NMR. The C-6 ring proton of 13 which came as a doublet at 5.51 ppm was shifted slightly upfield relative to the same C-6 proton on 12 which came as a singlet at 5.54 ppm. One would expect this with loss of the adjacent chloro substituent. Structure 15 was able to be ruled out since one would have to otherwise assume that the C-3 ring proton of 12 which came as a singlet at 5.37 ppm was shifted downfield in 15 to give a doublet at 5.51 ppm with loss of an adjacent electron-withdrawing chloro substituent which typically would not occur.



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(6) Campaigne, E.; Huffman, J. C.; Selby, T. P. *J. Heterocycl. Chem.* **1979**, *16*, 725. It was found that optimum yields of 11 could be obtained by adding the ethyl 4-chloroacetoacetate to a mixture of 10 and triethylamine already stirring in the ethanol solvent before heating at reflux. This minimized formation of the side product diethyl 3,6-dihydroxycyclohexadiene-1,4-dicarboxylate resulting from the self-condensation of ethyl 4-chloroacetoacetate in the presence of base. Heating the reaction at reflux for only 18 h rather than the originally reported 40 h also gave satisfactory yields of product and washing the crude isolated material with ethanol followed by methylene chloride was helpful in removing impurities, particularly diethyl 3,6-dihydroxycyclohexadiene-1,4-dicarboxylate so that the compound could be used directly in the next step without further purification.

(7) The author wishes to acknowledge Professor Emeritus of Chemistry, E. Campaigne, Indiana University, for his previous work in this area which was key to the eventual synthesis of this thiadiazacyclazine.

Simple HMO calculations on **9** using Extended Hückel Theory[8] indicated that electron charge density of the ring positions available for electrophilic substitution would be greatest on the carbon adjacent to the sulfur rather than the available enamine positions and would thus be the most likely position to undergo electrophilic substitution. Attempted bromination or reaction with diethyl acetylenedicarboxylate, however, resulted only in complex mixtures along with a certain amount of decomposition.

The chemical shift range for the protons on **9** was 6.96–4.95 ppm, significantly upfield from the general aromatic range of protons on an isolated pyrimidine or thiazole ring as well as the "aromatic" cyclazines **3–7**. These ring protons all generally absorb near or above 7.0 ppm. On the other hand, the chemical shift range for the protons on **9** did not come as far upfield as the protons on the known unstable "antiaromatic" cyclazines **1** (3.65–2.07 ppm) and **2** (6.10–3.90 ppm) which support paramagnetic ring currents. These NMR comparisons and the fact that **9** was inert to air-oxidation both as a solid and in solution suggested that **9** was actually a stable although "borderline" aromatic/nonaromatic ring system.

Experimental Section

All melting points were determined on a Thomas-Hoover Uni-Melt apparatus and are uncorrected. Infrared spectra were recorded on a Perkin-Elmer 783 spectrophotometer and NMR spectra were recorded on a Varian XL-200 spectrometer. Chemical shifts are expressed in parts per million downfield from Me_4Si. Low-resolution mass spectra were obtained on DuPont Model 21-492 spectrometer. Analytic TLC was performed on Merck silica gel 60-F254 precoated (0.25-mm thickness) glass plates. Elemental analyses were carried out by the Analytical Section of the Agricultural Products Department, E.I. Du Pont de Nemours & Company, Experimental Station, Wilmington, DE.

4,7-Dichloro-1-thia-5,8b-triazaacenaphthylene (12). To a thoroughly dried sample of **11** (16.0 g, 7.1 mmol) was added 50 mL of phosphorus oxychloride, and the mixture was heated at reflux for 30 min. Heating longer generally resulted in significantly lower yields due to gradual decomposition. The dark reaction mixture was poured, while still hot, onto excess ice. The resulting suspension was stirred and the remaining ice allowed to melt. CH_2Cl_2 (400 mL) was added, and the solution was stirred well and filtered to remove insoluble brown material. The CH_2Cl_2 extract was separated, washed with H_2O (2×), saturated $NaHCO_3$, and brine, and dried ($MgSO_4$). Evaporation of solvent in vacuo gave 5.5 g (32%) of **12**, a maroon solid which was recrystallized from *n*-butyl chloride: mp 180–183 °C dec; IR (Nujol) 1615, 1580 cm^{-1} (C=N); ^1H NMR ($CDCl_3$) δ 5.12 (s, 1 H), 5.37 (s, 1 H), 5.54 (s, 1 H); MS(EI), m/z 243 (M^+). Anal. Calcd for $C_8H_3Cl_2N_3S$: C, 39.36; H, 1.24; N, 17.22. Found: C, 39.38; H, 1.39; N, 16.98.

1-Thia-5,8,8b-triazaacenaphthylene (9), 4-Chloro-1-thia-5,8,8b-triazaacenaphthylene (13), and 4-Chloro-7-methoxy-1-thia-5,8,8b-triazaacenaphthylene (14). To a 4.0 g (1.6 mmol) of **12** and 6.0 g (4.3 mmol) of anhydrous potassium carbonate in 200 mL of methanol in a Parr bottle was added 4.0 g of 10% Pd/C, and the mixture was hydrogenated in a Parr apparatus (45–40 psi) at room temperature for 2 h. The mixture was filtered through Celite and concentrated in vacuo. H_2O (200 mL) was added, and the solution was extracted with 300 mL of CH_2Cl_2. The CH_2Cl_2 extract was washed with H_2O and brine, dried ($MgSO_4$), and evaporated in vacuo to give a dark solid which was shown to be a mixture of three major components (also a trace of starting material **12**) on TLC (1:1 CH_2Cl_2/EtOAc): R_f 0.68, 0.39, and 0.05. These three commpounds were separated by gravity silica gel column chromatography using initially 5:1 followed by 2:1 CH_2Cl_2/EtOAc followed in turn by straight EtOAc. Compound **14**, the first to elute, was isolated as a brick red colored solid (120 mg, 3%), compound **13**, a purple solid (400 mg, 12%), eluted next, and compound **9** (1.0 g, 35%), isolated as a maroon solid, eluted last. Only in the case of **9** was recrystallization from *n*-butyl chloride necessary to give an analytically pure sample. **9**: mp 117–119 °C dec; IR (Nujol) 1620, 1575, 1530 cm^{-1} (C=N, C=C); ^1H NMR ($CHCl_3$) δ 4.95 (s, 1 H), 5.23 (d, J = ~7 Hz, 1 H), 5.38 (d, J = ~7 Hz, 1 H), 6.21 (d, J = ~7 Hz, 1 H), 6.94 (d, J = ~7 Hz, 1 H); MS(EI), m/z 175 (M^+). Anal. Calcd for $C_8H_5N_3S$: C, 54.83; H, 2.88; N, 23.99. Found: C, 54.98; H, 2.92; N, 23.82. **13**: mp 195–200 °C dec; IR (Nujol) 1645, 1620, 1585, 1535 cm^{-1} (C=N, C=C); ^1H NMR ($CDCl_3$) δ 4.98 (s, 1 H), 5.30 (s, 1 H), 5.49 (d, J = ~6 Hz, 1 H), 7.10 (d, J = ~6 Hz, 1 H); MS(EI), m/z 209 (M^+). Anal. Calcd for $C_8H_4ClN_3S$: C, 45.83; H, 1.93; N, 20.05. Found: C, 45.82; H, 2.02; N, 19.99. **14**: mp 196–201 °C dec; IR (Nujol) 1645, 1625, 1595, 1540 cm^{-1} (C=N, C=C); ^1H NMR ($CDCl_3$) δ 3.77 (s, 34), 5.07 (s, 1 H), 5.08 (s, 1 H), 5.28 (s, 1 H). Anal. Calcd for $C_9H_6N_3ClOS$: C, 45.10; H, 2.53; N, 17.54. Found: C, 44.82; H, 2.61; N, 17.41.

Compound **14** was also prepared in higher yield by the following procedure. To 400 mg (1.7 mmol) of sodium metal dissolved in 30 mL of methanol was added 1.0 g (0.4 mmol) of **12** and the mixture was heated at reflux overnight. Glacial AcOH (2.0 mL) was added, followed by 100 mL of H_2O, and the solution was extracted with 250 mL of CH_2Cl_2. The CH_2Cl_2 extract was washed with H_2O (2×) and brine, dried ($MgSO_4$), and evaporated in vacuo to give a solid (0.6 g, 61%) which was recrystallized from CH_3CN/DMF to give a brick red colored sample of **14**. This compound migrated the same distance on TLC and had the same NMR and IR spectra as **14** obtained in the catalytic reduction above. Due to the instability of **14** on setting in $CDCl_3$ solution, the NMR spectrum was taken immediately after dissolving the sample.

(8) HMO calculations were carried out by using Extended Hückel Theory from *Chem Graf*, Molecular Design, Inc. Of the ring positions on **9** that would be expected to undergo electrophilic substitution, the thiazole ring position adjacent to sulfur was found to have an electron charge density of −0.37 versus values of −0.10 and −0.16 for the two available enamine positions on the pyrimidine rings.