ethylamine. After 5 min the mixture was poured into 100 mL of H_2O and 100 mL of CH_2Cl_2 and the phases were separated. The aqueous layer was extracted with CH_2Cl_2 and the solvent was removed from the combined, washed (H_2O) and dried organic solutions. Chromatography (silica gel column, 50:1 CH_2Cl_2–acetone) separated a yellow-orange solid which on rechromatography (silica gel plate, CH_2Cl_2) gave two fractions. The first yielded 11.3 mg (10.3%) of unchanged **1**: mp 123–125 °C (lit.[15] 128–129 °C); UV and visible spectrum identical with those of authentic sample. The second gave 10.5 mg (7.17%) of yellow solid, mp 152–154 °C, indicated to be a 3:1 mixture of **3** and **2** by its spectra: NMR (acetone) δ 9.63 (s, 3, H-4, **3**), 9.47 (s, 1, H-4, **2**), 9.35 (s, 1, H-1, **3**), 9.08 (s, 1, H-1, **2**), 7.86 (d, 3, H-6, **3**, J = 4 Hz), 7.73 (d, 1, H-6, **2**, J = 4 Hz), 6.80 (d, 1, H-7, **2**, J = 4 Hz), 6.70 (d, 3, H-5, **2**, J = 4 Hz), 4.53 (s, 9, N-CH_3, **3**), and 4.45 ppm (s, 3, N-CH_3, **2**); UV (ether) (D_{max}) 267 (1.58), 292 (0.80), 338 (0.97), 350 (sh, 0.84) 408 (1.10), and after dilution 243 (0.77) and 267 nm (0.40).

Reaction of 5,7-Dibromo-2-methyl-2*H*-cyclopenta[*d*]pyridazine with Silver Nitrite. A mixture of 69.6 mg (0.24 mmol) of the 5,7-dibromo compound[9] and 223.5 mg (1.45 mmol) of $AgNO_2$ in 5 mL of Me_2SO was heated (steam bath) under N_2 for 48 h and then shaken with 125 mL of H_2O and 30 mL of CH_2Cl_2. The separated aqueous layer was extracted with CH_2Cl_2 and the solvent was removed from the combined, washed (H_2O), dried, and filtered organic solutions. Chromatography (silica gel column, CH_2Cl_2) of the residue separated a yellow band which yielded 48.2 mg (78.5%) of yellow solid, mp 236–238 °C dec, indicated to be a 1:1 mixture of **4** and **5** by its spectra: NMR (Me_2SO) δ, 9.85 (s, 1 H), 9.55 (s, 1 H), 9.47 (s, 1 H), 9.08 (s, 1 H), 7.93 (s, 1 H), 7.82 (s, 1 H), 4.44 (s, 3 H) and 4.40 ppm (s, 3 H); UV (ether) ($\epsilon \times 10^{-3}$) 249 (18), 274 (12), 362 (sh 4.7), and 408 nm (6.7). Anal. Calcd for $C_8H_6N_3O_2Br$: C, 37.50; H, 2.34. Found: C, 37.66; H, 2.50.

Reaction of 5,7-Diiodo-2-methyl-2*H*-cyclopenta[*d*]pyridazine with Silver Nitrite. To a solution of the 5,7-diodo compound[9] prepared from the reaction of 31.9 mg (0.27 mmol) of **1** and 241.9 mg (1.06 mmol) of NIS in 11 mL of CH_2Cl_2 was added 5 mL of Me_2SO and a large excess of $AgNO_2$. The procedure (above) for the reaction with the 5,7-dibromo compound was followed except the reaction time was 4.5 h. The yellow solid (28.1 mg, 38.6% yield from **1**), mp 214–215 °C, was indicated to be a 1:1 mixture of **6** and **7** by its spectra: NMR (trifluoroacetic acid) δ 9.54 (s, 1 H), 8.95 (s, 0.5 H), 8.85 (s, 0.5 H), 8.07 (s, 0.5 H), 7.97 (s, 0.5 H), and 4.62 ppm (s, 3 H); UV (ether) ($\epsilon \times 10^{-3}$) 250 (16), 275 (13), 365 (4), and 410 nm (6.2). Anal. Calcd for $C_8H_6N_3O_2I$: C, 31.68; H. 1.98; N, 13.85. Found: C, 31.83; H, 2.11; N, 13.70.

5,7-Di(acetoxymercuri)-2-methyl-2*H*-cyclopenta[*d*]pyridazine (8). A mixture of 190.2 mg (0.597 mmol) of mercuric acetate and 35.8 mg (0.271 mmol) of **1** in 7 mL of methanol was stored in the dark for 18 h. The dried yellow crystals which formed amounted to 112.6 mg (65%) of **8** after washing with methanol and ether: darkening above 100 °C but no melting up to 265 °C; NMR (Me_2SO) δ 9.14 (s, 1 H), 8.92 (s, 1 H), 7.27 (broad, 1 H), and 4.19 ppm (s, 3 H); UV (THF) (D_{max}) 321 (1.74), 322 (1.80), 389 (0.41), and after dilution 260 nm. Anal. Calcd for $C_{12}H_{12}N_2O_4Hg_2$: C, 22.19; H, 1.89; N, 4.31. Found: C, 22.28; H, 2.15; N, 4.41.

Reaction of 1 with Tetracyanoethene. The addition of a mixture of 296 mg (2.24 mmol) of **1** and 10 mL of benzene to 283 mg (2.21 mmol) of tetracyanoethene in 10 mL of benzene at reflux temperature caused immediate darkening of the solution. After the addition of 3 drops of pyridine and 45 min under reflux, removal of the solvent and chromatography (silica gel column, 1:1 dry ether–ethyl acetate) gave as the first fraction 213 mg (41%) of **9** as maroon crystals, mp 244–248 °C after recrystallization from ethyl acetate and 247–248 °C after two further recrystallizations from acetone: NMR (acetone, CAT) 9.56 (s, 1 H), 9.09 (s, 1H), 8.29 (d, 1 H, J = 4.5 Hz), 7.06 (d, 1 H, J = 4.5 Hz), and 4.59 (s, 3 H); UV (ether)(D_{max}) 496 (0.70), 469 (0.44), 388 (0.09), and 261 nm (0.30); IR ($HCCl_3$) 2203 cm^{-1} (CN). Anal. Calcd for $C_{13}H_7N_5$: C, 66.95; H, 3.02; N, 30.03. Found: C, 66.96; H, 3.28; N, 30.21.

The second fraction was a mixture of **9** and other compounds and, after **9** was absent (TLC), 29.3 mg of red solid was obtained which after rechromatography (ethyl acetate) gave 18.6 mg (4%) of crystals, mp 227–231 °C, partially characterized as **10**: mp 229–230 °C after recrystallization from acetone; NMR (acetone, CAT) δ 9.51 (s, 1 H), 9.37 (s, 1 H), 8.12 (d, 1 H, J = 5 Hz), 7.07 (d, 1 H, J = 5 Hz), and 4.52 (s, 3 H); UV (ether)(D_{max}) 477 (0.26) and 4.54 nm (0.18); IR ($HCCl_3$) 2197 cm^{-1} (CN); mass spectrum m/e 233.076 (calcd for $C_{13}H_7H_5$: 233.070).

Registry No.—**1**, 22291-85-6; **2**, 65275-84-5; **3**, 65275-85-6; **4**, 65275-86-7; **5**, 65275-87-8; **6**, 65275-88-9; **7**, 65275-89-0; **8**, 65275-90-3; **9**, 65275-91-4; **10**, 65275-92-5; $AgNO_2$, 7783-99-5; 7-bromo-2-methyl-2*H*-cyclopenta[*d*]pyridazine, 55268-19-4; tetranitromethane, 509-14-8; 5,7-dibromo-2-methyl-2*H*-cyclopenta[*d*]pyridazine, 55268-20-7; 5,7-diodo-2-methyl-2*H*-cyclopenta[*d*]pyridazine, 55268-23-0; mercuric acetate, 1600-27-7; tetracyanoethene, 670-54-2.

References and Notes

(1) Support from the National Science Foundation (GP-9293 and GP-24623) is gratefully acknowledged.
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2-Aminomethylimidazole and Imidazole-2-carboxaldehyde: Two Facile Syntheses

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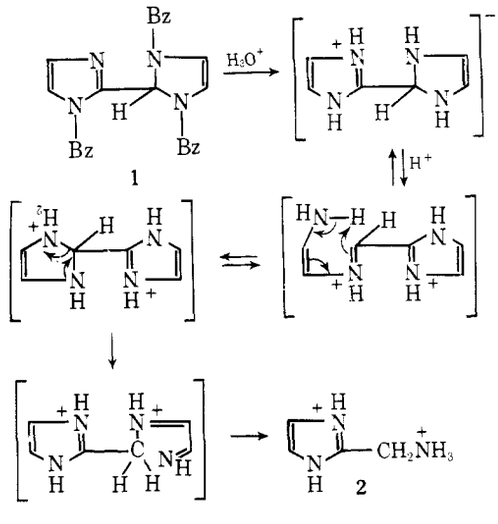
Interest in our laboratories has been directed toward elaborating methodologies for introducing functionality onto imidazoles available in bulk.[1,2] In a recent publication Regel described the reaction of imidazole with 3 equiv of benzoyl chloride; this led to compound **1**. The functionality latently



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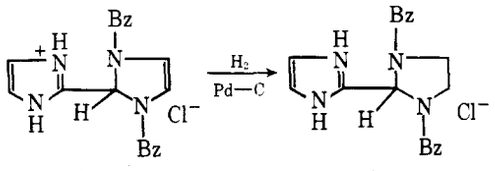
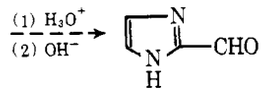
present in 1 was thought to be exploitable toward providing some key 2-substituted imidazoles, thus prompting us to examine some of its properties.

Efforts at bringing about total hydrolysis under the usual aqueous acidic or basic conditions were unrewarding or unpromising. On the other hand, refluxing 1 in methanol containing ca. 20% 2-propanolic hydrochloride readily afforded 2-aminomethylimidazole dihydrochloride (2) in 63% yield. The mechanism almost certainly involves a 1,5-hydrogen shift.

By the same token, 1 may be viewed as a derivatized aminal stemming from imidazole-2-carboxaldehyde (5). It was therefore hydrolyzed to dibenzoyl derivative 3.[3] Subsequent hydrogenation afforded 4, which, in refluxing aqueous HCl gave, besides benzoic acid and ethylenediamine dihydrochloride, aldehyde 5 cleanly and in consistently better than 85% yield.



3 4



5

Compound 5 has previously been obtained by MnO_2 oxidation of the appropriate carbinol[4] or via a multistep procedure centering on treatment of N-substituted 2-imidazolelithium reagents with dimethylformamide,[5] or by acid-promoted cyclization–deacetalization of *N*-(2,2-diethoxyethyl)-2,2-diethoxyacetamidine.[6] The amine (2) has been shown to be derivable from 5 through an oximation–reduction sequence.[7] Considering, however, both the yields and the ease of operation, the approach offered herein may well constitute the method of choice for synthesizing the title compounds.

Experimental Section

General. Melting points were measured with a Fisher-Johns apparatus and are uncorrected. The NMR spectra were recorded in a Varian EM 360A apparatus using Me_4Si as internal standard (δ 0.00). The analytical data furnished by Messrs. P. van den Bosch and H. Eding and the technical assistance of Miss Wilma Oomens are gratefully acknowledged.

2-Aminomethylimidazole Dihydrochloride (2). A solution of 8.96 g (0.02 mol) of 1[3] in 100 mL of methanol containing 20 mL of 2-propanol previously saturated with HCl gas was refluxed for 22 h. Solvents were then removed and the semicrystalline residue was triturated with acetone to give 2.16 g (63.5%) of 2, mp 240–242 °C, and spectrally identical to material reported earlier.[7] An analytical sample was prepared from methanol/isopropyl ether. Anal. Calcd for $C_4H_7N_3 \cdot 2HCl$: C, 28.25; H, 5.33; N, 24.71. Found: C, 28.15; H, 5.38; N, 24.72.

2-(1,3-Dibenzoyl-4-imidazolin-2-yl)imidazole Hydrochloride (3). This compound, previously prepared as the base by Regel[3] by aminolyzing 1, was obtained by us as follows.

Compound 1, 4.48 g (0.01 mol), in 25 mL of methanol containing 2.5 mL of 2-propanol saturated with HCl gas gave a green solution. After 18 h at room temperature the mixture had turned colorless; it was poured onto 200 mL of ethyl ether to give 3.54 g (93%) of 3, mp 240–242 °C; analytical material (methanol/isopropyl ether) gave mp 241–243 °C. Anal. Calcd for $C_{20}H_{16}N_4O_2 \cdot HCl$: C, 63.07; H, 4.56; N, 14.71. Found: C, 63.02; H, 4.60; N, 14.79.

2-(1,3-Dibenzoylimidazolidin-2-yl)imidazole Hydrochloride (4). A solution of 4.5 g (0.0118 mol) of 3 in 50 mL of methanol was hydrogenated in the presence of 0.1 g of Pd–C at room temperature and at atmospheric pressure till 1 equiv of H_2 was taken up. Catalyst and solvent were then successively removed to leave a solid residue. Recrystallization from ethanol–isopropyl ether gave 3.9 g of material: mp 215–217 °C; ^{1}NMR (CD_3OD) AA'BB' system centered around δ 4.17 (4, CH_2CH_2). Anal. Calcd for $C_{20}H_{18}N_4O_2 \cdot HCl$: C, 62.74; H, 5.00; N, 14.64. Found: C, 62.96; H, 4.98; N, 14.42.

Imidazole-2-carboxaldehyde (5). Two grams (0.0052 mol) of 4 in 30 mL of concentrated HCl was refluxed for 22 h. The resulting benzoic acid was removed on chilling and filtration; the filtrate was then evaporated. Addition of a minimum of ethanol to the residue gave 0.63 g (91%) of ethylenediamine dihydrochloride which was removed by filtration. Aqueous dilution of the filtrate, basification (NaOH), extraction with methylene dichloride, drying of the organic phase, and solvent removal left 0.44 g (88%) of 5, melting at 200–202 °C and spectrally identical to material reported earlier.[4,5]

Registry No.—1, 62457-77-6; 2, 22600-77-7; 3, 65276-00-8; 4, 65276-01-9; 5, 10111-08-7.

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Synthesis of 2-Cyanophenyl Thiocyanates and Related Disulfides by Nitro Displacement. A Novel Synthesis of 3-Chloro-1,2-benzisothiazole

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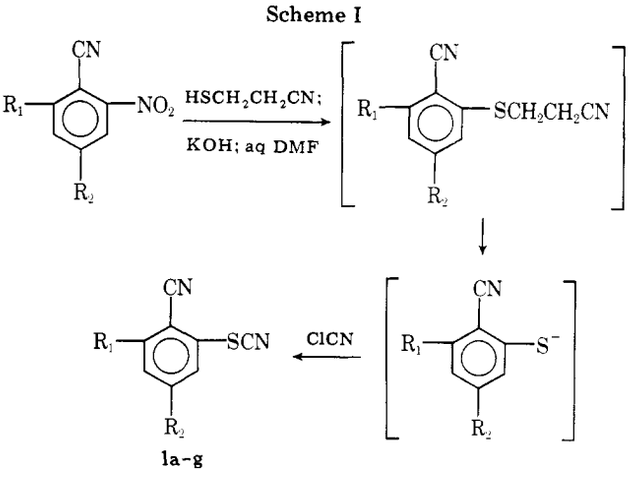
The conversion of a nitro group to a thiocyanate function ordinarily involves reduction, diazotization, and displacement with thiocyanate ion. In the case of a nitro group activated by an *o*-cyano function, a direct displacement by thiocyanate ion should be possible. However, in a previous report[1] we were unable to find conditions for this process, apparently because of the weak nucleophilicity of thiocyanate ion. We wish to report an alternate approach, which involves an initial displacement by 3-mercaptopropionitrile[2] anion to give a cyano ethyl thioether[3] (Scheme I). This intermediate is rapidly converted to the thiol anion by loss of acrylonitrile under the basic reaction conditions or, less likely, through direct displacement by hydroxide ion. Addition of cyanogen chloride then yields the thiocyanic acid ester 1.

Scheme I



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