88335-90-4; **11**, 88335-91-5; (−)-**12**, 110115-15-6; (+)-**12**, 110115-16-7; **13**, 98516-02-0; (±)-**14**, 98516-05-3; *meso*-**14**-diol, 54445-64-6; (−)-**15**, 75658-86-5; (+)-**15**, 89395-28-8; (−)-**16**, 88335-95-9; (+)-**16**, 75658-85-4; **17**, 75658-84-3; **18**, 65376-02-5; **19**, 82442-72-6; **20**, 88335-96-0; **21**, 14590-54-6; pig liver esterase, 9016-18-6; *cis*-cyclobutane-1,2-dicarboxylic acid, 1461-94-5; dimethyl *cis*-cyclopropane-1,2-dicarboxylate, 20315-30-4; methyl *cis*-2(*S*)-(hydroxymethyl)-1(*R*)-cyclopropanecarboxylate, 110115-17-8.

Simple Preparation of α-Acyl α-Arylthio Oximes (*N*-Hydroxy-2-oxoalkanimidothioates): Ambident Reactivity of α-Nitro Ketones

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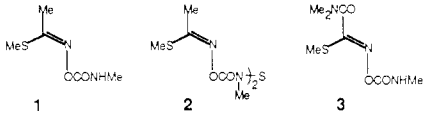
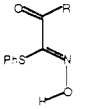
A one-step synthesis of α-acyl α-phenylthio oximes by nucleophilic dehydration of α-nitro ketones is described. Treatment of the α-nitro ketones **7a–c** (prepared by reaction of the sodium salt of nitromethane **6** with the acylimidazoles **5a–c**) with thiophenol and titanium tetrachloride in the presence of triethylamine gave the phenyl *N*-hydroxy-2-oxoalkanimidothioates **4a–c** in good yield. These products are potentially useful intermediates for the synthesis of analogues of the well-known pesticides, methomyl, thiodicarb, and oxamyl. Interestingly, when the α-nitro ketones **7a–c** are treated with thiophenol in the presence of boron trifluoride, only thioketalization is observed and the thioketals **8a–c** are produced. The stereochemistry of the oxime hydroxyl in the crystal was shown to be syn to the phenylthio group, i.e., *Z* stereochemistry, by a single-crystal X-ray structure determination. A reasonable mechanistic explanation is presented to explain the reaction pathway.

Methyl carbamate derivatives of a variety of oximes exhibit strong pesticidal activities. For example, the α-methylthio oxime carbamates—methomyl **1**, thiodicarb **2**, and oxamyl **3**—are potent acaricidal–insecticidal and nematicidal agents.[3-7] A major drawback to the use of



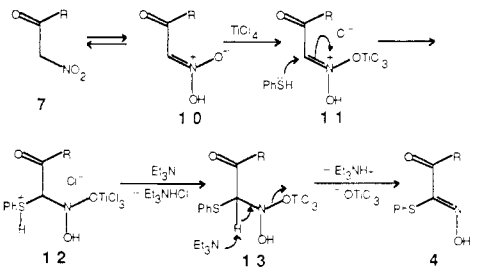
1 2 3

these compounds as commercial insecticides is their high mammalian toxicity. A large amount of effort has been expended in structure–activity and analogue studies in order to improve the effectiveness of these compounds as pesticides and to lower their toxicity.[3] However, few, if any, α-acyl derivatives of α-alkylthio or α-arylthio oximes have ever been prepared. We now report a very efficient synthesis of three α-acyl α-phenylthio oximes, **4a–c**, in only two steps from simple acylimidazoles with a key nucleophilic step that is sensitive to the Lewis acid used.

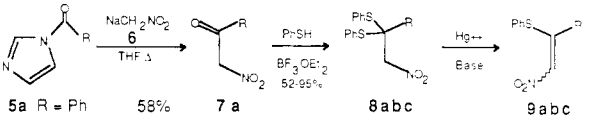


4a R = Ph
4b R = Et
4c R = Me

Scheme I



For another project in our laboratory, we required a quick route to β-phenylthio nitroolefins and chose to prepare them from α-nitro ketones via the corresponding dithioketals.[8] Thus the acylimidazoles **5a–c** were reacted with the preformed sodium salt of nitromethane **6** in THF to give good yields (60–80%) of the α-nitro ketones **7a–c**.



5a R = Ph	58%	**7a**
5b R = Et	70%	**7b**
5c R = Me	80%	**7c**

Formation of the bis(phenylthio) ketals **8a–c** occurred in excellent crude yields (isolated yields 52–95%) by treatment of **7** with thiophenol and boron trifluoride etherate.[8] These in turn were converted into the desired substituted functionalized olefins **9a–c** by treatment with mercuric salts and base.[8]

However, when a solution of the α-nitro ketone **7a** in dry THF at 25 °C was mixed with 1 equiv of titanium tetrachloride and then treated with a mixture of thiophenol and

(1) UCLA Gold Shield Faculty Awardee, 1986–88; Glenn T. Seaborg Awardee, 1987.
(2) Author to whom questions concerning the X-ray structure determination should be addressed.
(3) D'Silva, T. D. J. *Recent Advances in the Chemistry of Insect Control*; Janes, N. F., Ed.; Spec. *Publ.—R. Chem. Soc.* **1985**, *No. 53*, 205.
(4) Cremlyn, R. *Pesticides*; Wiley: Chichester, 1979; pp 98–99.
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(6) Ware, G. W. *Pesticides*; Freeman: San Francisco, 1975; p 42.
(7) Martin, H. *The Scientific Principles of Crop Protection*, 6th ed.; Arnold: London, 1973; p 242.
(8) (a) Jung, M. E.; Grove, D. D. Presented at the 192nd National Meeting of the American Chemical Society, Anaheim, CA, Sept 1986; ORGN82. (b) Jung, M. E.; Grove, D. D. *J. Chem. Soc., Chem. Commun.* **1987**, 753.

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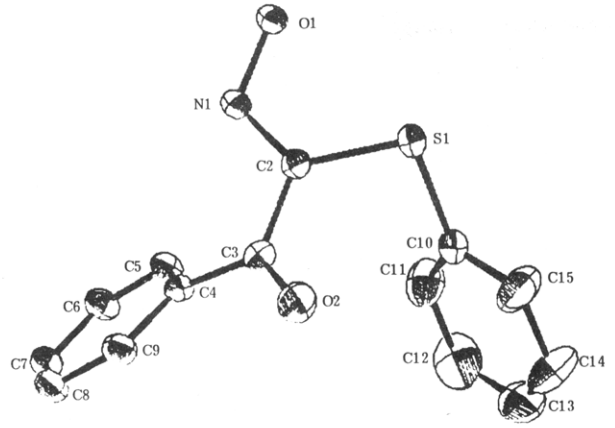
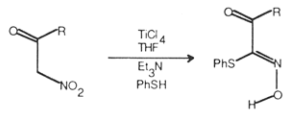


4a

Figure 1.

triethylamine,[9] a totally different reaction occurred. After aqueous workup and chromatography, a 60% yield of the α-benzoyl α-phenylthio oxime **4a** was obtained. Similar

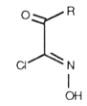


7a R = Ph	60%	**4a** R = Ph
7b R = Et	52%	**4b** R = Et
7c R = Me	31%	**4c** R = Me

treatment of **7b** and **7c** at −78 °C produced the analogous oximes **4b** and **4c** in 52% and 31% yields, respectively. The structures of the products were determined primarily from their spectroscopic data, especially the mass spectra, which showed fragments due to the phenylthio group and the acylium ion. The proton and carbon NMR spectra show only one set of absorptions, thus indicating either that there is only one oxime isomer formed or that there is fast equilibration between the two isomers on the NMR time scale.[10] In order to guarantee the structures and determine the stereochemistry of the oxime hydroxyl in the crystal, a single-crystal X-ray structure determination was performed on **4a**, indicating clearly the *Z* geometry as drawn (Figure 1).

We assume that under these conditions of strong Lewis acid and weak amine base, the mechanistic pathway of Scheme I is followed.[11] The nitro ketone **7**, or its *aci*-nitro tautomer **10**, reacts with $TiCl_4$ at its most basic center, namely the oxygen of the nitro group, to produce **11**. This is attacked by thiophenol at the now electrophilic carbon to give **12**, which then loses HCl to give **13**. A final elimination of $HOTiCl_3$ completes the nucleophilic dehydration to give the observed product **4**.

A second mechanism[12] is also reasonable: Conversion of **7** (or **10**) to the chloro oxime **14** with either $TiCl_4$ itself or adventitiously generated HCl, followed by addition–elimination with thiophenol to give **4**. We can rule out



14

this alternative in the case of **4b** and **4c**, but not for **4a**, as follows. Treatment of **4b** with $TiCl_4$ in THF (or CH_2Cl_2) at −78 °C for several hours with or without triethylamine followed by aqueous workup at −78 °C returns only starting material with no **14** being isolated. However, if the reaction is allowed to warm to room temperature overnight before aqueous workup, the chloro oxime **14b** is obtained. Treatment of **14b** with thiophenol and triethylamine produces **4b** in good yield. Therefore the conversion of **7a** into **4a**, which is carried out at 25 °C, may well proceed via the intermediary of **14a**, although the first mechanism is also possible. However, the failure of **14b** to form under the reaction conditions that convert **7b** into **4b** implies that it is not an intermediate in this transformation and thus lends evidence to the mechanism of Scheme I.

We can offer no good explanation for the difference in the reactivity of **7** with boron trifluoride etherate and $TiCl_4$ except to point out that in the former case there is no base present at all, and thus addition of thiophenol to the α-carbon of an intermediate analogous to **11** might well be reversible in the absence of base. Treatment of **7a** with thiophenol and triethylamine in the absence of $TiCl_4$ does produce some **4a** but at a very much slower rate, and so it is clear that the Lewis acid is greatly acclerating the addition.

The α-acyl analogues of the well-known α-arylthio oximes are thus readily available from α-nitro ketones by a mechanistically interesting one-step process.

Experimental Section

The IR spectra were recorded on a Perkin-Elmer 710B spectrometer. ^1H and ^{13}C NMR spectra were recorded at 500 (or 60) MHz and 125 MHz, respectively, on a Bruker AM-500 (or a Varian T-60) spectrometer with tetramethylsilane as an internal standard. The mass spectra were taken on an AEI MS-902 mass spectrometer. Elemental analyses were performed by Desert Analytics, Tucson, AZ. Tetrahydrofuran (THF) was distilled from sodium benzophenone ketyl immediately prior to use.

1-Nitro-2-propanone (7c).[13] To a solution of acetylimidazole **5c** (2.72 g, 25 mmol) in 50 mL of dry THF was added sodium nitronate (2.67 g, 32 mmol). This mixture was refluxed for 19 h and then cooled and filtered through a coarse sintered-glass filter. The crude enolate salt was place in a 250-mL separatory funnel and 100 mL of water added. The resultant solution was acidified to pH 3.2 with concentrated hydrochloric acid and this extracted with 3 × 75 mL of ethyl acetate. The combined extracts

(9) Mukaiyama, T.; Saigo, K. *Chem. Lett.* **1973**, 479.

(10) Generally the barrier to inversion (*E*/*Z* isomerization) of oximes is quite high ($E_a \approx 18$–25 kcal/mol) so that fast stereomutation at the C=N double bond would not be expected to occur at room temperature. However, the presence of an acyl group attached to the carbon of the oxime would be expected to lower this inversion barrier (via stabilization of zwitterionic resonance structures having a C–N single bond) and thereby increase stereomutation. Thus, while we believe that only the *Z* isomers of the oximes are formed, we cannot completely rule out fast isomerization.

(11) The addition of thiols to the α-carbon of nitroalkanes is well-known to occur in fair yield under strongly basic conditions to give α-alkylthio oximes. (a) Copenhaver, J. W. U.S. Patent 2 786 865, 1957; *Chem. Abstr.* **1957**, *51*, 13920. (b) Mulder, A. J.; van Helden, R. U.S. Patent 3 821 266, 1974; *Chem. Abstr.* **1974**, *81*, 120027.

(12) We thank Professor Tom Maricich at California State University, Long Beach, for suggesting this mechanism and for helpful discussions.

(13) Several syntheses of α-nitro ketones are known in the literature that use various activated acyl derivatives. (a) Hurd, C. D.; Nilson, M. E. *J. Org. Chem.* **1955**, *20*, 927. (b) Bachman, G. B.; Hokama, T. *J. Am. Chem. Soc.* **1959**, *81*, 4882. (c) Nelson, S. D., Jr.; Kasparian, D. J.; Trager, W. F. *J. Org. Chem.* **1972**, *37*, 2686. (d) Baker, D. C.; Pott, S. R. *Synthesis* **1978**, 478. (e) Field, G. F.; Zally, W. J. *Synthesis* **1979**, 295.

(14) The programs used in this work included modified versions of the following programs: CARESS (Broach, Coppens, Becker, and Blessing), peak profile analysis, Lorentz and polarization corrections; MULTAN (Main), package of programs including direct methods, structure factor normalization, Fourier transform, and peak search; ORFLS (Busing, Martin, and Levy), structure factors calculation and full-matrix least-square refinements; ORFFE (Busing, Martin, and Levy), distance, angle, and error calculations; ORTEP (Johnson), figure plotting; Hydrogen (Trueblood), calculations of hydrogen atomic positions. All calculations were performed on a DEC VAX 11/750 crystallographic computer.

were dried over $MgSO_4$ and filtered, and the solvent was removed in vacuo to give 2.06 g (80%) of **7c** as a light yellow solid. Recrystallization from methanol gave a white solid. Mp: 47–49 °C (lit.[13c] mp: 48–50 °C). NMR ($CDCl_3$, 60 MHz); δ 5.29 (2 H, s), 1.99 (3 H, s). **Note**: After several successful destructions of the excess powdery sodium salt of nitromethane by pouring water onto it, one such attempt resulted in a violent explosion, and this procedure is therefore not recommended.

1-Nitro-2-butanone (7b). By application of an analogous procedure to that described for **7c**, a 70% yield of **7b** was obtained as a clear colorless liquid. Bp 52–54 °C (0.19 mm) [lit.[13a] bp 92–100 °C (8 mm)]. NMR ($CDCl_3$, 60 MHz): δ 5.48 (2 H, s), 2.67 (2 H, q, J = 7 Hz), 1.18 (3 H, t, J = 7 Hz).

α-Nitroacetophenone (7a). By application of an analogous procedure to that described for **7c**, a 58% yield of **7a** was obtained as a light yellow solid after recrystallization from methanol. Mp: 103–105 °C (lit.[13c] mp 105–106 °C). NMR ($CDCl_3$, 60 MHz): δ 8.1–7.85 (2 H, m), 7.8–7.55 (3 H, m), 5.93 (2 H, s).

(*Z*)-Phenyl *N*-Hydroxy-2-oxo-2-phenylethanimidothioate (4a). In a flame-dried 100-mL three-neck flask equipped with an addition funnel, a septum, and an argon inlet was placed the nitro ketone **7a** (0.50 g, 3.0 mmol) dissolved in 50 mL of dry THF. To this was added dropwise via syringe $TiCl_4$ (0.36 mL, 3.0 mmol) at 25 °C. After addition was complete, a solution of thiophenol (0.34 g, 3.3 mmol) and triethylamine (0.66 g, 6.5 mmol) in 15 mL of THF was added dropwise via the addition funnel. The initially orange mixture turned dark red upon addition of the thiophenol–triethylamine solution. After addition was complete, the mixture was stirred overnight and then poured into 100 mL of water. The layers were separated, and the aqueous layer was extracted with 3 × 50 mL of diethyl ether. The combined organic phases were dried over $MgSO_4$, and the solvent was removed in vacuo to give 0.96 g of a yellow oil. Chromatography on silica gel, eluting with 5:4 petroleum ether–ether, afforded 0.46 g (60%) of **4a** as a light yellow solid. Slow recrystallization from a hexane–dichloromethane mixture gave crystals for the X-ray analysis. Mp: 105–107 °C. IR (KBr): 3240 (br), 1670, 1410, 1270, 1113, 992 cm^{-1}. ^1H NMR ($CDCl_3$, 60 MHz): δ 7.83 (2 H, dd, J = 12, 8 Hz), 7.60–7.03 (9 H, m). ^{13}C NMR ($CDCl_3$, 125 MHz): δ 186.49 (s, C=O), 154.18 (s, PhSC=NOH), 135.67 (s), 135.26 (d), 134.02 (d), 129.85 (d), 129.38 (d), 129.08 (d), 128.46 (d), 127.16 (s). Mass spectrum (m/e): 257 (M^+, 9.9), 110 (60.7), 105 (100), 77 (46.6). Anal. Calcd for $C_{14}H_{11}NO_2S$: C, 65.37; H, 4.28. Found: C, 65.39; H, 4.25.

(*Z*)-Phenyl *N*-Hydroxy-2-oxobutanimidothioate (4b). In a flame-dried 100-mL three-neck flask equipped with an addition funnel, a septum, and an argon inlet was placed the nitro ketone **7b** (0.50 g, 4.3 mmol) dissolved in 50 mL of dry THF. This solution was cooled to −78 °C, and $TiCl_4$ (0.47 mL, 4.3 mmol) was added dropwise via syringe. After addition was complete, a solution of thiophenol (0.51 g, 4.6 mmol) and triethylamine (0.93 g, 9.2 mmol) in 15 mL of THF was added dropwise via the addition funnel. The initially orange mixture turned dark red upon addition of the thiophenol–triethylamine solution. After addition was complete, the mixture was stirred at −78 °C for 2.5 h and then poured into 100 mL of water. To the resulting emulsion was added 50 mL of diethyl ether, and the layers were separated. The aqueous layer was extracted with 50 mL of diethyl ether, and the combined organic phases were washed with brine and then dried over $MgSO_4$. Removal of the solvents in vacuo gave 0.58 g of a yellow oil. Chromatography on silica gel, eluting with 3:2 petroleum ether–ether, afforded 0.19 g of the starting nitro ketone **7b** and 0.29 g (52% based on unrecovered starting material) of **4b** as a light yellow solid. Mp: 55–58 °C. IR (KBr): 3260 (br), 1685, 1400, 1075, 1000, 890 cm^{-1}. ^1H NMR ($CDCl_3$, 500 MHz): δ 7.6–7.2 (5 H, m), 2.73 (2 H, q, J = 7 Hz), 0.98 (3 H, t, J = 7 Hz). ^{13}C NMR ($CDCl_3$, 125 MHz): δ 196.20 (s, C=O), 153.45 (s, PhSC=NOH), 133.35 (d), 129.49 (s), 129.26 (d), 128.74 (d), 33.87 (t), 7.81 (q). Mass spectrum (m/e): 209 (M^+, 17.6), 110 (48.6), 109 (19.4), 77 (11.8), 57 (100).

(*Z*)-Phenyl *N*-Hydroxy-2-oxopropanimidothioate (4c). In a flame-dried 100-mL three-neck flask equipped with an addition funnel, a septum, and an argon inlet was placed the nitro ketone **7c** (1.00 g, 9.7 mmol) dissolved in 50 mL of dry THF. This solution was cooled to −78 °C, and $TiCl_4$ (1.05 mL, 9.6 mmol) was added dropwise via syringe. After addition was complete, a solution of thiophenol (1.15 g, 10.5 mmol) and triethylamine (1.96 g, 19.4 mmol) in 15 mL of THF was added dropwise via the addition funnel. The initially orange mixture turned dark red upon addition of the thiophenol–triethylamine solution. After addition was complete, the mixture was stirred at −78 °C for 4 h and then poured into 100 mL of water. To the resulting emulsion was added 50 mL of diethyl ether, and the layers were separated. The aqueous layer was extracted with 50 mL of diethyl ether, and the combined organic phases were washed with brine and then dried over $MgSO_4$. Removal of the solvents in vacuo gave 1.17 g of a yellow oil. Chromatography on silica gel, eluting with 3:2 petroleum ether–ether, afforded 0.59 g (31%) of **4c** as a light yellow solid. Mp: 54–56 °C IR (KBr): 3260 (br), 1685, 1400, 1075, 1000, 890 cm^{-1}. NMR ($CDCl_3$, 60 MHz): δ 7.6–7.2 (5 H, m), 2.4 (3 H, s). ^{13}C NMR ($CDCl_3$, 125 MHz): δ 192.64 (s, C=O), 152.98 (s, PhSC=NOH), 132.71 (d), 129.50 (s), 128.99 (d), 128.32 (d), 27.44 (q). Mass spectrum (m/e): 195 (M^+, 17.6), 110 (48.6), 109 (19.4), 77 (11.8), 43 (100).

Table I. Summary of Crystal Data and Refinement Results

	4a
crystal system	triclinic
space group	$P\bar{1}$
cryst dimens, mm	0.20 × 0.17 × 0.18
formula wt, g/mol	257.309
a, Å	9.705 (1)
b, Å	5.944 (1)
c, Å	12.991 (2)
α, deg	71.482 (6)
β, deg	110.319 (6)
γ, deg	109.597 (7)
volume, Å^3	642.17
Z (no. of molecules/unit cell)	2
calculated density, g/cm^3	1.33
wavelength, Å	0.7107 (Mo Kα X-rays)
2θ max, deg	50
scan rate, deg/min	6
Total no. of reflection	2263
Nonzero reflections	1693 ($I > 3\sigma(I)$)
R (F)	0.041
R_w (F)	0.062
error of fit	2.2583
no. of parameters refined	163

***N*-Hydroxy-2-oxobutanimidoyl Chloride (14b).** In a flame-dried 100-mL three-neck flask equipped with a stopper, a septum, and an argon inlet was placed **7b** (1.00 g, 8.5 mmol) dissolved in 50 mL of dry dichloromethane. This solution was cooled to −78 °C, and $TiCl_4$ (1.62 g, 8.5 mmol) was added by syringe. The mixture was allowed to come to room temperature overnight and then poured into 100 mL of water, and the layers were separated. The aqueous phase was extracted once with dichloromethane (50 mL). The pooled organic phases were dried over $MgSO_4$, and the solvents was removed to give 0.270 g (24%) of **14b** as a light-yellow solid. Mp: 83–85 °C (lit.[13a] mp: 80–81 °C). NMR ($CDCl_3$, 60 MHz): δ 9.90 (br s, 1 H), 2.95 (q, J = 7 Hz, 2 H), 1.18 (t, J = 7 Hz, 3 H).

Preparation of 4b from 14b. To **14b** (0.214 g, 1.58 mmol) dissolved in 8 mL of THF was added a solution of triethylamine (0.345 g, 3.41 mmol) and benzenethiol (0.188 g, 1.71 mmol) in 1 mL of THF. The mixture was stirred at room temperature for 17 h and then poured into a separatory funnel, and dichloromethane was added. This was extracted once with 3 N HCl and once with water. The organic layer was dried over $MgSO_4$ and the solvent removed to give a residue that after chromatography (3:2 petroleum ether–ether) furnished 0.202 g (66%) of **4b**.

X-ray Data Collection and Structure Refinement of 4a. A colorless crystal of **4a** of approximate dimensions 0.2 × 0.17 × 0.18 mm was mounted on a glass fiber and placed on a locally automated Picker diffractometer. Accurate unit cell parameters were obtained by a least-squares fit to the automatically centered settings of 22 reflections ($10 < 2\theta < 30$) and are listed in Table I together with other relevent crystallographic data. Intensity measurements were carried out with a $\theta/2\theta$ scan technique using Mo Kα radiation. The intensities of three monitor reflections measured every 100 reflections showed no significant variation

Table II

Interatomic Distances, Å

from	to	distance
N(1)	C(2)	1.274 (3)
N(1)	O(1)	1.390 (2)
O(1)	H(2A)	0.928
O(2)	C(3)	1.217 (3)
C(2)	C(3)	1.510 (3)
C(2)	S(1)	1.757 (2)
C(3)	C(4)	1.485 (3)
C(10)	S(1)	1.770 (3)

Bond Angles, deg

from	through	to	angle
C(2)	N(1)	O(1)	113.30 (17)
H(2A)	O(1)	N(1)	103.00
N(1)	C(2)	C(3)	114.60 (18)
N(1)	C(2)	S(1)	122.95 (16)
C(3)	C(2)	S(1)	122.10 (15)
O(2)	C(3)	C(4)	121.92 (21)
O(2)	C(3)	C(2)	119.48 (20)
C(4)	C(3)	C(2)	118.58 (19)
C(2)	S(1)	C(10)	100.78 (10)
O(1)	H(2A)	N(1)	47.53

throughout the data collection. A total of 2263 reflections were obtained over one hemisphere of reciprocal space ($+h,\pm k,\pm l$), of which 1693 with intensities greater than 3σ were retained for structural analysis.

The intensities were derived from an analysis of the scan profiles.[14] The data were corrected for Lorentz and polarization effects. No absorption correction was applied. The initial positions of sulfur and few other non-hydrogen atoms were obtained through direct methods (MULTAN), while the remaining non-hydrogen atoms were obtained through subsequent difference-Fourier maps. This was allowed by several cycles of full-matrix least-squares refinement until convergence. In the final cycles, the calculated hydrogen atom positions were also included but not refined. The final agreement factors with all non-hydrogen atoms as anisotropic are $R = 0.041$ and $R_w = 0.062$.

The final positional parameters are listed in a table in the supplementary material, whereas selected distances and angles can be found in Table II.

Acknowledgment. We thank the National Institutes of Health (Grants GM31349 and GM32279) for financial support.

Registry No. **4a**, 110097-27-3; **4b**, 110097-28-4; **4c**, 110097-29-5; **5a**, 10364-94-0; **5b**, 4122-52-5; **5c**, 2466-76-4; **6**, 20621-03-8; **7a**, 614-21-1; **7c**, 10230-68-9; **14b**, 110097-30-8.

Supplementary Material Available: Tables listing positional parameters and anisotropic temperature factors for **4a** (3 pages); observed and calculated structure factors for **4a** (9 pages). Ordering information is given on any current masthead page.

(H^+–K^+)-ATPase Inhibiting 2-[(2-Pyridylmethyl)sulfinyl]benzimidazoles. 1.[1] Their Reaction with Thiols under Acidic Conditions. Disulfide Containing 2-Pyridiniobenzimidazolides as Mimics for the Inhibited Enzyme

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A model for studying the mechanism of (H^+–K^+)-ATPase inhibition by the sulfoxides **1**, namely, the reaction of **1** with thiols at low pH, is described. These compounds were found to rearrange in acidic media and to incorporate the thiol to give the 2-pyridinio derivatives **3**, containing a disulfide side chain. These can be isolated as the neutral ylides **4**. The structure of **4** is unambiguously supported by detailed spectral data and by an X-ray analysis of **4d**. Cleavage of the disulfide bond of **4** by thiols leads to a second rearrangement, generating the sulfides **6**, which contain the original molecular backbone. Reductive desulfuration of **4c** results in degradation of the disulfide side chain giving 2-(2-methylpyridinio)benzimidazolide **5c**. O-Demethylation of the 4-methoxypyridinio derivative **3f** converts this compound to the pyridone **7f**. The structural prerequisites essential for the reactivity of **1** are discussed.

Introduction

The 2-[(2-pyridylmethyl)sulfinyl]benzimidazoles **1**, belonging to a class of highly potent inhibitors of gastric acid secretion,[2-5] have attracted considerable attention as potential therapeutics for the treatment of peptic ulcer. The antisecretory activity of **1b** in vivo has been ascribed to

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