Syntheses of Dialkyl and Functionalized Ketones via 1-(Benzotriazol-1-yl)alkyl Methyl Thioethers

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Benzotriazol-1-ylmethyl methyl thioether (**1**), after easy deprotonation by BuLi, reacted with alkyl halides to afford 1-(benzotriazol-1-yl)alkyl methyl thioethers **2** in good yields. The utility of compounds **2** as alkanoyl anion equivalents was demonstrated by the reactions of their anions with alkyl halides, aldehydes, ketones, esters, and phenyl isocyanate: the products were readily hydrolyzed to α-functionalized ketones in dilute aqueous acid.

Introduction

The use of acyl anion equivalents is a powerful strategy in the synthesis of carbonyl compounds.[1] This strategy is especially versatile when the acyl anion equivalent can be prepared by the alkylation of a formyl anion equivalent. The ability of benzotriazole to stabilize an α-anion and to act as a good leaving group has already allowed the development of several benzotriazole-containing formyl anion equivalents: (i) (carbazol-9-yl)(benzotriazol-1-yl)-methane[1a] functions well, except in reactions with sterically hindered electrophiles; (ii) benzotriazol-1-ylmethyl ethyl ether can react with bulky electrophiles, and the second alkylation works well provided the substituent already present is alkenyl,[2] alkynyl,[3] aryl,[4] or heteroaryl,[4] but not when it is alkyl; (iii) the most general formyl anion equivalent for the synthesis of ketones is benzotriazol-1-ylmethyl phenyl ether, which, as recently reported by our group, overcomes the aforementioned problems.[5] We herein demonstrate that benzotriazol-1-ylmethyl methyl thioether (**1**) gives results in most cases comparable to benzotriazol-1-ylmethyl phenyl ethers in the syntheses of aliphatic and functionalized ketones and furthermore possesses advantages as regards convenient preparation, high stability, and versatility.

Results and Discussion

Synthesis of Benzotriazole Derivatives 1−3. (Benzotriazol-1-yl)methyl methyl thioether (**1**)[6] was found to be conveniently prepared by the Pummerer reaction of dimethyl sulfoxide and acetic anhydride, in the presence of benzotriazole. This reaction afforded 98% of a mixture of the Bt-1 and Bt-2 isomers of **1** in a 4:1 ratio; the Bt-1 isomer was isolated from the distillation residue in 71% yield.

Treatment of compound **1** with *n*-BuLi at −78 °C, under nitrogen in THF, furnished deep green solutions of the corresponding anion, which reacted smoothly with alkyl halides to afford 1-(benzotriazol-1-yl)-1-(methylthio)alkanes **2a**−**f**. Good yields (55 to 85%) were obtained from primary alkyl straight chain, primary alkyl branched chain, secondary alkyl, cycloalkyl, benzyl, and alkyl halides. Compounds **2a**−**f** are stable, do not require special handling precautions, and can be stored indefinitely.

Moreover, compounds **2a**−**f** could themselves be converted into the corresponding anions and further reacted with a second electrophile to give a large variety of 1,1-disubstituted 1-(benzotriazol-1-yl)methyl methyl thioethers. Thus, the lithio derivatives of compounds **2a**−**f** with alkyl, allyl, and benzyl halides afforded the expected 1-(benzotriazol-1-yl)methyl methyl thioethers **3a**−**i**, in general, in excellent yields. In some cases, best results were attained by using LDA instead of BuLi, which furthermore allowed a one-pot synthesis for compounds **3b**,**c** and **3g**, starting from thioether **1**. It is recommended that the second alkyl halide used in the alkylation sequence be a primary halide. As described below, the lithio derivatives of compounds **2a**−**c** also reacted smoothly with a wide variety of other electrophiles, including aldehydes, ketones, esters, and phenyl isocyanate. The adducts thus obtained are stable compounds, most of them crystalline and easy to separate from their reaction mixtures.

Syntheses of Dialkyl Ketones. Previous work of this group has shown that deprotonation of 1-(phenoxymethyl)benzotriazole and reactions with various alkyl halides provided α,α-dialkyl-substituted 1-(phenoxymethyl)benzotriazoles, which, upon hydrolysis, furnished various dialkyl ketones[4] in a sequence in which the intermediate monosubstituted benzotriazole derivatives functioned as heterocycle-stabilized acyl anion equivalents. In the present work, 1-(benzotriazol-1-yl)-1-(methylthio)alkanes **3a**,**d**−**f** underwent quantitative hydrolysis into ketones **4a**−**e**; facile workup allowed high preparative yields, with even the volatile hexan-2-one **4a** being isolated in 72% yield. These ketones are thus obtained

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retrosynthetically by combining two alkyl groups derived from the corresponding halogeno derivatives with our −CO synthon. In comparison to other alkanoyl anion equivalents containing sulfur, the hydrolysis of **3a**,**d**−**f** utilizes dilute aqueous−methanolic sulfuric acid (no heavy metal or oxidizing agent), takes place in most cases at 20 °C, and is applicable to a wide range of combinations of substituents (aliphatic, benzylic, and allylic).

Syntheses of α-Hydroxy Ketones. Classical synthetic pathways to α-hydroxy ketones have often been reviewed, as they have wide applications.[7] Acyl-anion synthon methodology has advantages, in principle, in avoiding uncertainties, for example, of rearrangement to α,β-unsaturated ketones in the synthesis of α-ketols by acid-catalyzed opening of cyclopropane-1,2-diols,[8] or Dieckmann condensation competition in acyloin condensations.[9]

In the method now reported, 1-(benzotriazol-1-yl)-1-(methylthio)alkanes **2a**,**c** were reacted with aldehydes and ketones to give the hydroxy derivatives of type **5** and **7**. Monitoring (by GC or NMR) indicated that the products could revert to the starting materials when the reaction mixture reaches 20 °C; the quench is advantageously done at −78 °C, at the point when no more variation in the amount of starting material is detected. Under these conditions, yields higher than 80% were obtained.

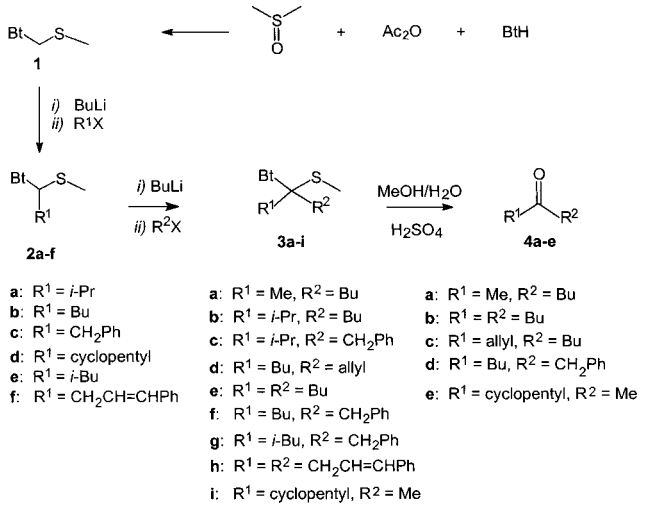
Products of type **5** are formed as mixtures of *erythro* and *threo* isomers, but as both isomers lead to the same acyloin, the mixtures were hydrolyzed directly. The lack of diastereoselectivity in similar reactions of aldehydes is well-known.[10,11] The diastereomers of compound **5a** were separated by column chromatograpy for analytical purposes.

Compounds of type **5** and **7** underwent hydrolysis under mild conditions similar to those described above for the synthesis of dialkyl ketones, to give the acyloins **6a**−**c** and **8a**,**b**, analytically pure after the reaction mixture was freed from benzotriazole (by extraction with aqueous sodium hydroxide or carbonate). Overall yields over three steps from (benzotriazol-1-yl)methyl methyl thioether (**1**) range from 34 to 65%.

Synthesis of Other Functionalized Ketones. Lithiated 1-(benzotriazol-1-yl)-1-(methylthio)pentane (**2b**) was reacted with ethyl benzoate, under the same conditions as mentioned for the synthesis of compounds **5**, but compound **9** was isolated in 40% yield instead of the expected thioether **9a**, required for the synthesis of α,β-diketone **9b**.

Lithiated 1-(1-benzotriazol-1-yl)-1-(methylthio)pentane (**2b**) was reacted with *n*-butyl acrylate to give product **10**, with a conversion greater than 80% and a preparative yield of 40%, which was transformed into compound **11** by hydrolysis, in a yield of 69%. However, when similar reactions were carried out with 1-(benzotriazol-1-yl)-1-(methylthio)alkanes **2a**,**d**, featuring secondary radicals as R^1, both methyl and *n*-butyl acrylate underwent anionic polymerization instead of leading to the desired product.

Scheme 1



When using benzylideneaniline, ethyl cinnamate, and ethyl crotonate as electrophiles, the conversions of 1-(benzotriazol-1-yl)-1-(methylthio)alkanes **2a**,**b** to the expected products were less than 50% (as shown by analyzing the ^{1}H and ^{13}C NMR spectra of the reaction mixtures). Thus, 1-(benzotriazol-1-yl)-1-(methylthio)alkanes **2** could not be viewed as good synthons for these types of functionalizations (*N*-substituted β-amino ketones and β-substituted γ-keto esters).

Syntheses of α-Oxo Amides. The nucleophilic acylation of isocyanates by acyllithium reagents RC(O)Li is limited by the availability of these lithium reagents.[12] In our previous approach, isocyanates reacted with (carbazol-9-yl)(benzotriazol-1-yl)methyllithium to give adducts subsequently hydrolyzed to the corresponding α-oxo amides.[1a]

By the present approach, 1-(benzotriazol-1-yl)-1-(methylthio)alkanes **2a**−**c** reacted with phenyl isocyanate to give adducts **12a**,**b**, in yields of ca. 70% (Scheme 3). The hydrolysis of adducts **12a**,**b** in methanol and in the presence of sulfuric acid or sodium hydroxide gave mixtures of the expected products **14a**,**b** with their corresponding methylthioalkenes **13a**,**b**, as shown by both NMR and GC/MS (only methylthioalkene **13a** and product **14a** were purified and characterized). Following the reactions by gas chromatography demonstrated that the adducts **12a**,**b** were quantitatively and instantaneously converted to compounds **13a**,**b**, which subsequently gave compounds **14a**,**b** in less than 2 h. Conveniently, the hydrolysis was performed in THF/aq HCl 5% (10:1), when compounds **14b**,**c** were obtained in isolated yields of 48% and 55%, respectively.

Conclusions

Benzotriazole-containing acyl-anion equivalents present several advantages over 1,3-dithiane derivatives: more versatile starting materials, milder conditions for hydrolysis, avoidance of hazardous byproducts, and high versatility, as discussed earlier in detail.[3]

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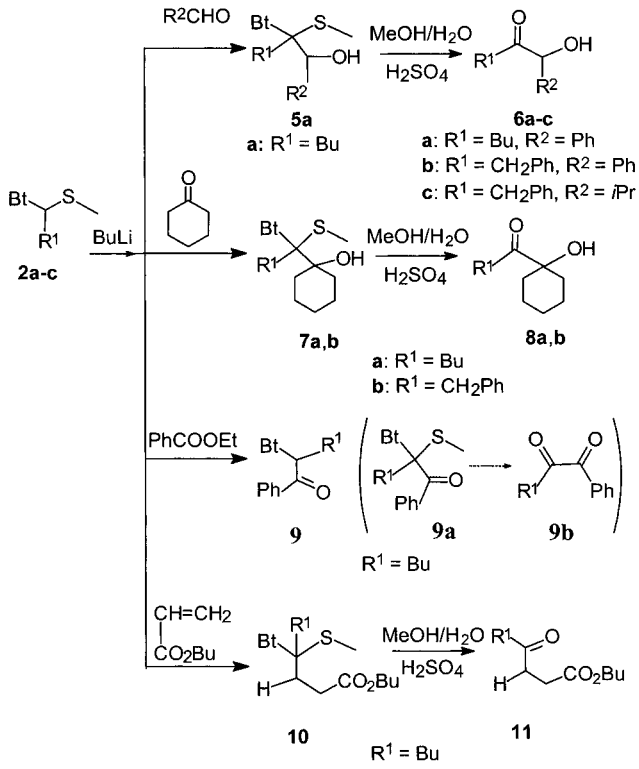
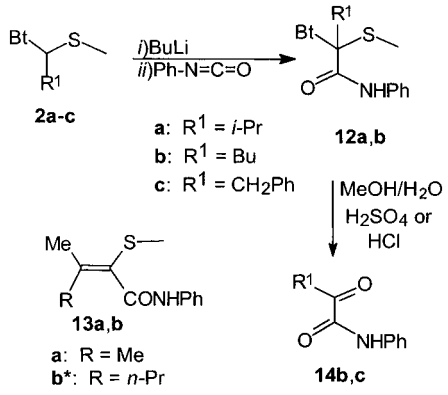
Scheme 2



Scheme 3



* compound **13b** was not fully characterized

The present work demonstrates that benzotriazol-1-ylmethyl methyl thioether (**1**) is complementary to benzotriazolylmethyl phenyl ether,[5] as an acyl anion equivalent for the synthesis of ketones RCOR′ from alkyl halides RX and R′X, and functionalized ketones for other electrophiles. Compound **1** presents features similar to those that, taken together, distinguish 1-(phenoxymethyl)benzotriazole from numerous other acyl-anion equivalents: (*i*) the (methylthio) group is active enough to allow deprotonation of intermediates of type **2**, (*ii*) the products of the reactions of deprotonated compounds **2** with electrophiles are easily hydrolyzed, without the need of heavy metals or oxidizing reagents, (*iii*) they can be used as shelf reagents, as their preservation does not require any precautions, and (*iv*) easy preparation. Additional advantages of compound **1** are its lower molecular weight and lack of steric hindrance. Furthermore, a one-pot procedure is possible in some cases, when the introduction of the first substituent is realized in high yield (e.g. **2a**,**c**,**e**), or when the second electrophile is very reactive (e.g. aldehydes and phenyl isocyanate).

There are, however, some limitations of the uses of compound **1**, as already mentioned: (*i*) it cannot be utilized in the synthesis of α,β-diketones (some other benzotriazole-containing acyl ion equivalents can be used instead);[13] (*ii*) δ-alkyl substituted γ-keto esters could not be synthesized by this method (phenoxymethylbenzotriazole can be used);[5] (*iii*) oxoamides, although accessible by this method, have been isolated in lower yield than reported when using (carbazol-9- yl)(benzotriazol-1-yl)-methane for umpolung.[1a]

Experimental Section

General. Melting points were determined with a hot-stage apparatus and are uncorrected. NMR spectra were recorded in $CDCl_3$ with tetramethylsilane as the internal standard for ^{1}H (300 MHz) or solvent as the internal standard for ^{13}C (75 MHz). The abbreviations for the multiplicity of the proton signals are as follows: q for quartet, qv for quintet, sx for sextet and h for heptet. THF was distilled under nitrogen immediately prior to use from sodium/benzophenone. All reactions with air-sensitive compounds were carried out under an argon atmosphere. Column chromatography was conducted with silica gel 230−400 mesh. GC Analyses were performed on a Hewlett-Packard 5890 II instrument (flame ionization detector, FID), with a 15 m capillary column (SPB-1) and an oven temperature program of 20 °C/min from 100 to 250 °C after 1 min at 50 °C. (Benzotriazol-1-yl)methyl methyl thioether (**1**) was prepared by a different procedure than the previously reported procedure.[6]

(Benzotriazol-1-yl)methyl Methyl Thioether (1). A mixture of benzotriazole (23.8 g, 0.2 mol), dimethyl sulfoxide (21.3 mL, 0.3 mol), and acetic anhydride (18.9 mL, 0.2 mol) was heated under nitrogen at 100 °C for 0.5 h, and then the acetic acid and dimethyl sulfoxide were cautiously distilled under reduced pressure (ca. 50 °C/1 Torr). The temperature was then raised to 125−150 °C/1 Torr, when a mixture of Bt-1 and Bt-2 isomers were distilled. The residue was the expected compound, obtained as white crystals, mp 60 °C (lit. mp not available) (71%, lit.[6] 60%): ^{1}H NMR δ 2.09 (s, 3 H), 5.67 (s, 2 H), 7.40 (t, J = 8.3 Hz, 1 H), 7.52 (t, J = 8.3 Hz, 1 H), 7.68 (d, J = 8.3 Hz, 1 H), 8.07 (d, J = 8.3 Hz, 1 H); ^{13}C NMR δ 14.7, 50.8, 110.1, 120.0, 124.2, 127.5, 131.9, 146.4.

General Procedure for the Preparation of α-Benzotriazolylalkyl Methyl Thioethers 2a−f. To a solution of (benzotriazol-1-yl)methyl methyl thioether (**1**) (8.96 g, 50 mmol) in THF (200 mL) at −78 °C under nitrogen was added *n*-BuLi (2.22 M in hexane, 23.6 mL, 52.5 mmol) over a period of 5 min. After 10 min, a solution of an appropriate halogenated derivative (60 mmol) in THF (10 mL) was added. The mixture was stirred at −78 °C for 2 h, allowed to warm to room temperature and stirred for an additional 12 h. The reaction was quenched with saturated ammonium chloride (100 mL) and extracted with methylene chloride (3 × 50 mL), and the combined extracts were washed with water (2 × 100 mL) and dried ($MgSO_4$). After the solvent was removed, the residue was subjected to column chromatography to give the pure product.

1-(Benzotriazol-1-yl)-2-methyl-1-(methylthio)propane (2a). Hexanes:ethyl acetate (9:1) was used as the eluent to give yellow crystals, mp 38−40 °C (85%): ^{1}H NMR δ 0.75 (d, J = 6.6 Hz, 3 H), 1.28 (d, J = 6.6 Hz, 3 H), 1.83 (s, 3 H), 2.65 (dh, J_1 = 9.9 Hz, J_2 = 6.6 Hz, 1 H), 5.64 (d, J = 9.9 Hz, 1 H), 7.39 (t, J = 8.3 Hz, 1 H), 7.47 (t, J = 8.3 Hz, 1 H), 7.88 (d, J = 8.3 Hz, 1 H), 8.09 (d, J = 8.3 Hz, 1 H); ^{13}C NMR δ 13.8, 19.7, 20.7, 33.1, 73.0, 111.6, 120.1, 124.0, 126.9, 131.22, 146.8. Anal. Calcd for $C_{11}H_{15}N_3S$: C, 59.70; H, 6.83; N, 18.99. Found: C, 59.81; H, 7.00; N, 19.06.

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1-(Benzotriazol-1-yl)-1-(methylthio)pentane (2b). Hexanes:ethyl acetate (10:1) was used as the eluent to give a colorless oil (62%): ^{1}H NMR δ 0.84 (t, J = 6.6 Hz, 3 H), 1.10−1.47 (m, 4 H), 1.88 (s, 3 H), 2.22−2.47 (m, 2 H), 5.93 (dd, J_1 = 9.0 Hz, J_2 = 6.4 Hz, 1 H), 7.39 (t, J = 8.3 Hz, 1 H), 7.49 (t, J = 8.3 Hz, 1 H), 7.84 (d, J = 8.3 Hz, 1 H), 8.09 (d, J = 8.3 Hz, 1 H); ^{13}C NMR δ 13.6, 13.7, 21.8, 28.6, 33.7, 66.0, 111.3, 120.2, 124.1, 127.0, 131.0, 146.9. Anal. Calcd for $C_{12}H_{17}N_3S$: C, 61.24; H, 7.28. Found: C, 61.41; H, 7.43.

1-(Benzotriazol-1-yl)-2-phenyl-1-(methylthio)ethane (2c). Hexanes:diethyl ether (2:1) was used as the eluent to give white crystals, mp 58−62 °C (78%): ^{1}H NMR δ 1.88 (s, 3 H), 3.56 (dd, J_1 = 14.2 Hz, J_2 = 6.5 Hz, 1 H), 3.68 (dd, J_1 = 14.2 Hz, J_2 = 8.6 Hz, 1 H), 6.12 (dd, J_1 = 8.6 Hz, J_2 = 6.5 Hz, 1 H), 6.99−7.07 (m, 2 H), 7.12−7.20 (m, 3 H), 7.37 (ddd, J_1 = 8.3 Hz, J_2 = 6.9 Hz, J_3 = 1.1 Hz, 1 H), 7.47 (ddd, J_1 = 8.3 Hz, J_2 = 6.9 Hz, J_3 = 1.1 Hz, 1 H), 7.80 (d, J = 8.3 Hz, 1 H), 8.05 (d, J = 8.3 Hz, 1 H); ^{13}C NMR δ 13.8, 40.5, 66.8, 111.1, 120.2, 124.1, 127.1, 127.2, 128.5 (2C), 128.8 (2C), 131.3, 135.8, 146.9. Anal. Calcd for $C_{15}H_{15}N_3S$: C, 66.88; H, 5.61; N, 15.60. Found: C, 66.82; H, 5.55; N, 15.41.

1-(Benzotriazol-1-yl)-1-cyclopentyl-1-(methylthio)-methane (2d). Hexanes:ethyl acetate (10:1) was used as the eluent to give white crystals, mp 58 °C (61%): ^{1}H NMR δ (HETCOR) 1.13 (m, 1 H), 1.29 (m, 1 H), 1.48 (m, 1 H), 1.62 (m, 3 H), 1.78 (m, 1 H), 1.85 (s, 3 H), 2.09 (m, 1 H), 2.90 (m, 1 H), 5.69 (d, J = 11.0 Hz, 1 H), 7.39 (t, J = 8.3 Hz, 1 H), 7.48 (t, J = 8.3 Hz, 1 H), 7.87 (d, J = 8.3 Hz, 1 H), 8.08 (d, J = 8.3 Hz, 1 H); ^{13}C NMR δ 13.8, 24.8, 25.3, 30.3, 31.3, 43.9, 71.4, 111.5, 120.1, 124.0, 126.9, 131.0, 146.8. Anal. Calcd for $C_{13}H_{17}N_3S$: C, 63.12; H, 6.93; N, 16.99. Found: C, 63.03; H, 7.09; N, 17.10.

1-(Benzotriazol-1-yl)-3-methyl-1-(methylthio)butane (2e). Hexanes:ethyl acetate (10:1) was used as the eluent to give colorless crystals, mp 45 °C (77%): ^{1}H NMR δ 0.87 (d, J = 6.6 Hz, 3 H), 0.99 (d, J = 6.6 Hz, 3 H), 1.30−1.50 (m, 1 H), 1.85 (s, 3 H), 2.10 (ddd, J_1 = 14.1 Hz, J_2 = 8.2 Hz, J_3 = 6.0 Hz, 1 H), 2.35 (ddd, J_1 = 14.1 Hz, J_2 = 9.6 Hz, J_3 = 5.9 Hz, 1 H), 6.05 (dd, J_1 = 14.1 Hz, J_2 = 8.2 Hz, 1 H), 7.39 (t, J = 8.3 Hz, 1 H), 7.49 (t, J = 8.3 Hz, 1 H), 7.84 (d, J = 8.3 Hz, 1 H), 8.09 (d, J = 8.3 Hz, 1 H); ^{13}C NMR δ 13.6, 21.5, 22.2, 25.2, 42.4, 64.2, 111.2, 120.1, 124.0, 127.0, 130.9, 146.8. Anal. Calcd for $C_{12}H_{17}N_3S$: N, 17.85. Found: N, 18.23.

1-(Benzotriazol-1-yl)-4-phenyl-1-(methylthio)but-3-ene (2f). Benzene:diethyl ether (95:5) was used as the eluent to give a colorless oil (55%): ^{1}H NMR δ 1.91 (s, 3H), 3.13−3.34 (m, 2 H), 5.98−6.10 (m, 2H), 6.40 (d, J = 15.7 Hz, 1 H), 7.14−7.25 (m, 5 H), 7.38 (ddd, J_1 = 8.2 Hz, J_2 = 6.9 Hz, J_3 = 1.0 Hz, 1 H), 7.49 (ddd, J_1 = 8.2 Hz, J_2 = 6.9 Hz, J_3 = 1.0 Hz, 1 H), 7.85 (d, J = 8.2 Hz, 1 H), 8.07 (d, J = 8.2 Hz, 1 H); ^{13}C NMR δ 13.6, 37.7, 65.6, 112.2, 120.3, 123.3, 124.2, 126.2 (2C), 127.2, 127.6, 128.4 (2C), 131.2, 134.0, 136.4, 146.8. Anal. Calcd for $C_{17}H_{17}N_3S$: N, 14.22. Found: N, 14.54.

General Procedure for the Preparation of α-Benzotriazolylalkyl Methyl Thioethers 3a−j, 5a, 7a,b, 10, and 12a,b. (a) To a solution of the appropriate 1-(benzotriazol-1-yl)-1-(methylthio)alkanes **2a**−**f** (50 mmol) in THF (200 mL) at −78 °C under nitrogen was added *n*-BuLi (2.22 *M* in hexane, 23.6 mL, 52.5 mmol) over a period of 5 min. After 10 min, a solution of the appropriate electrophile (60 mmol) in THF (10 mL) was added. The mixture was stirred at −78 °C for 2 h, allowed to warm to room temperature, and stirred for an additional 12 h. The reaction was quenched with saturated ammonium chloride (100 mL) and extracted with methylene chloride (3 × 50 mL), and the combined extracts were washed with water (2 × 100 mL) and dried ($MgSO_4$). After the solvent was removed, the residue was subjected to column chromatography or recrystallization to give the pure product.

(b) When *n*-butyl acrylate was the electrophile, the reaction was quenched after stirring for 1 h at −78 °C. The mixture was extracted with CH_2Cl_2 (3 × 50 mL), and the combined extracts washed with water (2 × 100 mL) and dried ($MgSO_4$). After the solvent was removed, the residue was subjected to column chromatography to give the pure product. When the electrophile was an aldehyde, the reaction was monitored by TLC and was usually quenched after stirring for less than 1 h at −78 °C. The crude product was used in the next step without prior purification.

(c) One pot-procedure: reactions of 1-(benzotriazol-1-yl)-methyl methyl thioether (**1**) (50 mmol) with the corresponding alkyl halides (52.5 mmol) took place with conversions greater than 90% (monitored by NMR), to give compounds **3b**,**c**, and **3g**, and in these cases the reaction mixture was cooled again at −78 °C under nitrogen and BuLi (2.22 M in hexane, 23.6 mL, 52.5 mmol) was added over a period of 5 min. After 10 min, a solution of the appropriate halogenated derivative (60 mmol) in THF (10 mL) was added. The mixture was stirred at −78 °C for 2 h, allowed to warm to room temperature and stirred for an additional 12 h. The reaction was subjected to the same workup as described above.

2-(Benzotriazol-1-yl)-2-(methylthio)hexane (3a). Hexanes:ethyl acetate (9:1) was used as the eluent to give a colorless oil (42%): ^{1}H NMR δ 0.81 (t, J = 7.3 Hz, 3 H), 0.80−0.96 (m, 1 H), 1.18−1.37 (m, 2H), 1.40−1.57 (m, 1 H), 1.66 (s, 3 H), 2.23 (ddd, J_1 = 14.0 Hz, J_2 = 12.2 Hz, J_3 = 4.5 Hz, 1 H), 2.26 (s, 3 H), 2.54 (ddd, J_1 = 14.0 Hz, J_2 = 12.2 Hz, J_3 = 4.5 Hz, 1 H), 7.38 (t, J = 7.5 Hz, 1 H), 7.46 (t, J = 7.5 Hz, 1 H), 8.07 (d, J = 7.5 Hz, 1 H), 8.10 (d, J = 7.5 Hz, 1 H); ^{13}C NMR δ 11.2, 13.7, 22.4, 25.5, 25.8, 40.1, 71.5, 113.4, 120.0, 123.8, 126.5, 131.6, 147.1. Anal. Calcd for $C_{13}H_{19}N_3S$: C, 62.61; H, 7.68. Found: C, 62.45; H, 7.76.

3-(Benzotriazol-1-yl)-2-methyl-3-(methylthio)heptane (3b). Hexanes:ethyl acetate (10:1) was used as the eluent to give white crystals, mp 78 °C (91%): ^{1}H NMR δ (HETCOR), 0.88 (d, J = 6.6 Hz, 3 H), 0.95 (t, J = 7.0 Hz, 3 H), 1.12 (d, J = 6.6 Hz, 3 H), 1.30−1.50 (m, 3 H), 1.68 (s, 3 H), 1.75 (m, 1 H), 2.41 (m, 1 H), 2.86 (h, J = 6.6 Hz, 1 H), 2.88 (m, 1 H), 7.35 (t, J = 8.3 Hz, 1 H), 7.43 (t, J = 8.3 Hz, 1 H), 8.06 (d, J = 8.3 Hz, 1 H), 8.37 (d, J = 8.3 Hz, 1 H); ^{13}C NMR δ 12.5, 14.0, 18.1, 23.0, 26.7, 35.1, 36.9, 79.8, 114.4, 119.6, 123.6, 126.6, 132.9, 146.4. Anal. Calcd for $C_{15}H_{23}N_3S$: N, 15.15. Found: N, 15.50.

2-(Benzotriazol-1-yl)-3-methyl-1-phenyl-2-(methylthio)butane (3c). Hexanes:ethyl acetate (10:1) was used as the eluent to give white crystals, mp 53 °C (87%): ^{1}H NMR δ 0.86 (d, J = 6.6 Hz, 3 H), 1.14 (d, J = 6.6 Hz, 3 H), 1.20 (s, 3 H), 2.83 (h, J = 6.6 Hz, 1 H), 3.72 (d, J = 14.4 Hz, 1 H), 4.17 (d, J = 14.4 Hz, 1 H), 7.15−7.30 (m, 3 H), 7.35 (t, J = 8.3 Hz, 1 H), 7.42 (t, J = 8.3 Hz, 1 H), 7.46−7.50 (m, 2 H), 8.07 (d, J = 8.3 Hz, 1 H), 8.35 (d, J = 8.3 Hz, 1 H); ^{13}C NMR δ 12.6, 17.8, 18.1, 37.9, 39.1, 79.8, 114.2, 119.9, 123.9, 126.8, 127.7 (2C), 131.7 (2C), 132.6, 135.7, 146.7. Anal. Calcd for $C_{18}H_{21}N_3S$: C, 69.42; H, 6.80; N, 13.49. Found: C, 69.81; H, 6.89; N, 13.77.

4-(Benzotriazol-1-yl)-4-(methylthio)oct-1-ene (3d). Hexanes:diethyl ether (5:1) was used as the eluent to give a white solid, mp 39−41 °C (89%): ^{1}H NMR δ 0.82 (t, J = 7.3 Hz, 3 H), 0.80−0.95 (m, 1 H), 1.28 (sx, J = 7.3 Hz, 2 H), 1.38−1.58 (m, 1 H), 1.62 (s, 3 H), 2.29 (ddd, J_1 = 14.2 Hz, J_2 = 12.3 Hz, J_3 = 4.3 Hz, 1 H),), 2.56 (ddd, J_1 = 14.2 Hz, J_2 = 12.0 Hz, J_3 = 3.2 Hz, 1 H),), 3.22 (ddd, J_1 = 15.0 Hz, J_2 = 6.5 Hz, J_3 = 1.1 Hz, 1 H), 3.46 (dd, J_1 = 15.0 Hz, J_2 = 7.6 Hz, 1 H), 5.13−5.23 (m, 2 H), 5.74−5.90 (m, 1 H), 7.38 (t, J = 8.2 Hz, 1 H), 7.47 (t, J = 8.2 Hz, 1 H), 8.08 (d, J = 8.2 Hz, 1 H), 8.14 (d, J = 8.2 Hz, 1 H); ^{13}C NMR δ 10.9, 13.8, 22.4, 25.2, 35.3, 39.0, 74.5, 113.5, 119.5, 120.0, 123.9, 126.6, 131.4, 131.7, 146.9. Anal. Calcd for $C_{15}H_{21}N_3S$: C, 65.41; H, 7.69; N, 15.26. Found: C, 65.52; H, 7.90; N, 15.50.

5-(Benzotriazol-1-yl)-5-(methylthio)nonane (3e). Hexanes:ethyl acetate (9:1) was used as the eluent to give white crystals, mp 76−84 °C (90%): ^{1}H NMR δ 0.88 (t, J = 7.3 Hz, 6 H), 0.92−1.10 (m, 2 H), 1.34 (sx, J = 7.3 Hz, 4 H), 1.45−1.62 (m, 2 H), 1.58 (s, 3 H), 2.33 (ddd, J_1 = 14.5 Hz, J_2 = 12.4 Hz, J_3 = 4.2 Hz, 2 H), 2.65 (ddd, J_1 = 14.5 Hz, J_2 = 12.4 Hz, J_3 = 4.2 Hz, 2 H), 7.37 (t, J = 8.2 Hz, 1 H), 7.45 (t, J = 8.2 Hz, 1 H), 8.08 (d, J = 8.2 Hz, 1 H), 8.14 (d, J = 8.2 Hz, 1 H); ^{13}C NMR δ 10.9, 13.9 (2C), 22.5 (2C), 25.5 (2C), 34.6 (2C), 75.6, 113.6, 120.0, 123.8, 126.4, 131.6, 146.9. Anal. Calcd for $C_{16}H_{25}N_3S$: C, 65.93; H, 8.65. Found: C, 65.91; H, 8.85.

2-(Benzotriazol-1-yl)-1-phenyl-2-(methylthio)hexane (3f). Benzene:diethyl ether (95:5) was used as the eluent to give a white solid, mp 84−87 °C (72%): ^{1}H NMR δ δ 0.91 (t, J = 7.0 Hz, 3 H), 1.20−1.45 (m, 3 H), 1.65 (s, 3 H), 1.68−1.84 (m, 1 H), 2.28 (td, J_1 = 12.5 Hz, J_2 = 3.6 Hz, 1 H), 2.47 (td, J_1 = 12.5 Hz, J_2 = 4.5 Hz, 1 H), 3.55 (d, J = 14.2 Hz, 1 H), 3.92 (d, J = 14.2 Hz, 1 H), 6.76 (d, J = 7.7 Hz, 2 H), 7.10−7.23 (m, 2 H); 7.24−7.56 (m, 3H), 8.10 (d, J = 8.3 Hz, 1 H), 8.23 (d, J = 8.3 Hz, 1 H); ^{13}C NMR δ 11.2, 14.0, 22.5, 26.1, 34.4, 41.1, 76.0, 113.8, 120.1, 124.0, 126.7, 127.2, 128.1, 130.0, 132.2, 134.6, 146.9. Anal. Calcd for $C_{19}H_{23}N_3S$: N, 12.91. Found: N, 13.30.

2-(Benzotriazol-1-yl)-4-methyl-1-phenyl-2-(methylthio)pentane (3g). Hexanes:ethyl acetate (10:1) was used as the eluent to give a white solid, mp 68 °C (92%): ^{1}H NMR δ 0.31 (d, J = 6.6 Hz, 3 H), 0.95 (d, J = 6.6 Hz, 3 H), 1.58 (s, 3 H), 2.06 (dd, J_1 = 15.4 Hz, J_2 = 8.5 Hz, 1 H), 2.07−2.18 (m, 1 H), 2.35 (dd, J_1 = 15.4 Hz, J_2 = 4.0 Hz, 1 H), 3.79 (d, J_1 = 14.5 Hz, 1 H), 4.12 (d, J_1 = 14.5 Hz, 1 H), 7.05−7.15 (m, 2 H), 7.20−7.28 (m, 3 H), 7.38 (t, J = 8.3 Hz, 1 H), 7.44 (t, J = 8.3 Hz, 1 H), 8.08 (d, J = 8.3 Hz, 1 H), 8.22 (d, J = 8.3 Hz, 1 H); ^{13}C NMR δ 11.3, 22.4, 24.4, 24.5, 40.8, 43.8, 75.9, 113.9, 119.9, 123.9, 126.6, 127.1, 127.9 (2C), 130.8 (2C), 132.4, 134.9, 146.8. Anal. Calcd for $C_{16}H_{25}N_3OS$: C, 70.12; H, 7.12; N, 12.91. Found: C, 70.33; H, 7.22; N, 12.85.

4-(Benzotriazol-1-yl)-1,7-diphenyl-4-(methylthio)-1,6-heptadiene (3h). Benzene:diethyl ether (95:5) was used as the eluent to give a yellow oil (65%): ^{1}H NMR δ 1.70 (s, 3 H), 3.34 (dd, J_1 = 14.6 Hz, J_2 = 7.5 Hz, 2 H), 3.56 (dd, J_1 = 14.6 Hz, J_2 = 7.5 Hz, 2 H), 6.08 (dt, J_1 = 15.7 Hz, J_2 = 7.5 Hz, 2 H), 6.46 (dt, J_1 = 15.7 Hz, J_2 = 7.5 Hz, 2 H), 7.10−7.30 (m, 10 H), 7.45 (d, J = 8.3 Hz, 1 H), 7.50 (d, J = 8.3 Hz, 1 H), 8.10 (d, J = 8.3 Hz, 1 H), 8.22 (d, J = 8.3 Hz, 1 H); ^{13}C NMR δ 11.2, 39.6 (2C), 74.4, 113.7, 120.2, 122.2 (2C), 124.2, 126.3 (4C), 126.9, 127.6 (2C), 128.5 (4C), 131.8, 134.9 (2C), 136.8 (2C), 147.0. Anal. Calcd for $C_{26}H_{25}N_3S$: N, 10.21. Found: N, 10.10.

1-(Benzotriazol-1-yl)-1-cyclopentyl-1-(methylthio)-ethane (3i). The crude compound was pure (by NMR), as a yellow oil (94%); ^{1}H NMR δ 1.00−1.70 (m, 6 H), 1.90−2.00 (m, 1 H), 2.10−2.25 (m, 1 H), 2.70 (s, 3 H), 3.10−3.20 (m, 1 H), 7.30−7.50 (m, 2 H), 8.10 (d, J = 8.2 Hz, 1 H), 8.22 (d, J = 8.2 Hz, 1 H); ^{13}C NMR δ 11.1, 20.9, 25.2, 25.9, 27.1, 28.3, 48.6, 75.0, 113.8, 119.6, 123.9, 126.4, 131.7, 146.7. HRMS (POS FAB) calcd for $C_{14}H_{20}N_3S$ (M + 1): 262.1378, found 262.1370.

2-(Benzotriazol-1-yl)-1-hydroxy-1-phenyl-2-(methylthio)hexane (5a). The crude product (3.56 g) was separated by flash column chromatography on silica gel (175 g), eluting with benzene:Et_2O (95:5). A mixture of two diastereoisomers were obtained. The first one (2.08 g, 61%) decomposed in a few days, in the presence of atmospheric humidity, into product **6a**, the second (0.48 g, 29%) was obtained as white crystals, mp 110.5−113 °C (overall reaction yield 90%): ^{1}H NMR δ 0.80 (t, J = 7.2 Hz, 3 H), 1.10−1.30 (m, 2 H), 1.50−1.65 (m, 2 H), 1.92 (s, 3 H), 2.50 (td, J_1 = 7.4 Hz, J_2 = 3.9 Hz, 2 H), 4.20 (br s, 1 H, O*H*), 6.10 (s, 1 H), 7.20−7.40 (m, 3 H), 7.40−7.50 (m, 4 H), 8.10−8.20 (m, 2 H); ^{13}C NMR δ 13.6, 14.0, 22.4, 25.8, 36.0, 77.9, 78.7, 113.6, 120.0, 124.4, 127.4, 127.6, 128.4, 128.5, 132.6, 137.7, 146.2. Anal. Calcd for $C_{19}H_{23}N_3OS$: C, 66.83; H, 6.79; N, 12.31. Found: C, 66.93; H, 6.80; N, 12.09.

1-(Benzotriazol-2-yl)-1-(1-hydroxycyclohexyl)-1-(methylthio)hexane (7a). Recrystallized from hexanes:diethyl ether to give a white solid, mp 40−45 °C (80%): ^{1}H NMR δ 0.90 (t, J = 7.2 Hz, 3 H), 0.90−1.00 (m, 2 H), 1.01−1.24 (m, 2 H), 1.30−1.80 (m, 10 H), 2.20 (s, 3 H) 2.40 (td, J_1 = 7.4 Hz, J_2 = 3.9 Hz, 1 H), 2.90 (td, J_1 = 7.4 Hz, J_2 = 3.9 Hz, 1 H), 4.40 (br s, 1 H, O*H*), 7.40 (dd, J_1 = 8.2 Hz, J_2 = 1.8 Hz, 2 H), 7.90 (dd, J_1 = 8.2 Hz, J_2 = 1.8 Hz, 2 H); ^{13}C NMR δ 13.9, 14.8, 21.6, 21.7, 23.1, 25.4, 27.2, 32.4, 32.7, 33.7, 79.2, 88.1, 118.2, 126.7, 143.1. Anal. Calcd for $C_{18}H_{27}N_3OS$: C, 64.47; H, 8.16. Found: C, 64.47; H, 8.14.

1-[1-(Benzotriazol-1-yl)-2-phenyl-1-(methylthio)ethyl]-1-hydroxycyclohexane (7b). Recrystallized from ethanol to give a white solid, mp 143−145 °C (85%): ^{1}H NMR (DMSO-d_6) δ 0.90 (s, 3 H), 1.20−1.80 (m, 10 H), 3.65 (d, J = 14.2 Hz, 1 H), 4.82 (d, J = 14.2 Hz, 1 H), 5.04 (s, 1H, O*H*), 7.10−7.20 (m, 3 H), 7.35 (t, J = 8.2 Hz, 1 H), 7.45−7.40 (m, 3 H), 8.02 (d, J = 8.2 Hz, 1 H), 8.45 (d, J = 8.2 Hz, 1 H); ^{13}C NMR δ 12.8, 21.3, 24.9, 25.6, 31.6, 31.7, 78.8, 84.6, 116.8, 118.8, 123.4, 126.6, 126.7, 127.7, 131.4, 136.9, 145.6, 147.3. Anal. Calcd for $C_{18}H_{27}N_3OS$: C, 64.47; H, 8.16. Found: C, 64.47; H, 8.14.

***n*-Butyl 3-(Benzotriazol-1-yl)-3-(methylthio)octanoate (10).** Hexanes:ethyl acetate (10:1) was used as the eluent to give a colorless oil, (40%): ^{1}H NMR δ 0.85 (t, J = 7.2 Hz, 3 H), 0.92 (t, J = 7.4 Hz, 3 H), 1.20−1.40 (m, 6 H), 1.65 (s, 3 H), 2.21 (dd, J_1 = 7.2 Hz, J_2 = 5.0 Hz, 1 H), 2.26 (dd, J_1 = 7.4 Hz, J_2 = 5.0 Hz, 1 H), 2.50−2.70 (m, 2 H), 2.80 (dt, J_1 = 10.8 Hz, J_2 = 5.4 Hz, 1 H), 3.06 (ddd, J_1 = 10.8 Hz, J_2 = 5.4 Hz, J_3 = 5.0 Hz, 4 H), 4.05 (t, J = 7.4 Hz, 4 H), 7.40 (t, J = 8.2 Hz, 1 H), 7.45 (t, J = 8.2 Hz, 1 H), 8.10 (d, J = 8.2 Hz, 1 H), 8.15 (d, J = 8.2 Hz, 1 H); ^{13}C NMR δ 10.9, 13.6, 13.7, 19.0, 22.4, 25.3, 29.1, 29.9, 30.5, 35.1, 64.6, 74.8, 113.4, 120.1, 124.0, 126.7, 131.6, 146.5, 172.4. Anal. Calcd for $C_{19}H_{29}N_3O_3S$: C, 64.47; H, 8.16. Found: C, 64.47; H, 8.14.

***N*-Phenyl 1-(Benzotriazol-1-yl)-2-methyl-1-(methylthio)butanamide (12a).** The crude material was recrystallized from ethanol to give white crystals, mp 155 °C (75%): ^{1}H NMR δ 1.30−1.50 (m, 6 H), 1.70 (s, 3 H), 3.55 (qv, J = 6.5 Hz, 1 H), 7.10−7.50 (m, 5 H), 7.60−7.80 (m, 4 H), 8.80 (s, 1 H, N*H*); ^{13}C NMR δ 12.5, 18.6, 19.1, 34.5, 81.8, 113.1, 119.3, 120.6, 124.2, 127.4, 125.2, 129.1, 132.8, 136.9, 146.0, 164.0. Anal. Calcd for $C_{18}H_{20}N_4OS$: C, 63.53; H, 5.88; N, 16.47. Found: C, 63.49; H, 5.97; N, 16.49.

***N*-Phenyl 1-(Benzotriazol-1-yl)-1-(methylthio)hexanamide (12b).** The crude material was recrystallized from ethanol to give white crystals, mp 142−143 °C (75%): ^{1}H NMR δ 1.00 (t, J = 7.2 Hz, 3 H), 1.40−1.80 (m, 4H), 1.65 (s, 3 H), 2.80−3.10 (m, 2 H), 7.10−7.20 (m, 2 H), 7.21−7.50 (m, 5 H), 7.65−7.80 (m, 2 H), 9.45 (s, 1 H, N*H*); ^{13}C NMR δ 11.1, 13.9, 22.6, 26.1, 36.5, 78.6, 112.2, 118.8, 120.7, 124.7, 125.0, 127.6, 128.9, 131.7, 137.3, 146.0, 165.7. Anal. Calcd for $C_{19}H_{22}N_4OS$: C, 64.40; H, 6.21; N, 15.82. Found: C, 64.78; H, 6.60; N, 15.82.

2-(Benzotriazol-1-yl)-1-oxo-1-phenylhexane (9). 1-(Benzotriazol-1-yl)-1-(methylthio)pentane **2b** (2.35 g, 10 mmol) was dissolved in THF (50 mL), and a solution of *n*-BuLi (1.6 N in hexane, 6.6 mL, 10.5 mmol) was added at −78 °C under nitrogen while stirring. After 1 h, ethyl benzoate (1.65 g, 11 mmol) was added, and the reaction mixture was stirred at −78 °C for 2 h and then at room temperature for 12 h. The reaction was refluxed for 2 h and finally quenched with 100 mL of NaCl 5%. The layers were separated, and the aqueous layer was extracted with Et_2O (3 × 25 mL). The joint organic extracts were dried over $MgSO_4$, and the solvent was removed in vacuo. The residue (3.57 g) was purified by flash column chromatography on silica gel (175 g) eluting with benzene:Et_2O (95:5). The main fraction obtained was a yellow solid, which was recrystallized from ethanol, mp 104−104.5 °C (1.38 g, 40%): ^{1}H NMR δ 0.85 (t, J = 7.2 Hz, 3 H), 1.00−1.20 (m, 1 H), 1.22−1.50 (m, 3 H), 2.45 (t, J = 7.2 Hz, 2 H), 6.60 (dd, J_1 = 7.2 Hz, J_2 = 3.9 Hz, 1 H), 7.25−7.68 (m, 7 H), 8.00−8.10 (m, 2 H); ^{13}C NMR δ 13.7, 22.0, 27.9, 29.6, 63.8, 110.7, 120.1, 124.0, 127.6, 128.7, 128.9, 132.1, 134.0, 134.5, 146.5, 193.7. Anal. Calcd for $C_{18}H_{19}N_3O$: C, 73.70; H, 6.53; N, 14.32. Found: C, 73.23; H, 6.62; N, 14.46.

General Procedure for the Preparation of Ketones 4a−e. The appropriate α-benzotriazolylalkyl thioether **3a−e** (1 mmole) was solubilized in methanol (1 mL), and sulfuric acid 5% (1.1 mL) was added. The mixture was stirred at room temperature for 24 h for compounds **3a** and **3d** and heated at 60 °C for 4 h for compounds **3b,c,e** then treated with water (10 mL) and diethyl ether (25 mL). The two layers were separated in a separatory funnel, and the aqueous layer was extracted with diethyl ether (10 mL). The combined ethereal fractions were subsequently washed with sodium hydroxide 10% (2 × 10 mL) and saturated ammonium chloride (2 × 10 mL), and then the organic extract was dried over anhydrous sodium sulfate. Evaporation of the solvent gave the expected product.

Hexan-2-one (4a). Yellow oil[14] (72%): ^{1}H NMR δ 0.92 (t, J = 7.5 Hz, 3 H), 1.35 (sx, J = 7.5 Hz, 2 H), 1.55 (qv, J = 7.5 Hz, 2 H), 2.16 (s, 3 H), 2.45 (t, J = 7.5 Hz, 2 H); ^{13}C NMR δ 13.8, 22.3, 25.9, 29.8, 43.5, 209.7.

Nonan-5-one (4b). Yellow oil[14] (77%): ^{1}H NMR δ 0.92 (t, J = 7.4 Hz, 6 H), 1.31 (sx, J = 7.4 Hz, 4 H), 1.55 (q, J = 7.4 Hz, 4 H), 2.40 (t, J = 7.4 Hz, 4 H); ^{13}C NMR δ 13.8 (2C), 22.3 (2C), 25.9 (2C), 42.4 (2C), 211.6.

Oct-1-en-4-one (4c). Yellow oil[15] (80%): ^{1}H NMR δ 0.82 (t, J = 7.4 Hz, 3 H), 1.24 (sx, J = 7.4 Hz, 2 H), 1.48 (q, J = 7.4 Hz, 2 H), 2.35 (t, J = 7.4 Hz, 2 H), 3.10 (d, J = 6.8 Hz, 2 H), 5.08 (dd, J_1 = 15.5 Hz, J_2 = 9.6 Hz, 2 H), 5.84 (ddt, J_1 = 15.5 Hz, J_2 = 9.6 Hz, J_3 = 7 Hz, 1 H); ^{13}C NMR δ 13.7, 22.1, 25.6, 41.8, 47.5, 118.5, 130.6, 208.8.

1-Phenylhexan-2-one (4d). Yellow oil[16] (83%): ^{1}H NMR δ 0.86 (t, J = 7.4 Hz, 3 H), 1.26 (sx, J = 7.4 Hz, 2 H), 1.53 (qv, J = 7.4 Hz, 2 H), 2.44 (t, J = 7.4 Hz, 2 H), 3.68 (s, 2 H), 7.11−7.40 (m, 5 H); ^{13}C NMR δ 13.7, 22.1, 25.7, 41.6, 50.0, 126.8, 128.5 (2C), 129.3 (2C), 134.3, 208.5.

1-Cyclohexyl-ethanone (4e). Yellow oil[17] (74% as 87% pure); ^{1}H NMR δ 1.50−1.90 (m, 8 H) 2.20 (s, 2 H), 2.87 (qv, J = 7.7 Hz, 1 H); ^{13}C NMR δ 25.9 (2C), 28.7 (2C), 28.9, 31.0, 211.5.

General Procedure for the Hydrolysis to Functionalized Ketones 6, 8, 11, 13, and 14. The appropriate α-benzotriazolylalkyl thioether (5 mmol) was solubilized in MeOH (5 mL) and H_2SO_4 5% (5.5 mL) for **6a**,**b**, **8a**,**b**, and **11** and in THF (20 mL) and HCl 5% (11 mL) for **12a**−**c**. The reaction mixture was stirred for 24 h at room temperature for **6a**,**b**, **8a**,**b**, and **11**, and for 4 h at reflux for **12a**−**c**, and then treated with water (50 mL) and Et_2O (50 mL). The two layers were separated in a separatory funnel, and the aqueous layer was extracted with Et_2O (50 mL). The combined ethereal fractions were subsequently washed with NaOH 10% (2 × 30 mL), or $NaHCO_3$ for compound **6c** (3 × 30 mL) and satuated NH_4Cl (2 × 50 mL), and then the organic extract was dried over anhydrous Na_2SO_4. Evaporation of the solvent gave the expected product.

1-Hydroxy-1-phenylhexan-2-one (6a). Yellow oil[18] (76%): ^{1}H NMR δ 0.80 (t, J = 7.2 Hz, 3 H), 1.16 (sx, J = 7.4 Hz, 2 H), 1.46 (q, J = 7.4 Hz, 2 H), 2.32 (q, J = 7.4 Hz, 2 H), 4.45 (d, J = 4.2 Hz, 1 H), 5.05 (d, J = 4.2 Hz, 1 H), 7.20−7.40 (m, 5 H); ^{13}C NMR δ 13.5, 21.9, 25.5, 37.3, 79.5, 127.2 (2C), 128.4, 128.7 (2C), 138.0, 209.5.

1,3-Diphenyl-1-hydroxypropan-2-one (6b). White crystals[1a] (86%): ^{1}H NMR δ 3.63 (s, 2 H), 4.25 (d, J = 4.4 Hz, 1 H), 5.18 (d, J = 4.4 Hz, 1 H), 6.95−7.06 (m, 2 H), 7.20−7.46 (m, 8H); ^{13}C NMR δ 44.6, 79.2, 127.2, 127.7 (2C), 128.6 (2C), 128.9, 129.1 (2C), 129.3 (2C), 132.8, 137.5, 206.9.

1-Hydroxy-4-methyl-1-phenyl-2-pentanone (6c). Hexane was used as the eluent, to give a yellow oil, easily decomposed in air (34%, based on thioether **1**); ^{1}H NMR δ 0.70 (d, J = 6.7 Hz, 3 H), 1.10 (d, J = 6.7 Hz, 3 H), 2.20−2.34 (m, 1 H), 3.24−3.30 (m, 1 H), 3.80 (s, 2 H), 4.10−4.22 (m, 1 H), 7.15−7.40 (m, 5 H); ^{13}C NMR δ 14.8, 19.9, 30.9, 44.9, 80.2, 127.1, 128.6 (2C), 129.3 (2C), 132.9, 209.6. HRMS (CI POS) calcd for $C_{12}H_{17}O_2$ (M + 1): 193.1228, found 193.1244.

1-[(1-Hydroxy)cyclohexyl]pentan-1-one (8a). Yellow oil[18] (74%): ^{1}H NMR δ 0.92 (t, J = 7.2 Hz, 3 H), 1.33 (sx, J = 7.4 Hz, 2 H), 1.40−1.80 (m, 12 H), 2.58 (t, J = 7.4 Hz, 2 H), 3.70 (br s, 1 H); ^{13}C NMR δ 13.7, 20.9 (2C), 22.2, 25.2, 25.6, 33.7 (2C), 35.3, 77.8, 214.9.

1-(Hydroxycyclohexyl)-2-phenylethanone (8b). Yellow oil[19] (85%): ^{1}H NMR δ 1.45−1.80 (m, 10 H), 3.30 (br s, 1 H), 3.85 (s, 2 H), 7.20−7.40 (m, 5 H); ^{13}C NMR δ 20.9 (2C), 25.1, 33.7 (2C), 42.5, 78.4, 126.8, 128.4 (2C), 129.4 (2C), 133.8, 212.0.

***n*-Butyl 4-Ketooctanoate (11).** Yellow oil[20] (69%): ^{1}H NMR δ 0.80 (t, J = 7.2 Hz, 3 H), 0.90 (t, J = 7.2 Hz, 3 H), 1.20−1.40 (m, 4 H), 1.50−1.60 (m, 4 H), 2.45 (t, J = 7.2 Hz, 2 H), 2.60 (t, J = 6.3 Hz, 2 H), 2.72 (t, J = 6.3 Hz, 2 H), 4.05 (t, J = 6.6 Hz, 2 H); ^{13}C NMR δ 13.7, 13.8, 19.1, 22.3, 25.9, 27.9, 30.6, 37.0, 42.5, 64.5, 172.9, 209.2.

***N*-Phenyl 3-Methyl-2-(methylthio)-2-butenamide (13a).** White crystals mp 105−106 °C (56%): ^{1}H NMR δ 2.00 (s, 3 H), 2.10 (s, 3 H), 2.15 (s, 3 H), 7.06 (t, J = 8.0 Hz, 1 H), 7.28 (t, J = 8.0 Hz, 2 H), 7.55 (d, J = 8.0 Hz, 2 H), 8.35 (br s, 1 H, N*H*); ^{13}C NMR δ 16.9, 23.2, 24.01, 119.6 (2C), 124.3, 125.1, 129.0 (2C), 138.0, 147.3, 165.2. HRMS calcd for $C_{12}H_{15}NOS$: 221.087, found 221.090.

***N*-Phenyl 2-Ketohexanamide (14b).** White crystals[1a] mp 99−101 °C (lit. mp 99−101 °C) (48%): ^{1}H NMR δ 0.92 (t, J = 7.3 Hz, 3 H), 1.40 (sx, J = 7.3 Hz, 2 H), 1.65 (qv, J = 7.3 Hz, 2 H), 2.98 (t, J = 7.3 Hz, 2 H), 7.15 (t, J = 7.9 Hz, 1 H), 7.35 (t, J = 7.9 Hz, 2 H), 7.65 (d, J = 7.9 Hz, 2 H), 8.86 (br s, 1 H); ^{13}C NMR δ 13.7, 22.01, 25.3, 36.0, 119.7 (2C), 125.1, 129.0 (2C), 136.3, 157.6, 199.4.

3,*N*-Diphenyl-2-ketopropanamide (14c). White crystals[1a] mp 126−129 °C (lit. mp 127−129 °C) (55%): ^{1}H NMR δ 4.31 (s, 2 H), 7.14−7.43 (m, 8 H), 7.61−7.67 (m, 2H), 8.74 (brs, 1 H); ^{13}C NMR δ 42.7, 119.7 (2C), 125.3, 127.3, 128.7 (2C), 129.2 (2C), 129.8, 132.4, 136.2, 157.3, 196.2.

Supporting Information Available: ^{1}H NMR, ^{13}C NMR, and HRMS spectra for compound **13a** (4 pages). This material is contained in libraries on microfiche, immediately follows this article in the microfilm version of the journal, and can be ordered from the ACS; see any current masthead page for ordering information.

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