JOC*Note*

Ammonia-Promoted Fragmentation of 2-Alkyl- and 2,4-Dialkyl-3-iodo-1-oxocyclohexan-2,4-carbolactones

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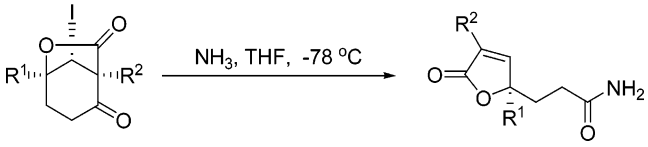


2-Alkyl- and 2,4-dialkyl-3-iodo-1-oxocyclohexan-2,4-carbolactones undergo ammonia-promoted fragmentation reactions to provide butenolides, γ-butyrolactone, and/or β,γ-epoxycyclohexanones. Product distribution is governed by the relative size of the substituents at C-2 and C-4 of the cyclohexanones. Butenolide amide, the major product from the fragmentation, is further converted into their respective piperidinone and pyrrolidine derivatives.

Previously, we reported that conformationally constrained 2-alkyl- and 2,4-dialkyl-3-iodo-1-oxocyclohexan-2,4-carbolactones (**1**) undergo a Grob-type fragmentation.[1] These reactions are promoted by either lithium hydroxide or lithium alkoxides to give a mixture of 3,5-disubstituted butenolide **2**, 5-substituted γ-butyrolactone **3**, and/or γ-hydroxycyclohexenone **4**, as depicted in Scheme 1. We have demonstrated that the distributions of the products in this process are primarily dependent upon the nature of nucleophiles (hydroxide vs alkoxide) and the steric nature of the substituents at C-2 and C-4 of substrate **1**. Herein we describe the preliminary investigation of the scope and limitations of the ammonia-promoted fragmentation of **1**.

Treatment of iodolactones **1a**−**g**[1b] with ammonia in THF at −78 °C effected an efficient fragmentation to provide butenolide **5** along with lactone **6** or cyclohexanone **7** (Table 1). Fragmentation of **1a** (R^1 = H, R^2 = Me; entry 1) afforded a 3:1 ratio of **5a** and **6a**, while the more sterically encumbered iodolactones **1b**−**d** formed butenolides **5b**−**d** exclusively in excellent yields (entries 2−4, 87−91% yields). When both C-2 and C-4 of substrate **1e** are substituted with a methyl group (entry 5), cyclohexanone **7e** was formed as a major product in 70% yield along with a 17% yield of **5e**. Fragmentation of **1f** (R^1 = Me, R^2 = Et; entry 6) gave **5f** in 92% yield and **7f** in 3% yield, whereas fragmentation of **1g** (R^1 = Bn, R^2 = Et; entry 7) gave **5g** in 83% yield and **7g** in 6% yield. It should be noted that no lactone **6** was observed in these reactions (entries 5−7).

SCHEME 1

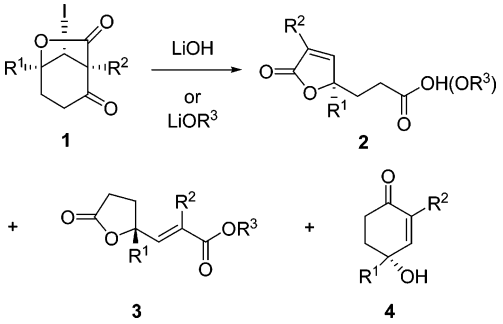
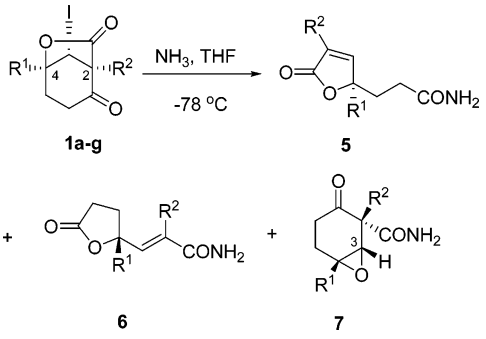


TABLE 1. Fragmentation of 1 with NH_3



				yield (%)[a]		
entry	**1**	R^1	R^2	**5**	**6**	**7**
1	**1a**	H	Me	59	18	
2	**1b**	H	$(CH_2)_3Cl$	88		
3	**1c**	H	$(CH_2)_3OBn$	91		
4	**1d**	H	$CH_2O(CH_2)_2TMS$	87		
5	**1e**	Me	Me	17		70
6	**1f**	Me	Et	92		3
7	**1g**	Bn	Et	83		6

[a] Isolated yields.

The structures of butenolides **5a**−**g** were determined by judging the characteristic downfield shifts of the vinyl protons (6.80−7.28 ppm). The structure of lactone amide **6a** was assigned on the basis of the diagnostic chemical shift of the vinyl proton (6.36 ppm) and a coupling constant (J = 8.0 Hz). Cyclohexanones **7e**−**g** showed the characteristic singlet of the methine proton at C-3 around 3.34−3.51 ppm.

Two plausible mechanisms could explain the change in selectivity as a result of C-2 and C-4 substitutions (Figure 1). Formation of **5** could commence with the addition of NH_3 to the ketone carbonyl group (pathway A) to give the aminal intermediate **8**. Subsequent ring opening of aminal **8** would provide enol **9**, which then undergoes an elimination to afford butenolide **5**. In contrast, when NH_3 attacks the lactone carbonyl carbon of **1** (pathway B), the lactone ring-opened iodo alcohol **11** would be formed through intermediate aminal **10**. An

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† Deceased January 20, 2000.

(1) (a) Schultz, A. G.; Dai, M.; Khim, S.-K.; Pettus, L.; Thakkar, K. *Tetrahedron Lett.* **1998**, *39*, 4203. (b) Khim, S.-K.; Dai, M.; Zhang, X.; Chen, L.; Pettus, L.; Thakkar, K.; Schultz, A. G. *J. Org. Chem.* **2004**, *69*, 7728. (c) Khim, S.-K.; Schultz, A. G. *J. Org. Chem.* **2004**, *69*, 7734.

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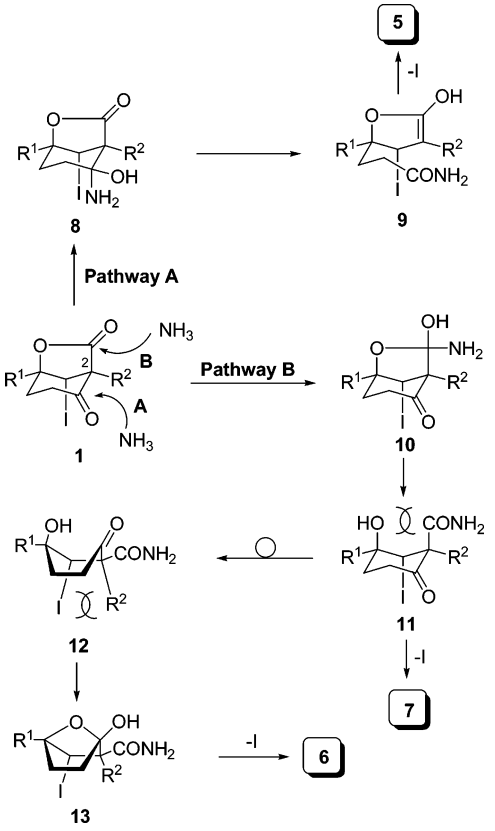
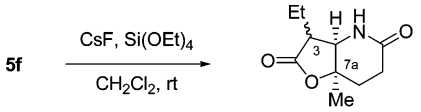


FIGURE 1. Proposed mechanisms for fragmentation of **1** with NH_3.

intramolecular substitution reaction of the resultant iodo alcohol **11** then provides cyclohexanone **7**. On the other hand, it is conceivable that **11** could undergo a conformational change to render the boat conformer **12**. This might be preferred, due to the sterically unfavorable 1,3-diaxial interaction between the tertiary alcohol and amide functional groups of **11**. Transannular cyclization of **12** would give rise to lactol **13**, which then undergoes a fragmentation to give **6**. The observation that **6a** is the only byproduct resulting from the fragmentation of substrates **1a**−**d** (Table 1, entries 1−4) suggests that R^2 substituents at C-2 of **1** play an important role in determining the chemoselectivity of substrates. It appears that when R^2 is small (entry 1), pathways A and B are competitive. However, when R^2 substituents are sterically demanding (entries 2−4), the approach of NH_3 to the lactone carbonyl (pathway B) is completely blocked by the substituents on R^2. Consequently, NH_3 chemoselectively attacks the ketone carbonyl (pathway A) to provide butenolide **5**. It is interesting to note that epoxide **7**, not lactone **6**, is the only byproduct resulting from the fragmentation of carbolactones **1e**−**g** (entries 5−7). These results imply that the conformational change from **11** to **12** is far slower than the intramolecular substitution of **11** to **7**, due to a repulsive 1,2-interaction between iodo and R^2 (Et) groups.

Selective formation of butenolide **5** prompted us to investigate the synthetic application of the fragmentation products. We were particularly interested in the construction of *N*-heterocycles such as quinolizidines, indolizidines, and pyrrolizidines, which are pivotal structural elements of a number of biologically interesting

SCHEME 2



14 (α-Et):**15** (β-Et)

Reaction time (h)	Yield (%)	
	14	**15**
12	38	38
72	0	62

natural alkaloids. To this end, first we explored the feasibility of forming piperidine ring systems from **5** through an intramolecular cyclization.[2] To achieve this goal, sufficiently mild reaction protocols were needed. After a brief investigation, we were delighted to find that employing cesium fluoride (CsF) and tetraethyl orthosilicate ($Si(OEt)_4$) rendered the desired intramolecular conjugate addition product with good yields.[3] Thus, treatment of **5f** with CsF and $Si(OEt)_4$ in CH_2Cl_2 at room temperature smoothly afforded cyclized products **14** and **15** as a mixture of diastereomers (1:1) in 76% combined yield, as shown in Scheme 2.[4,5] Increased reaction times (72 h) allowed the complete epimerization at C-3 to give **15** as the sole product in 62% yield from **5f**. The structure and stereochemistry of **15** were determined unambiguously by a single-crystal diffraction study.[6] The X-ray crystal structure of **15** indicates that the 1,3-repulsive interaction between the methyl group at C-7a and the ethyl group at C-3 of **14** might be responsible for this thermodynamic equilibration. In addition, Gaussian 98 calculations show that **15** is more stable than **14** by 0.28 kcal/mol.[7] Absolute facial selectivity (*Re* face addition of the nucleophilic amide group) observed in this cyclization process is the direct consequence of the stereochemical configuration at the C-7a tether bearing a terminal amide group.

It should be mentioned that subjecting 5-monosubstituted butenolides **5a**−**d** to identical reaction conditions (CsF and $Si(OEt)_4$) failed to provide the corresponding cyclized product. This is probably due to the presence of an acidic methine hydrogen at C-5 of **5**, which could be

(2) For a few examples of *N*-conjugate additions to α,β-unsaturated esters, see: (a) Fang, F. G.; Prato, M.; Kim, G.; Danishefsky, S. J. *Tetrahedron Lett*. **1989**, *30*, 3625. (b) Cabral, J.; Laszlo, P.; Mahé, L.; Montaufier, M.-T.; Randriamahefa, S. L. *Tetrahedron Lett*. **1989**, *30*, 3969. (c) Maggini, M.; Prato, M.; Ranelli, M.; Scorrano, G. *Tetrahedron Lett*. **1992**, *33*, 6537.

(3) (a) Chuit, C.; Corriu, R. J. P.; Reye, C. *Tetrahedron Lett*. **1982**, *23*, 5531. (b) Corriu, R. J. P.; Perz, R. *Tetrahedron Lett*. **1985**, *26*, 1311. (c) Chuit, C.; Corriu, R. J. P.; Perz, R.; Reye, C. *Tetrahedron* **1986**, *42*, 2293.

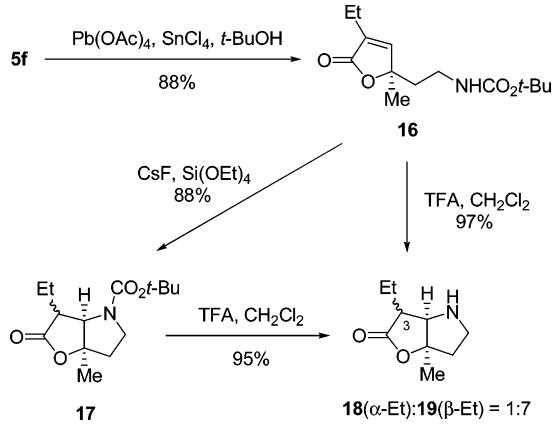
(4) (a) Ahn, K. H.; Lee, S. J. *Tetrahedron Lett*. **1994**, *35*, 1875. (b) Iovel, I.; Golomba, L.; Popelis, J.; Gaukhman, A.; Lukevics, E. *Appl. Organomet. Chem*. **2001**, *15*, 67.

(5) For inter- and intramolecular conjugate additions of *N*-nucleophiles to γ-butenolides, see: (a) Feringa, B. L.; de Lange, B. *Tetrahedron Lett.* **1988**, *29*, 1303. (b) de Lange, B.; van Bolhuis, F.; Feringa, B. L. *Tetrahedron* **1989**, *45*, 6799. (c) Tanaka, M.; Murakami, T.; Suemune, H.; Sakai, K. *Heterocycles* **1992**, *33*, 697. (d) Collis, M. P.; Hockless, D. C. R.; Perlmutter, P. *Tetrahedron Lett.* **1995**, *36*, 7133. (e) Wang, Z. Y.; Jian, T. Y.; Chen, Q. H. *Chin. Chem. Lett*. **1999**, *10*, 889. (f) Niu, D.; Zhao, K. *J. Am. Chem. Soc*. **1999**, *121*, 2456. (g) Sohtome, Y.; Tanatani, A.; Hashimoto, Y.; Nagasawa, K. *Chem. Pharm. Bull*. **2004**, *52*, 477.

(6) See the Supporting Information for X-ray crystallographic data.

(7) See the Supporting Information for energy-minimized structures of **14** and **15**.

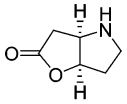
SCHEME 3



readily deprotonated by the ethoxide anion formed in situ and consequently impede the desired conjugate addition process.

Next, we envisioned that pyrrolidines could be obtained from butenolide **5** through a similar cyclization reaction. However, to gain an access to such frameworks, a butenolide possessing a nitrogen atom two carbons away from C-5 was needed. The required transformation was achieved through an oxidative Hoffmann rearrangement (Scheme 3).[8] Thus, treatment of **5f** with lead tetraacetate ($Pb(OAc)_4$) and *tert*-butyl alcohol in the presence of tin(IV) chloride ($SnCl_4$) uneventfully provided the desired butenolide carbamate **16** in 88% yield.[9] Reaction of **16** with CsF and $Si(OEt)_4$ in CH_2Cl_2 at room temperature provided pyrrolidine **17** in 88% yield. After *t*-Boc group deprotection with trifluoroacetic acid (TFA), pyrrolidines **18** and **19** were cleanly produced in a 1:7 ratio with a 95% combined yield. The structures of **18** and **19** were assigned by ^{1}H NMR analysis of methine protons at C-3 (3.54 ppm and 6.6 Hz for **18**, 3.34 ppm and 2.5 Hz for **19**). It was also found that direct treatment of **16** with TFA effected cyclization to give rise to pyrrolidines **18** and **19** in the same ratio with a 97% combined yield. Preferential formation of the β-isomer **19** reflects the greater thermodynamic stability of **19** over **18**, which was determined to be 0.96 kcal/mol by Gaussian 98 calculations.[10]

It is of interest to note that **18** and **19** resemble the Geissman−Waiss lactone **20**,[11,12] which has served as a versatile synthon for the synthesis of pyrrolizidine alkaloids such as retronecine and platynecine.[13] Therefore,



20

the method presented above may offer an easy access to the analogue synthesis of necine-type alkaloids.

In summary, we have shown that iodolactones **1a**−**g** undergo facile fragmentation reactions with NH_3 to selectively give butenolide **5** over lactone **6** and cyclohexanone **7** in good to excellent yields.[14] It is proposed that the pathways leading to the different products are governed primarily by the relative size of substituents at C-2 and C-4 of **1**. Butenolide **5f** can be converted into *N*-heterocycles such as piperidones and pyrrolidines. In particular, the efficient synthesis of the substituted Geissman−Waiss lactones using this method may offer a valuable means for the efficient synthesis of a variety of necine analogues.

Experimental Section

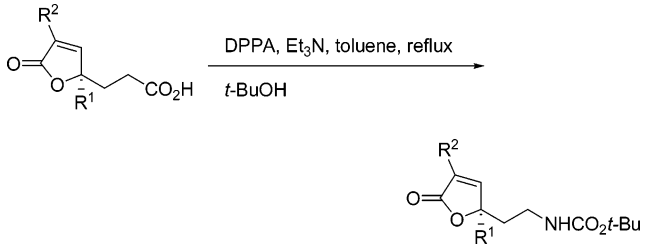
General Procedure for Fragmentation of 1 with NH_3. To a solution of **1a** (280 mg, 1.0 mmol) in dry THF (5 mL) was introduced NH_3 (ca. 3 mL by condensing with a cold finger condenser) at −78 °C. The resulting solution was stirred for 0.5 h and slowly warmed to room temperature under a stream of nitrogen until NH_3 and THF were completely evaporated. ^{1}H NMR spectrum analysis of the crude mixture showed the ratio of **5a** and **6a** to be 76:24. The crude residue was partitioned between water and CH_2Cl_2. The organic layers were separated, dried over anhydrous Na_2SO_4, and concentrated under reduced pressure. The residue was purified by flash column chromatography (hexanes/EtOAc, 4:1 to 1:1) to give **5a** (99 mg, 59%) and **6a** (30 mg, 18%).

(5*R*)-[3-Methyl-5-(2′-aminocarbonyl)ethyl]furan-2(5*H*)-one (5a): white solid; $[\alpha]^{25}_D = -121.4$ (*c* 2.52, MeOH); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.05 (s, 1 H), 5.85 (br s, 1H), 5.69 (br s, 1H), 4.97 (m, 1H), 2.43−2.32 (m, 2H), 2.26−2.20 (m, 1H), 1.90 (d, J = 1.5 Hz, 3H), 1.82−1.74 (m, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 173.9, 164.4, 148.7, 130.1, 80.1, 30.4, 28.6, 10.6; IR 3422, 3207, 1748, 1669 cm^{-1}; CIMS *m/z* 170 ($M^+ + 1$, 100). Anal. Calcd for $C_8H_{11}NO_3$: C, 56.80; H, 6.55; N, 8.28. Found: C, 56.72; H, 6.40; N, 8.17.

(2*R*,2*E*)-2-Methyl-3-(tetrahydro-5-oxofuranyl)-2-propenamide (6a): white solid; $[\alpha]^{25}_D = -72.6$ (*c* 1.15, MeOH); ^{1}H NMR (500 MHz, CD_3OD) δ 6.36 (d, J = 8.0 Hz, 1H), 5.26 (q, J = 7.6 Hz, 1H), 2.62−2.58 (m, 2H), 2.51−2.45 (m, 1H), 2.07−1.99 (m, 1H), 1.94 (s, 3H); ^{13}C NMR (125 MHz, CD_3OD) δ 177.1, 173.0, 137.9, 131.4, 67.3, 32.0, 31.1, 12.9; IR 3689, 3373, 1734, 1668 cm^{-1}; CIMS *m/z* 170 ($M^+ + 1$, 100). Anal. Calcd for $C_8H_{11}NO_3$: C, 56.80; H, 6.55; N, 8.28. Found: C, 56.77; H, 6.49; N, 8.16.

(8) (a) Acott, B.; Beckwith, A. L. J.; Hassanali, A. *Aust. J. Chem.* **1968**, *21*, 185. (b) Simon, S. S., Jr. *J. Org. Chem.* **1973**, *38*, 414. (c) Baumgarten, H. E.; Smith, H. L.; Staklis, A. *J. Org. Chem.* **1975**, *40*, 3554.

(9) These carbamates could also be directly obtained from butenolide carboxylic acids **2** by Curtius rearrangement. (a) Reference 1b. (b) Schultz, A. G.; Dai, M. Unpublished results.



(10) See the Supporting Information for energy-minimized structures of **18** and **19**.

(11) Geissman, T. A.; Waiss, A. C., Jr. *J. Org. Chem.* **1962**, *27*, 139.

(12) For the recent synthesis of the Geissman−Waiss lactone, see: (a) Thaning, M.; Wistrand, L.-G. *J. Org. Chem.* **1990**, *55*, 1406. (b) Takahata, T.; Banba, Y.; Momose, T. *Tetrahedron: Asymmetry* **1991**, *2*, 445. (c) Tanaka, M.; Murakami, T.; Suemune, H.; Sakai, K. *Heterocycles* **1992**, *33*, 697. (d) Cooper, J.; Gallagher, P. T.; Knight, D. W. *J. Chem. Soc., Perkin Trans. 1* **1993**, 1313. (e) de Faria, A. R.; Matos, C. R. R.; Correia, C. R. D. *Tetrahedron Lett.* **1993**, *34*, 27. (f) Paolucci, C.; Venturelli, F.; Fava, A. *Tetrahedron Lett.* **1995**, *36*, 8127. (g) Kouyama, T.; Matsunaga, H.; Ishizuka, T.; Kunieda, T. *Hetercycles* **1997**, *44*, 479. (h) Wee, A. G. H. *Tetrahedron Lett.* **2000**, *41*, 9025.

(13) For the synthetic applications of the Gaissman−Waiss lactone to pyrrolizidine alkaloids, see: (a) Rüeger, H.; Benn, M. *Heterocycles* **1983**, *20*, 1331. (b) See also ref 10h.

(14) As an exception, **7** is preferred for the substrate **1e** (Table 1, entry 5).

Cyclization of 5f. To a solution of butenolide amide **5f** (200 mg, 1.01 mmol) and $Si(OEt)_4$ (0.49 mL, 2.20 mmol) in CH_2Cl_2 (2 mL) was added CsF (334 mg, 2.20 mmol) at room temperature. The reaction mixture was stirred overnight and diluted with water. The reaction mixture was then extracted with 10% MeOH in CH_2Cl_2. The combined organic layers were dried over anhydrous Na_2SO_4 and concentrated under reduced pressure. Flash column chromatography (EtOAc) of the crude residue gave an inseparable mixture of **14** and **15** in a ratio of 1:1 (152 mg, 76%) as a white solid.

(3*R*,3a*R*,7a*R*)-3-Ethyltetrahydro-7a-methylfuro[3,2-*b*]-pyridine-2,5(3*H*,4*H*)-dione (14); white solid; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.53 (br s, 1H), 3.60 (dd, J = 6.8, 3.4 Hz, 1H), 2.60 (m, 1H), 2.47−1.70 (m, 6H), 1.57 (s, 3H), 1.09 (t, J = 7.5 Hz, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 175.7, 172.1, 79.4, 61.2, 51.6, 30.9, 27.9, 26.3, 23.1, 11.4; IR 1769, 1662 cm^{-1}; CIMS *m/z* 198 (M^+ + 1, 100).

(3*S*,3a*R*,7a*R*)-3-Ethyltetrahydro-7a-methylfuro[3,2-*b*]-pyridine-2,5(3*H*,4*H*)-dione (15). The same reaction described above was performed for 72 h. Flash column chromatography (EtOAc) of the crude residue provided **15** (122 mg, 62%) as a white solid. The compound was crystallized from hexanes/EtOAc (3:1): $[\alpha]^{25}_D = -116.7$ (*c* 1.2, $CHCl_3$); ^{1}H NMR (500 MHz, $CDCl_3$) δ 6.94 (br s, 1H), 3.93 (d, J = 6.1 Hz, 1H), 2.76 (m, 1H), 2.48−1.52 (m, 6H), 1.50 (s, 3H), 1.06 (t, J = 7.5 Hz, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 176.1, 172.0, 79.4, 58.7, 47.3, 31.1, 26.4, 25.5, 17.9, 12.4; IR 1769, 1662 cm^{-1}; CIMS *m/z* 198 (M^+ + 1, 100). Anal. Calcd for $C_{10}H_{15}NO_3$: C, 60.90; H, 7.67; N, 7.10. Found: C, 60.68; H, 7.63; N, 6.93.

Hoffmann Rearrangement of 5f. To a solution of butenolide amide **5f** (160 mg, 0.80 mmol) in pyridine (8 mL) was added $Pb(OAc)_4$ (1.06 g, 2.40 mmol) at room temperature. The reaction mixture was stirred at 60 °C for 2 h. The resulting mixture was then treated with anhydrous *t*-BuOH (600 μL) via syringe and stirred at 60 °C overnight. The reaction mixture was cooled to room temperature, diluted with diethyl ether, and washed with water and brine. The combined organic layers were dried over anhydrous Na_2SO_4 and concentrated under reduced pressure. Flash column chromatography (hexanes/EtOAc, 2:1) of the crude residue gave **16** (192 mg, 88%) as a pale yellow oil.

(5*R*)-3-Ethyl-5-methyl-5-[[2′-[(*tert*-butoxy)carbonyl]-amino]ethyl]furan-2(5*H*)one (16): $[\alpha]^{25}_D = -25.7$ (*c* 1.4, $CHCl_3$); ^{1}H NMR (500 MHz, $CDCl_3$) δ 6.91 (s, 1 H), 4.76 (br s, 1 H), 3.04 (m, 2 H), 2.22 (AB q, J = 7.4 Hz, 2 H), 1.90 (m, 2 H), 1.38 (s, 3 H), 1.36 (s, 6 H), 1.09 (t, J = 7.4 Hz, 3 H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 173.0, 155.9, 151.3, 135.1, 85.7, 79.3, 38.3, 36.0, 28.4, 24.4, 18.5, 11.8; IR 3855, 1756, 1704 cm^{-1}; CIMS *m/z* 270 (M^+ + 1, 2), 214 (100). Anal. Calcd for $C_{14}H_{23}NO_4$: C, 62.43; H, 8.61; N, 5.20. Found: C, 62.22; H, 8.61; N, 5.14.

Cyclization of 16 in the Presence of TFA. To a solution of **16** (168 mg, 0.62 mmol) in CH_2Cl_2 (10 mL) was added TFA (0.5 mL) at room temperature. The reaction mixture was stirred overnight, neutralized with saturated aqueous $NaHCO_3$ solution, and extracted with CH_2Cl_2. The combined organic layers were dried over anhydrous Na_2SO_4 and concentrated under reduced pressure. Flash column chromatography (MeOH/EtOAc, 1:10) of the crude residue gave a mixture of **18** and **19** (102 mg, 97%) in a ratio of 1:7 as a yellow oil.

(3*R*,3a*R*,6a*R*)-3-Ethylhexahydro-6a-methyl-2*H*-furo-[3,2-*b*]pyrrol-2-one (18): yellow oil; $[\alpha]^{25}_D = +37.5$ (*c* 0.4, $CHCl_3$); ^{1}H NMR (500 MHz, $CDCl_3$) δ 3.54 (d, J = 6.6 Hz, 1H), 3.00 (m, 2H), 2.54 (m, 1H), 2.19 (m, 1H), 1.85 (m, 3H), 1.60 (m, 1H), 1.50 (s, 3H), 1.03 (t, J = 7.3 Hz, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 178.0, 92.0, 65.0, 46.3, 45.7, 40.0, 23.1, 18.7, 12.6; IR 3853, 1759 cm^{-1}; CIMS *m/z* 170 (M^+ + 1, 100); HRMS calcd for $C_9H_{15}NO_2$ (M^+ + 1) *m/z* 170.1182, found *m/z* 170.1179.

(3*S*,3a*R*,6a*R*)-3-Ethylhexahydro-6a-methyl-2*H*-furo-[3,2-*b*]pyrrol-2-one (19): yellow oil; $[\alpha]^{25}_D = +39.1$ (*c* 1.1, $CHCl_3$); ^{1}H NMR (500 MHz, $CDCl_3$) δ 3.34 (d, J = 2.5 Hz, 1H), 3.00 (m, 2H), 2.40−1.62 (m, 6H), 1.56 (s, 3H), 1.06 (t, J = 7.5 Hz, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 178.8, 92.5, 68.6, 51.4, 45.5, 40.8, 25.7, 24.6, 11.9; IR 1755 cm^{-1}; CIMS *m/z* 170 (M^+ + 1, 100); HRMS calcd for $C_9H_{15}NO_2$ (M^+ + 1) *m/z* 170.1182, found *m/z* 170.1178.

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Note Added after ASAP Publication. There was an error in the discussion of the attempted reaction of **5a**−**d** to provide cyclized product and an error in the yield data of **18** and **19** in the version published ASAP November 24, 2004; the corrected version was published ASAP December 3, 2004.

Supporting Information Available: Text giving experimental procedures and characterization data for all new compounds, figures giving ^{1}H and ^{13}C NMR spectra of **5b**, an 1:1 mixture of **14** and **15**, **18**, and **19**, and an ORTEP drawing and tables of crystallographic data for **15**; crystal data are also available as a CIF file. This material is available free of charge via the Internet at http://pubs.acs.org.

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