Chiral Enol Ethers in Asymmetric Synthesis: Preparation of the β-Oxygenated Lactones (−)-Blastmycinolactol, (+)-Blastmycinone, (−)-NFX-2, and (+)-Antimycinone

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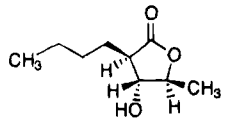
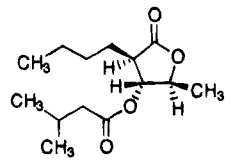
β-Oxygenated γ-butyrolactones have been isolated from several different natural sources and also obtained as degradation products of metabolites.[1] Representative of members of this class are (−)-blastmycinolactol (**1**) and (+)-blastmycinone (**2**), hydrolysis products of (+)-antimycin A_3,[1a-c] (−)-NFX-2 (**3**), a virginiamycin inducing factor from *Streptomyces antibioticus* NF-18,[1g] and (+)-antimycinone (**4**), a degradation product from (+)-antimycin A_1.[1h] While several approaches to racemic and optically active blastmycinolactol and blastmycinone have been published,[2,3] to date only two kinetic resolution (lipase) based syntheses of (−)-NFX-2 have been reported,[1h,3] and (+)-antimycinone has apparently yet to be prepared by total synthesis.



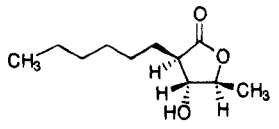
(-)-Blastmycinolactol

1



(+)-Blastmycinone

2



(-)-NFX-2

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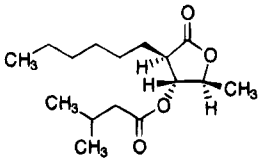
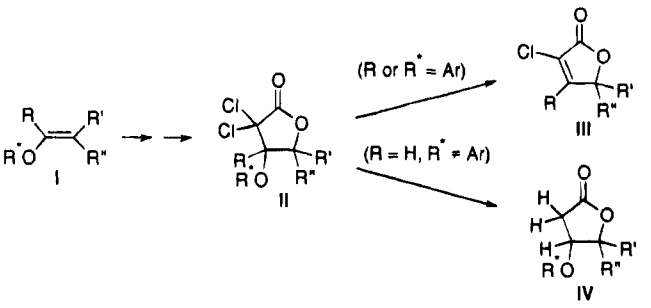


(+)-Antimycinone

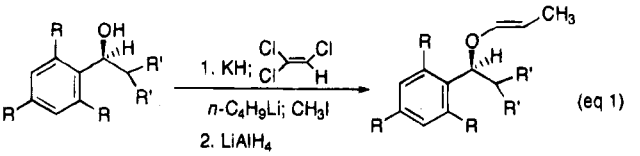
4

We have recently demonstrated the feasibility of using chiral olefin diastereofacial differentiation for enantioselective lactone construction through the preparation of methylenolactocin,[4a] protolichesterinic acid,[4b] and whiskey lactone.[4c] In these syntheses, reductive elimination leading to the α-chlorobutenolides III smoothly occurred on treatment of the α,α-dichloro-γ-butyrolactones II with zinc metal or chromous perchlorate (Chart 1). Contrariwise, it was found that in the absence of aryl activation, clean reduction took place *without* concomitant auxiliary elimination and provided the butyrolactones IV. At the time unwelcome, this result has now been exploited for highly enantioselective syntheses of (−)-blastmycinolactol, (+)-blastmycinone, (−)-NFX-2, and (+)-antimycinone.

Chart 1



To permit ultimate cleavage to a hydroxyl group, benzylic alcohol inductors were the obvious choice, in particular 2-methyl-1-phenylpropanol (**5a**), which had previously been used with notable success by Posner and Wettlaufer[5] for chirality control in an inverse electron demand Diels–Alder reaction. This alcohol was readily converted[6] to its *E*-propenyl derivative **6a** as shown in eq 1; dichloroketene cycloaddition proceeded though with



5 a, R = H, R' = CH_3
b, R = R' = H
c, R = CH_3, R' = H
d, R = *i*-C_3H_7, R' = H

6 a-d

remarkably little face preference (55:45). The corresponding enol ether **6b** derived from 1-phenylethanol, however, displayed enhanced diastereoselection (75:25), and therefore the *E*-propenyl derivatives **6c** and **6d** from 1-mesitylethanol and 1-(triisopropylphenyl)ethanol, respectively, were prepared. While use of the former auxiliary afforded the diastereomeric α,α-dichlorocyclobutanones in a somewhat improved 85:15 ratio, *application of the latter produced a much more impressive 95:5 diastereofacial preference in this key cycloaddition reaction.* The representation in Figure 1 depicts the lowest-energy ground state conformation of enol ether **6d** as discerned by molecular mechanics calculations and clearly indicates that cycloaddition should in fact take place, as observed, highly selectively on the C_α-*re* face.[7]

(1) See, for example: (a) Yonehara, H.; Takeuchi, S. *J. Antibiot., Ser. A* **1958**, *11*, 254. (b) van Tamelen, E. E.; Dickie, J. P.; Loomans, M. E.; Dewey, R. S.; Strong, F. M. *J. Am. Chem. Soc.* **1961**, *83*, 1639. (c) Birch, A. J.; Cameron, D. W.; Harada, Y.; Richards, R. W. *J. Chem. Soc.* **1961**, 889. (d) Takeda, K.; Sakurawi, K.; Ishii, H. *Tetrahedron*, **1972**, *28*, 3757. (e) Martinez, V. J. C.; Yoshida, M.; Gottlieb, O. R. *Phytochemistry* **1981**, *20*, 459. (f) Ravi, B. N.; Wells, R. *Aust. J. Chem.* **1982**, *35*, 105. (g) Li, W.; Nihira, T.; Sakuda, S.; Nishida, T.; Yamada, Y. *J. Ferment. Bioeng.* **1992**, *74*, 214. (h) Nishida, T.; Nihira, T.; Yamada, Y. *Tetrahedron* **1991**, *47*, 6623.

(2) See: Nishide, K.; Aramata, A.; Kamanaka, T.; Inoue, T.; Node, M. *Tetrahedron* **1994**, *50*, 8337, and references cited therein.

(3) Takahata, H.; Uchida, Y.; Momose, T. *J. Org. Chem.* **1994**, *59*, 7201.

(4) (a) B. M. de Azevedo, M.; Murta, M. M.; Greene, A. E. *J. Org. Chem.* **1992**, *57*, 4567. (b) Murta, M. M.; B. M. de Azevedo, M.; Greene, A. E. *J. Org. Chem.* **1993**, *58*, 7537. (c) Luche, M-J. Unpublished results from this laboratory ((3*S*,4*R*)-3-methyl-4-octanolide).

(5) Posner, G. H.; Wettlaufer, D. G. *Tetrahedron Lett.* **1986**, *27*, 667; *J. Am. Chem. Soc.* **1986**, *108*, 7373.

(6) Moyano, A.; Charbonnier, F.; Greene, A. E. *J. Org. Chem.* **1987**, *52*, 2919.

(7) Molecular modeling was performed on a Silicon Graphics 25G workstation running Insight II Discover, version 2.3.0 (Biosym Technologies, San Diego). The structure was energy minimized with the force field cvff.frc. and the minimization algorithm VA09A. The molecular dynamics was performed at 300 K *in vacuo* (dielectric constant fixed at 1; 10 000 steps of 1 fs) and consisted of generation and minimization of 500 structures. The depicted conformation is lowest in energy by 1.7 kcal/mol. (The next lowest in energy would also be expected to undergo cycloaddition largely on the C_α-*re* face.)

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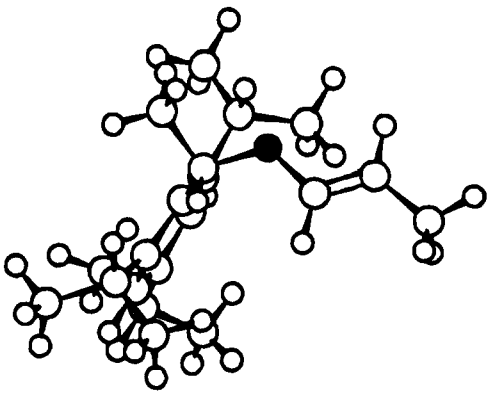
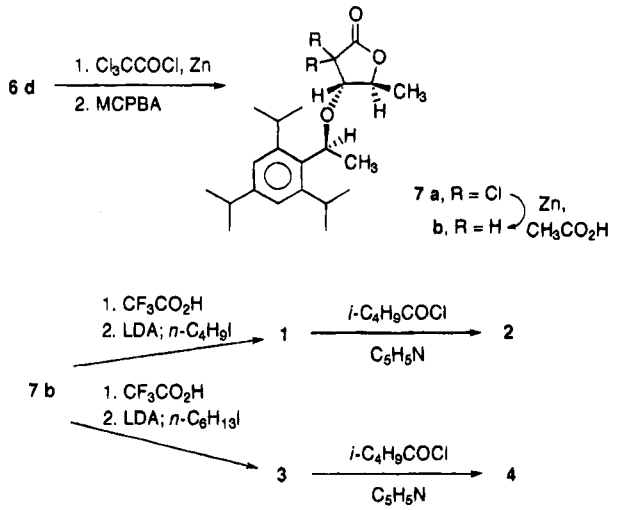


Figure 1. Global minimum-energy conformation of enol ether **6d** (● = oxygen).

Scheme 1



Baeyer–Villiger ring expansion of this 95:5 α,α-dichlorocyclobutanone mixture occurred with apparently total regioselectivity on reaction with *m*-chloroperbenzoic acid (MCPBA) in dichloromethane in the presence of sodium bicarbonate[4] to give efficiently α,α-dichloro-γ-butyrolactone **7a** (Scheme 1). The crude product, as expected, suffered dechlorination without discernible inductor elimination with zinc in acetic acid to provide lactone **7b** in 50% yield from ether enol **6d** (79%/step). The ca. 5% diastereomeric contamination carried forth to this stage from the cycloaddition could now be conveniently removed by simple recrystallization.

The enantiomerically pure hydroxy lactone was secured in 80% yield from **7b** by exposure to neat trifluoroacetic acid[8] at ambient temperature, and then alkylated[9] with 1-iodobutane and 1-iodohexane to produce stereoselectively (−)-blastmycinolactol (**1**) and (−)-NFX-2 (**3**), respectively. Finally, esterification of these alcohols with isovaleryl chloride[10] provided enantiomerically pure (+)-blastmycinone (**2**) and (+)-antimycinone (**4**).

In that β-hydroxy-γ-butyrolactone α-alkylidenation has been reported,[9b] the above approach is also directly applicable to the preparation of such derivatives in enantiopure form (e.g., (−)-isodihydromahubanolide B[1e] and (−)-litsenolides B1, B2, C1, and C-2[1d]).

(8) Posner, G. H.; Kinter, C. M. *J. Org. Chem.* **1990**, *55*, 3967.

(9) (a) Shieh, H-M.; Prestwich, G. D. *J. Org. Chem.* **1981**, *46*, 4319; *Tetrahedron Lett.* **1982**, *23*, 4643. (b) Chen, S-Y.; Joullié, M. M. *J. Org. Chem.* **1984**, *49*, 2168. See also reference 3.

(10) Nakata, T.; Fukui, M.; Oishi, T. *Tetrahedron Lett.* **1983**, *24*, 2657. See also reference 2.

Experimental Section[11]

(−)-2-((1*S*)-1-((1*E*)-1-Propenyloxy)ethyl)-1,3,5-triisopropylbenzene (6d). A 250-mL flask was flushed with argon and charged with 2.60 g (22.7 mmol) of a 35% suspension of potassium hydride in mineral oil. The mineral oil was removed by washing with pentane and the flask was capped with a rubber septum and connected to a Nujol-filled bubbler by means of a syringe needle. A solution of 2.80 g (11.3 mmol) of alcohol **5d**[12] in 23 mL of anhydrous tetrahydrofuran was then added dropwise by syringe over 20 min. The mixture was stirred until hydrogen evolution was complete (ca. 20 min), cooled to −50 °C, and treated dropwise over 15 min with a solution of trichloroethylene (1.00 mL, 1.46 g, 11.1 mmol) in 13.5 mL of anhydrous tetrahydrofuran, after which the reaction mixture was allowed to warm to 20 °C and stirred for 2 h. The resulting brown solution was then cooled to −70 °C and treated dropwise with 15.4 mL (33.9 mmol) of 2.2 M *n*-butyllithium in hexanes. After being stirred for 30 min at −70 °C, the reaction mixture was warmed to −40 °C over 30 min and treated dropwise with a solution of 4.20 mL (9.58 g, 67.5 mmol) of iodomethane in 17.3 mL of hexamethylphosphoramide. The solution was stirred at 20 °C for 2 h, whereupon it was quenched by slow addition of methanol and poured into cold saturated aqueous ammonium chloride. The crude product was isolated with pentane in the usual way and purified by flash chromatography on silica gel (pretreated with 2.5% triethylamine, v/v) with hexane to afford 2.80 g (87%) of the acetylenic ether: mp 38–40 °C; $[\alpha]^{20}_D$ −117° (*c* 2.5, chloroform); IR 2270, 1620, 1260 cm^{-1}; ^{1}H NMR (300 MHz) δ 1.17–1.30 (m, 18 H), 1.65 (s, 3 H), 1.69 (d, *J* = 6.9 Hz, 3 H), 2.81–2.91 (m, 1 H), 3.33–3.37 (m, 2 H), 5.61 (q, *J* = 6.9 Hz, 1 H), 7.00 (s, 2 H). Anal. Calcd for $C_{20}H_{30}O$: C, 83.86; H, 10.56. Found: C, 83.60; H, 10.54.

A solution of 500 mg (1.75 mmol) of the acetylenic ether in 13 mL of THF was added to a stirred suspension of 500 mg (13.2 mmol) of lithium aluminum hydride in 13 mL of THF, and the resulting mixture was refluxed for 2 h. After being allowed to cool to 20 °C, the mixture was slowly treated sequentially with 0.5 mL of water, 0.5 mL of 10% aqueous sodium hydroxide, and 1.5 mL of water. Following the addition of sodium sulfate, the mixture was filtered and the solvent was removed under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (pretreated with 2.5% triethylamine, v/v) with hexane to give 355 mg (71%) of enol ether **6d**: mp 39–41 °C; $[\alpha]^{20}_D$ −31° (*c* 2.0, chloroform); IR 1670, 1655, 1610 cm^{-1}; ^{1}H NMR (300 MHz) δ 1.20–1.27 (m, 18 H), 1.47 (dd, *J* = 7.0, 1.7 Hz, 3 H), 1.52 (d, *J* = 7.0 Hz, 3 H), 2.86 (m, 1 H), 3.50 (m, 2 H), 4.88 (dq, *J* = 13.5, 7.5 Hz, 1 H), 5.32 (q, *J* = 7.0 Hz, 1 H), 6.04 (dd, *J* = 13.5, 7.0 Hz, 1 H), 6.99 (s, 2 H); mass spectrum (EI), *m*/*z* 288 (M^+), 273, 245, 231, 147, 43. Anal. Calcd for $C_{20}H_{32}O$: C, 83.27; H, 11.18. Found: C, 83.66; H, 11.21.

(−)-(4*R*,5*S*)-Dihydro-5-methyl-4-((*S*)-1-(2,4,6-triisopropylphenyl)ethoxy)-2(3*H*)-furanone (7b). To a stirred mixture

(11) Isolation of the crude product was generally accomplished by pouring the reaction mixture into water and then thoroughly extracting the separated aqueous phase with the specified solvent. After being washed with 10% aqueous hydrochloric acid and/or saturated aqueous sodium bicarbonate (if required), water, and brine, the combined organic phases were dried over anhyd sodium sulfate or magnesium sulfate and then filtered and concentrated under reduced pressure on a Büchi Rotovapor to yield the crude reaction product. Tetrahydrofuran and ether were distilled from sodium–benzophenone, and dichloromethane, pyridine, and hexamethylphosphoric triamide were distilled from calcium hydride. Thin-layer chromatography was performed on Merck 60F_{254} (0.2 mm) sheets, which were visualized with molybdophosphoric acid in ethanol. Merck 70–230 silica gel 60 was employed for column chromatography. A Perkin–Elmer 397 spectrophotometer was used to record IR spectra (neat or as Nujol films). Brucker WPSY 80, AC 200, and AM 300 spectrometers were used for the ^{1}H and ^{13}C NMR spectra ($CDCl_3$ solutions). Mass spectra were obtained on an AEI MS-30 mass spectrometer (70 eV, direct insert probe). Optical rotations were measured on a Perkin-Elmer 241 polarimeter. Melting points were obtained with a Buchi-Tottoli apparatus and are not corrected. Microanalysis were performed by the Central Service of the CNRS.

(12) (*S*)-1-(Triisopropylphenyl)ethanol was prepared by the CBS method (Corey, E. J.; Bakshi, R. K.; Shibata, S.; Chen, C-P.; Singh, V. K. *J. Am. Chem. Soc.* **1987**, *109*, 7925) and enriched to enantiopurity through recrystallization of its menthoxycarbonyl derivative: mp 75–76 °C; $[\alpha]^{24}_D$ −23 ° (*c* 2.1, chloroform).

of 1.50 g (5.21 mmol) of enol ether **6d** and 4.80 g (ca. 73 mmol) of Zn–Cu couple in 45 mL of ether under argon was added over 1 h 1.40 mL (2.28 g, 12.5 mmol) of freshly distilled trichloroacetyl chloride in 14 mL of ether. After an additional 1 h, the ether solution was separated from the excess couple and added to hexane, and the resulting mixture was partially concentrated under reduced pressure in order to precipitate the zinc chloride. The supernatant was decanted and washed successively with a cold aqueous solution of sodium bicarbonate, water, and brine and then dried over anhydrous sodium sulfate. Evaporation of the solvent under reduced pressure left 2.00 g of crude (−)-(2*S*,3*S*)-4,4-dichloro-2-methyl-3-((1*S*)-1-(2,4,6-triisopropylphenyl)-ethoxy)cyclobutanone. An analytical sample, prepared from a similar crude product, showed the following: mp 119–120.5 °C (pentane); $[\alpha]^{20}_D$ −124° (*c* 2.1, chloroform); IR 1800, 1590 cm^{-1}; ^1H NMR (300 MHz) δ 1.08–1.22 (m, 21 H), 1.62 (d, J = 6.6 Hz, 3 H), 2.77–2.84 (m, 1 H), 3.25 (m, 2 H), 3.46 (pseudo quint, 1 H), 3.87 (d, J = 7.3 Hz, 1 H), 5.28 (q, J = 6.6 Hz, 1 H), 6.95 (s, 2 H). (Approximately 5% of the diastereomer was also present: δ 4.20 (d, J = 7.0 Hz, 1 H).); mass spectrum (EI), m/z 398 (M^+), 231, 215, 201, 189, 147, 133, 119, 77, 43. Anal. Calcd for $C_{22}H_{32}O_2Cl_2$: C, 66.16; H, 8.08. Found: 66.08; H, 7.99.

A mixture of the above crude cyclobutanone, 5.00 g of sodium bicarbonate (59.5 mmol), and 4.90 g (70%, 19.9 mmol) of 3-chloroperoxybenzoic acid in 400 mL of dichloromethane was stirred overnight at 0 °C and then processed with ether in the usual manner to give 2.20 g of crude (4*S*,5*S*)-3,3-dichlorodihydro-5-methyl-4-((1*S*)-1-(2,4,6-triisopropylphenyl)ethoxy)-2(3*H*)-furanone (**7a**): IR 1810, 1200 cm^{-1}; ^1H NMR (300 MHz) δ 1.16–1.30 (m, 21 H), 1.67 (d, J = 7.5 Hz, 3 H), 2.77–2.84 (m, 2 H), 3.15–3.38 (m, 1 H), 3.93 (d, J = 3.4 Hz, 1 H), 4.21 (m, 1 H), 5.34–5.42 (m, 1 H), 6.9–7.0 (m, 2 H).

A mixture of the above crude lactone and 2.80 g (42.8 mmol) of zinc powder in 35 mL of glacial acetic acid was stirred for 1 h at 20 °C and 1 h at 70 °C and then allowed to cool to 20 °C. The crude product was isolated in the usual way and purified by dry silica gel chromatography with 5% ethyl acetate in hexane to afford 900 mg (50% overall from **6d**) of lactone **7b** (containing ca. 5% of its diastereomer, δ 4.68 ppm). Recrystallization from pentane yielded pure **7b**: mp 119–120 °C; $[\alpha]^{20}_D$ −83° (*c* 2.2, chloroform); IR 1780, 1170 cm^{-1}; ^1H NMR (300 MHz) δ 1.18–1.33 (m, 21 H), 1.54 (d, J = 6.7 Hz, 3 H), 2.67 (d, J = 4.8 Hz, 2 H), 2.79–2.93 (m, 2 H), 3.01–3.20 (m, 1 H), 3.77 (m, 1 H), 4.51 (dd, J = 6.7, 2.3 Hz, 1 H), 5.19 (q, J = 6.7 Hz, 1 H), 7.00 (s, 2 H); mass spectrum (EI), m/z 346 (M^+), 331, 230, 215, 201, 187, 173, 131, 43. HRMS m/e calcd for $C_{22}H_{34}O_3$ (M^+): 346.2508. Found: 346.2500.

(−)-(3*R*,4*R*,5*S*)-3-Butyldihydro-4-hydroxy-5-methyl-2(3*H*)-furanone ((−)-Blastmycinolactol, 1) and (−)-(3*R*,4*R*,5*S*)-3-Hexyldihydro-4-hydroxy-5-methyl-2(3*H*)-furanone ((−)-NFX-2, 3). A solution of 340 mg (0.98 mmol) of lactone **7b** in 10 mL of trifluoroacetic acid was allowed to stand at 20 °C for 3 h and then after the addition of a small amount of methanol concentrated under reduced pressure. The crude product was purified by dry silica gel chromatography with 50% ethyl acetate in cyclohexane to afford 90 mg (79%) of (−)-(4*R*,5*S*)-dihydro-4-hydroxy-5-methyl-2(3*H*)-furanone, shown to be enantiomerically pure by ^1H NMR of its Mosher ester.[13] (Unrecrystallized **7b** produced material containing 4% enantiomer.) $[\alpha]^{21}_D$ −8° (*c* 2.0, chloroform); IR 3450, 1740, 1275 cm^{-1}; ^1H NMR (300 MHz) δ 1.38 (d, J = 6.5 Hz, 3 H), 1.85–2.20 (br s, 1H), 2.52 (dd, J = 17.8, 3.6 Hz, 1 H), 2.86 (dd, J = 17.8, 6.5 Hz, 1 H), 4.25 (quint, J = 3.2 Hz, 1 H), 4.51 (dq, J = 6.6, 2.8 Hz, 1 H); ^{13}C NMR (50.3 MHz) δ 174.0, 84.1, 72.8, 37.4, 18.5; mass spectrum (CI), m/z 116 (M^+), 99, 84. Anal. Calcd for $C_5H_8O_3$: C, 51.72; H, 6.94. Found: 51.35; H, 7.37.

A solution of 70 mg (0.60 mmol) of the above hydroxy lactone in 8 mL of tetrahydrofuran and 0.34 mL of hexamethylphosphoric triamide was added to a stirred solution at −65 °C of lithium diisopropylamide (from treatment of 200 μL (154 mg, 1.52 mmol) of diisopropylamine in 8.0 mL of tetrahydrofuran with 700 μL (1.40 mmol) of 2.0 M *n*-butyllithium in hexanes). After being stirred for 35 min −65 °C, the mixture was cooled to −78 °C and 400 μL (647 mg, 3.52 mmol) of 1-iodobutane was added. After an additional 1 h at −78 °C and 1 h at −50 °C, the mixture was treated with aqueous ammonium chloride. The crude product was isolated with ether in the normal way and purified by dry silica gel chromatography with 10% ethyl acetate in cyclohexane to afford 80 mg (77%) of (−)-blastmycinolactol (**1**):[2,3] mp 49–50.5 °C; $[\alpha]^{22}_D$ −18° (*c* 1.0, chloroform); IR 3400, 1760, 1180 cm^{-1}; ^1H NMR (200 MHz) δ 0.92 (t, J =7.1 Hz, 3 H), 1.45 (d, J = 6.3 Hz, 3 H), 1.28–1.92 (m, 6 H), 2.50–2.61 (m, 1 H), 2.60–2.80 (br m, 1 H), 3.84 (dd, J = 8.6, 7.1 Hz, 1 H), 4.21 (quint, J = 6.3 Hz, 1 H); ^{13}C NMR (50.3 MHz) δ 176.6, 80.2, 78.8, 48.5, 28.8, 28.1, 22.6, 18.2, 13.8; mass spectrum (EI), m/z 173 (M^+ + 1), 172 (M^+), 155, 116, 100. Anal. Calcd for $C_9H_{16}O_3$: C, 62.77; H, 9.36. Found: 62.81; H, 9.40.

(−)-NFX-2 (**3**)[1g,h,3] was prepared in a similar manner (1-iodohexane in place of 1-iodobutane): mp 60–62 °C; $[\alpha]^{21}_D$ −14° (*c* 1.0, methanol).

(+)-(3*R*,4*R*,5*S*)-3-Butyldihydro-5-methyl-4-((3-methylbutanoyl)oxy)-2(3*H*)-furanone ((+)-Blastmycinone, 2) and (+)-(3*R*,4*R*,5*S*)-3-Hexyldihydro-5-methyl-4-((3-methylbutanoyl)oxy)-2(3*H*)-furanone ((+)-Antimycinone, 4). A 30-mg (0.17 mmol) sample of (−)-blastmycinolactol (**1**) and 39 mg (0.32 mmol) of isovaleryl chloride in 1.0 mL of pyridine were stirred for 72 h. Water was then added to the mixture, and the crude reaction product was isolated with ether in the usual way and purified by dry silica gel chromatography with 20% ethyl acetate in cyclohexane to give 41 mg (92%) of (+)-blastmycinone (**2**):[1a–c,2] $[\alpha]^{22}_D$ +11° (*c* 1.0, chloroform); IR 1760, 1730 cm^{-1}; ^1H NMR (200 MHz) δ 0.91 (t, J = 7 Hz, 3 H), 0.97 (d, J = 6.6 Hz, 6 H), 1.30–1.93 (m, 6 H), 1.47 (d, J = 6.8 Hz, 3 H), 2.11 (m, 1 H), 2.23 (d, J = 6.2 Hz, 2 H), 2.68 (dt, J = 8.3, 5.5 Hz, 1 H), 4.36 (dq, J = 6.6, 4.7 Hz, 1 H), 4.94 (dd, J = 5.7, 4.7 Hz, 1 H); ^{13}C NMR (50.3 MHz) δ 175.8, 172.8, 79.3, 78.4, 46.4, 43.1, 29.0, 28.9, 25.7, 22.4, 22.3, 19.4, 14.0; mass spectrum (CI), m/z 257 (M^+ + 1), 256 (M^+), 200, 184, 155, 99, 85, 69, 57. Anal. Calcd for $C_{14}H_{24}O_4$: C, 65.60; H, 9.44. Found: 65.65; H, 9.31.

(+)-Antimycinone (**4**)[1h] was prepared analogously: $[\alpha]^{21}_D$ +8° (*c* 0.5, chloroform).

Acknowledgment. We thank Prof. J. Lhomme for his interest in our work, Ms. M-L. Dheu-Andries and Dr. P. Vatton for the molecular modeling, and Prof. B. M. Nakata for the spectra of naturally derived (+)-blastmycinone. Financial support from the CNRS (URA 332) and a fellowship award from the CNPq to M.B.M.A. are gratefully acknowledged.

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(13) Dale, J. A.; Dull, D. L.; Mosher, H. S. *J. Org. Chem.* **1969**, *34*, 2543.