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Concise Total Synthesis of (+)-Aspergillide B

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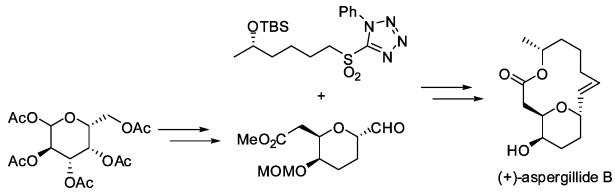

An efficient total synthesis of (+)-aspergillide B has been achieved, which features the *C*-glycosylation reaction for constructing the 2,6-*trans*-substituted pyran core, a highly effective four-step sequence without purification to produce the key intermediate **13** and an advantegous *E*-selective Julia−Kocienski olefination on a highly elaborate substrate. The synthesis confirmed the revised structure of aspergillide B by Uenishi.

Aspergillides A−C are novel 14-membered macrolides (Figure 1) which were isolated from marine-derived fungus *Aspergillus ostianus* strain 01F313 and exhibit significant cytoxic activity against mouse lymphocytic leukemica cells (L1210) with LD_{50} values of 2.1, 71.0, and 2.0 μg/mL, respectively.[1a] Structures of these three 14-membered macrolides were proposed as **1**,[1b] **2a**, and **3** based on spectral analysis of 1D and 2D NMR and a modified Mosher's method. The intriguing structure and characteristic biological activity of these aspergillides have stimulated interest in the synthetic community. Recently, Hande and Uenishi reported a successful total synthesis of the proposed structure of **1** and **2a**, in which the structural nonidentity to the isolated natural products was revealed and the structure of aspergillide B was revised as **2b**.[2] More recently, aspergillide C was also synthesized by Nagasawa and Kuwahara.[3]

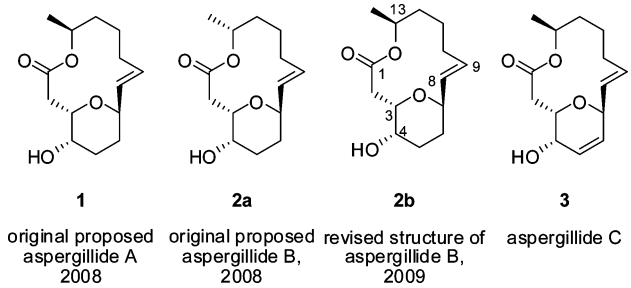

FIGURE 1. Structure of aspergillides.

Structurally, aspergillides A−C all bear a 14-membered lactone ring incorporating a 2,6-*trans*-trisubstituted pyran subunit and an *E*-olefin bond at C8−C9, which is very rare in natural products[4,5] (Figure 1). The challenges from a synthetic point of view are construction of the bridged 2,6-*trans*-trisubstituted pyran and cyclization of the bridged 14-membered macrocyclic core with an *E*-olefin bond. Although the synthesis of aspergillides has been made, the longer reaction sequences were usually involved.[2,3] Herein, we reported a concise total synthesis of (+)-aspergillide B, an enantiomer of the natural product, using galactose pentaacetate as the starting material.

Our retrosynthetic analysis was outlined in Scheme 1. We figured that aspergillides are a perfect example to demonstrate diversity-oriented synthesis due to its commonly shared 2,6-*trans*-substituted pyran ring and the same side chain. To this end, we dissected aspergillides into two segments, a chained sulphone **4** and a 2,6-*trans*-trisubstituted pyran derivative. The sulphone **4** could be easily prepared from (*S*)-2-methyloxirane **8**. The pyran aldehyde units **5** and **6** were proposed to be generated from dihydropyran alcohol **7**, which could be obtained from galactose by *C*-glycosylation. This strategy will be primarily displayed by total synthesis of aspergillide B.

According to the retrosynthetic analysis, our synthesis of sulphone **4** began with (*S*)-methyloxirane **8** (Scheme 2). Regioselective ring-opening of epoxide **8** by allylmagnesium bromide in the presence of CuI yielded the secondary alcohol,[6] which was then protected as TBS ether **9** in satisfactory yield (83% yield, two steps). Hydroboration and oxidation of the terminal olefin moiety of **9** afforded alcohol **10**,[7] which was further converted into the desired sulphone **4** via Mitsunobu reaction and oxidation in one pot.

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(1) (a) Kito, K.; Ookura, R.; Yoshida, S.; Namikoshi, M.; Ooi, T.; Kusumi, T. *Org. Lett.* **2008**, *10*, 225–228. (b) Quite recently, the revised structure of aspergillide A has been reported. See: Ookura, R.; Kito, K.; Saito, Y.; Kusumi, T.; Ooi, T. *Chem. Lett.* **2009**, *38*, 384.

(2) Hande, S. M.; Uenishi, J. *Tetrahedron Lett.* **2009**, *50*, 189–192.

(3) Nagasawa, T.; Kuwahara, S. *Org. Lett.* **2009**, *11*, 761–764.

(4) For the only synthesis of a non-natural 14-membered macrolide containing a 2,6-*trans*-substituted tetrahydropyran ring, see: Zacuto, M. J.; Leighton, J. L. *Org. Lett.* **2005**, *7*, 5525–5527.

(5) For examples of natural 14-membered macrolides containing a 2,6-*cis*-substituted tetrahydropyran ring either as a hemiacetal or as a nonhemiacetal form, see: (a) Sone, H.; Kigoshi, H.; Yamada, K. *J. Org. Chem.* **1996**, *61*, 8956–8960. (b) Zampella, A.; D'Auria, M. V.; Minale, L.; Debitus, C.; Roussakis, C. *J. Am. Chem. Soc.* **1996**, *118*, 11085–11088. (c) Zampella, A.; D'Auria, M. V.; Minale, L. *Tetrahedron* **1997**, *53*, 3243–3248. (d) Trost, B. M.; Gunzner, J. L.; Dirat, O.; Rhee, Y. H. *J. Am. Chem. Soc.* **2002**, *124*, 10396–10415. (e) Tan, L. T.; Márquez, B. L.; Gerwick, W. H. *J. Nat. Prod.* **2002**, *65*, 925–928. (f) Luesch, H.; Yoshida, W. Y.; Harrigan, G. G.; Doom, J. P.; Moore, R. E.; Paul, V. J. *J. Nat. Prod.* **2002**, *65*, 1945–1948. (g) Wright, A. E.; Botelho, J. C.; Guzmán, E.; Harmody, D.; Linley, P.; McCarthy, P. J.; Pitts, T. P.; Pomponi, S. A.; Reed, J. K. *J. Nat. Prod.* **2007**, *70*, 412–416. (h) Youngsaye, W.; Lowe, J. T.; Pohlki, F.; Ralifo, P.; Panek, J. S. *Angew. Chem., Int. Ed.* **2007**, *46*, 9211–9214.

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(7) Solladié, G.; Lohse, O. *J. Org. Chem.* **1993**, *58*, 4555–4563.

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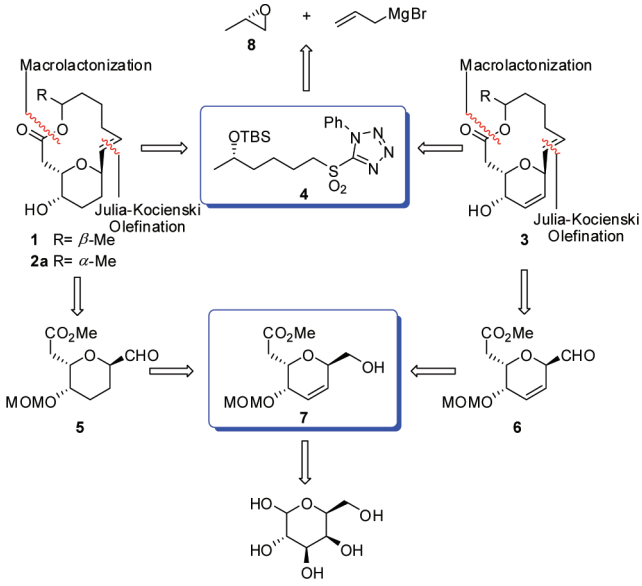
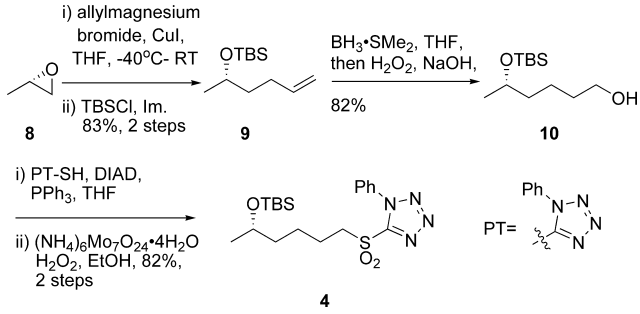
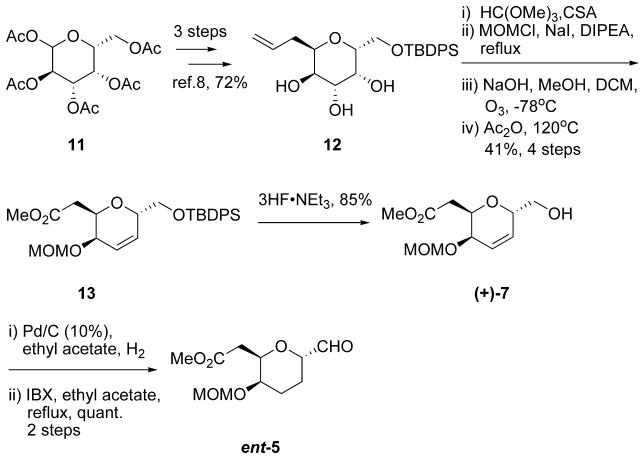
SCHEME 1. Retrosynthetic Analysis



SCHEME 2



SCHEME 3



To develop facile synthesis of aspergillide B, D-galactose pentaacetate **11** was chosen as a starting material which was more available and cheaper compared with L-galactose (Scheme 3). After three chemical transformations, the known triol **12** was prepared in good selectivity and high yield.[8] To our delight, the key intermediate **13** could be easily obtained through a highly efficient four-step sequence (protection of *syn*-dihydroxy with trimethyl orthoformate; protection the residual hydroxy as

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SCHEME 4

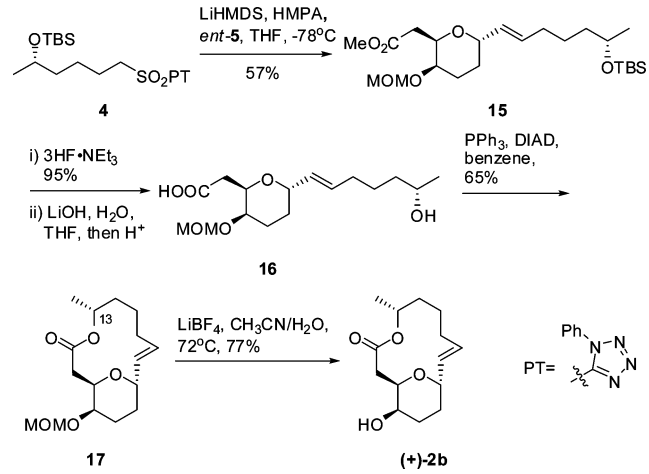

TABLE 1. Condition Optimization of Julia−Kocienski Olefination

entry	base	solvent	E/Z	yield (%)
1	KHMDS	DME	1:1	40
2	KHMDS	THF	1.5−1.3:1	54
3	KHMDS	THF/HMPA = 5/1	2:1	48
4	LiHMDS	THF/HMPA = 5/1	>9:1	57
5	NaHMDS	THF/HMPA = 5/1	7:1	61

MOM ether; ozonolysis of olefin in methanolic NaOH;[9] elimination of the orthoformate ester[10]) without purification (41% yield for above consecutive steps). Treatment of **13** with 3HF•NEt$_3$ deprotected the TBDPS ether smoothly and furnished dihydropyran alcohol (−)-**7**.[11] In the case of conducting the Pd/C-catalyzed hydrogenation of (−)-**7** in a protic solvent such as MeOH, an unpredicted epimerization occurred. When ethyl acetate was used as solvent, the above epimerization was overcome. The resulting alcohol was then subjected to IBX oxidation,[12] and the aldehyde *ent*-**5** was obtained in nearly quantitative yield.

With essential segments **4** and *ent*-**5** in hand, we then turned to the venerable Julia−Kocienski olefination as a means of constructing the *E*-olefin at C8−C9 and installing the required side chain meanwhile (Scheme 4).[13] The *E*/*Z* ratio of olefin **15** was unsatisfactory when KHMDS was used as base and DME as solvent (*E*/*Z* = 1 by NMR analysis). Gratifyingly, after many trials (Table 1), the best *E*/*Z* ratio was obtained by performing the olefination with LiHMDS in THF/HMPA at −78 °C to room temperature (entry 4), and the desired *E*-olefin **15** was obtained in 57% yield along with 5% of the *Z*-isomer. Removal of TBS and hydrolysis of methyl ester gave the desired *seco* acid **16**. The completion of the macrolactone **17** required the inversion of chiral center at C-13. To this end, we attempted to use the Mitsunobu reaction to construct the macrolactone **17**.[14] Fortu-

(9) Marshall, J.; Garofalo, A. W. *J. Org. Chem.* **1993**, *58*, 3675–3680.
(10) (a) Ando, M.; Ohhara, H.; Takase, K. *Chem. Lett.* **1986**, 879–882. (b) Takahashi, S.; Nakata, T. *J. Org. Chem.* **2002**, *67*, 5739–5752.
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(13) For a excellent review of Julia−Kocienski olefination, see: Blakemore, P. R. *J. Chem. Soc., Perkin Trans. 1* **2002**, 2563–2585.
(14) (a) Mitsunobu, O.; Eguchi, M. *Bull. Chem. Soc. Jpn.* **1971**, *44*, 3427–3430. (b) Mitsunobu, O. *Synthesis* **1981**, 1–28. (c) Hughes, D. L. *Org. React.* **1992**, *42*, 335–656. (d) Hughes, D. L. *Org. Prep. Proced. Int.* **1996**, *28*, 127–164.

nately, treatment of the hydroxy acid **16** with PPh_3 and DIAD in anhydrous benzene in high dilution (1 mM) gave the desired macrolactone **17**. Deprotection of MOM group smoothly by $LiBF_4$ in CH_3CN/H_2O completed the synthesis of aspergillide B.[15] Synthetic (+)-**2b** was identical in all respects to the natural product (−)-aspergillide B, with the exception of its optical rotation, which had the opposite sign but a similar absolute value ($[\alpha]^{20}_D$ +84, *c* 0.12, MeOH; lit.[1a] $[\alpha]^{31}_D$ −97.2, *c* 0.27, MeOH). On the other hand, our synthesis confirmed the report by Uenishi.[2]

In conclusion, we have finished a concise total synthesis of (+)-aspergillide B. Highlights of the synthetic venture included the *C*-glycosylation reaction when constructing the 2,6-*trans*-disubstituted pyran core, a highly effective four-step sequence without purification to produce the key intermediate **13**, and an advantegous *E*-selective Julia−Kocienski olefination on a highly elaborate substrate. As for our total synthesis, the longest linear sequence comprised 12 steps involving a four-step sequence without purification and 9% overall yield. The synthetic approaches toward aspergillides C are still under investigation in our laboratory.

Experimental Section

Sulfone 4. Triphenylphosphine (1.76 g, 6.7 mmol), 1-phenyl-1*H*-tetrazole-5-thiol (PT-SH, 1.19 g, 6.7 mmol), and **10** (1.01 g, 4.47 mmol) were dissolved in 45 mL of anhydrous THF, to which was added DIAD (1.35 g, 6.7 mmol) at room temperature. After being stirred for 0.5 h, the reaction mixture was diluted with 50 mL of EtOH and cooled to 0 °C. In a separate flask were mixed 30% aqueous H_2O_2 (10 g, 88 mmol) and ammonium molybdate (1.09 g, 0.88 mmol), producing a bright yellow solution that was added to the reaction via pipet. After being stirred overnight at room temperature, the reaction mixture was diluted by the addition of water and CH_2Cl_2. The layers were separated, and the aqueous layer was extracted three times with CH_2Cl_2. The combined organic layers were washed with water and brine, dried over Na_2SO_4, filtered, and concentrated in vacuo. Purification on silica gel (10% EtOAc in PE) provided 1.6 g (82% yield) of **4**: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.69−7.71 (2H, m), 7.61−7.64 (3H, m), 3.79−3.83 (1H, m), 3.74 (2H, t, J = 8 Hz), 1.93−2.01 (2H, m), 1.41−1.63 (4H, m), 1.13 (3H, d, J = 6.4 Hz), 0.89 (9H, s), 0.05 (6H, d, J = 4 Hz); ^{13}C NMR (100 MHz, $CDCl_3$) δ 153.5, 133.1, 131.4, 129.7, 125.1, 67.9, 56.1, 38.8, 25.9, 24.3, 23.8, 22.1, 18.1, − 4.4, − 4.8; $[\alpha]^{20}_D$ +8 (*c* 1.7, $CHCl_3$); IR (KBr) ν_{max} 2955, 2929, 2857, 1732, 1596, 1498, 1462 cm^{-1}; HRMS (ESIMS) *m*/*z* $[M + H]^+$ calcd for $C_{19}H_{33}N_4O_3SSi$ 425.2037, found 425.2033.

Compound 13. To a stirred mixture of **12** (700 mg, 1.58 mmol) and trimethyl orthoformate (1.75 mL, 16 mmol) in CH_2Cl_2 (8 mL) was added *d*-camphorsulfonic acid (18 mg, 0.08 mmol). The mixture was stirred at room temperature for 1 h and then diluted with ether, washed with saturated $NaHCO_3$ solution, water, and brine, dried, and concentrated to give the corresponding ortho ester, which was used directly in the next step. To a solution of the resulting ortho ester in CH_2Cl_2 (16 mL) at 0 °C were added diisopropylethylamine (2.8 mL, 16 mmol), chloromethyl methyl ether (0.78 mL, 10 mmol,) and NaI (12 mg, 0.08 mmol). The reaction mixture was immediately allowed to warm to 40 °C. After 6 h, saturated $NaHCO_3$ (aq) was added. The organic layer was separated, and the aqueous layer was extracted with CH_2Cl_2 three times. The combined organic layers was washed with water and brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. The residue was filtrated through a shot pad of Celite to provide MOM ether. A solution of MOM ether in 12 mL of CH_2Cl_2 and 3 mL of 2.5 M methanolic NaOH was stirred at −78 °C as ozone was passed through the solution. After 75 min, the initially yellow reaction mixture acquired the blue characteristic color of ozone and a yellow precipitate formed. The reaction mixture was diluted with ether and water, allowed to warm to room temperature, and extracted with ether. The organic layer was dried over $MgSO_4$, and removal of the solvent by distillation under reduced pressure gave the corresponding methyl ester, which was heated in acetic anhydride (10 mL) at 130 °C with stirring for 6 h, concentrated, and coevaporated with xylene. Chromatography on silica gel (8% EtOAc in PE) provided 310 mg (41% yield from **12**) of **13**: ^{1}H NMR (400 MHz, $CDCl_3$) δ ^{1}H NMR (400 MHz): δ 7.68−7.69 (4H, m), 7.37−7.44 (6H, m), 6.08 (1H, m), 6.01 (1H, dd, J = 10.4 Hz, 2.4 Hz), 4.76 (1H, d, J = 6.8 Hz), 4.65 (1H, d, J = 6.8 Hz), 4.44 (1H, td, J = 6.8 Hz, 3.2 Hz), 4.33 (1H, b), 3.98 (1H, t, J = 3.6 Hz), 3.77 (2H, d, J = 5.6 Hz), 3.68 (3H, s), 3.39 (3H, s), 2.70 (2H, m), 1.07 (9H, s); ^{13}C NMR (100 MHz) δ 171.8, 135.6, 135.6, 133.5, 133.4, 130.5, 129.7, 129.7, 127.7, 125.7, 95.8, 73.0, 69.7, 68.1, 65.0, 55.6, 51.6, 35.3, 26.8, 19.2; $[\alpha]^{20}_D$ −36 (*c* 1.2, $CHCl_3$); IR (KBr) ν_{max} 3070, 3048, 1736, 1466, 1432 cm^{-1}; HRMS (ESIMS) *m*/*z* $[M + Na]^+$ calcd for $C_{27}H_{36}NaO_6Si$ 507.2173, found 507.2182.

Alcohol (−)-7. To a solution of **13** (50 mg, 0.1 mmol) in CH_3CN (2 mL) was added $Et_3N\cdot 3HF$ (0.32 mL, 2 mmol). This mixture was heated at 45 °C for 4 h followed by addition of ethyl acetate (10 mL) and saturated $NaHCO_3$ (10 mL). After being stirred for 5 min, the organic layer was separated and the aqueous layer was extracted with ethyl acetate (3 × 10 mL). The combined organic extracts were dried over Na_2SO_4, filtered, and concentrated under reduced pressure. The residue was purified by flash column chromatography (40% EtOAc in PE) to afford alcohol (−)-**7** (21 mg, 85%) as a colorless oil: ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.10 (1H, ddd, J = 10.4 Hz, 4.8 Hz, 2 Hz), 5.91 (1H, dd, J = 10.4 Hz, 2.8 Hz), 4.78 (1H, d, J = 6.8 Hz), 4.65 (1H, d, J = 6.8 Hz), 4.36 (1H, m), 4.32 (1H, m), 3.81−3.84 (2H, m), 3.73 (3H, s), 3.54 (1H, dd, J = 12.4 Hz, 2.6 Hz), 3.39 (3H, s), 2.87 (1H, dd, J = 17.2 Hz, 10.4 Hz), 2.56 (1H, dd, J = 17.2 Hz, 2.8 Hz); ^{13}C NMR (100 MHz, $CDCl_3$) δ 172.7, 129.7, 126.2, 95.6, 73.7, 68.1, 66.9, 61.3, 55.6, 52.0, 35.1; $[\alpha]_D^{20}$ −152 (*c* 1.2, $CHCl_3$); IR (KBr) ν_{max} 3440, 2925, 1734, 1651, 1035, 916, 719 cm^{-1}; HRMS (ESIMS) *m*/*z* $[M + Na]^+$ calcd for $C_{11}H_{18}NaO_6$ 269.0996, found 269.0993.

Olefin 15. To a solution of sulfone **4** (147 mg, 0.35 mmol) in 4 mL of THF/HMPA (4:1 v/v) was added LiHMDS (1 M in THF, 0.22 mL, 0.22 mmol) at −78 °C. After the mixture was stirred for 15 min, a solution of the aldehyde *ent*-**5** (57 mg, 0.23 mmol) in 0.5 mL of THF/HMPA (4:1 v/v) was added dropwise. The reaction was stirred at −78 °C for 2 h, warmed to room temperature, and stirred for 2 h. Saturated NH_4Cl (aq) was added. The mixture was then extracted with EtOAc (3 × 10 mL). The combined organic layers was washed with brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. The residue was purified by flash column chromatography (8% EtOAc in PE) to afford a mixture of two geometrical isomers **15** (55 mg, 57% yield, *E*/*Z* = 9 based on ^{1}H NMR): ^{1}H NMR (400 MHz, $CDCl_3$) δ 5.64−5.71(1H, dt, J = 15.6 Hz, 6.8 Hz), 5.49 (1H, dd, J = 15.6 Hz, 4.8 Hz), 4.70 (1H, d, J = 7.2 Hz), 4.63 (1H, d, J = 7.2 Hz), 4.32−4.36 (1H, m), 4.27−4.29 (1H, m), 3.76−3.81 (1H, m), 3.70−3.73 (1H, m), 3.70 (3H, s), 3.38 (3H, s), 2.75 (1H, dd, J = 15.4 Hz, 8.4 Hz), 2.61 (1H, dd, J = 15.4 Hz, 5.6 Hz), 1.93−2.09 (2H, m), 1.75−1.86 (2H, m), 1.33−1.53 (6H, m), 1.12 (3H, d, J = 6.4 Hz), 0.89 (9H, s), 0.05 (3H, s), 0.04 (3H, s); ^{13}C NMR (100 MHz, $CDCl_3$) δ 172.0, 133.1, 129.2, 95.3, 71.9, 71.3, 70.3, 68.5, 55.7, 51.6, 39.2, 34.6, 32.5, 26.2, 25.9, 25.3, 25.2, 23.9, 23.8, 18.1, −4.4, −4.7; $[\alpha]^{20}_D$ +19 (*c* 1.0, $CHCl_3$); IR (KBr) ν_{max} 3424, 2931, 1740, 1036 cm^{-1}; HRMS (ESIMS) *m*/*z* $[M + Na]^+$ calcd for $C_{23}H_{44}NaO_6Si$ 467.2799, found 467.2795.

Macrolactone 17. PPh_3 (83 mg, 0.3 mmol) and DIAD (60 μL, 63 mg, 0.3 mmol) were dissolved in benzene (10 mL). After 30 min of stirring, a slight yellow color remained. The crude hydroxy acid **16** (10 mg, 0.03 mmol) was dissolved in benzene (20 mL) and slowly added to the solution during 1 h. After 5 h, the reaction

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was quenched by adding water. The organic layer was separated, and the aqueous layer was extracted three times with ethyl acetate. The combined organic layers were washed with water and brine, dried over Na_2SO_4, filtered, and concentrated in vacuo. The residue was purified by flash column chromatography (10% EtOAc in CH_2Cl_2) to afford the macrolactone **17** (6 mg, 65% yield) as a colorless oil: ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.17−6.25 (1H, m), 5.66 (1H, dd, J = 15.6 Hz, 4 Hz), 5.06−5.11 (1H, m), 4.77(1H, d, J = 6.8 Hz), 4.63(1H, d, J = 6.8 Hz), 4.50(1H, b), 4.27(1H, d, J = 10.8 Hz), 3.60(1H, s), 3.40(3H, s), 2.62 (1H, dd, J = 14 Hz, 11.2 Hz), 2.30(1H, dd, J = 14 Hz, 1.6 Hz), 2.11−2.24(2H, m), 1.91−2.20 (2H, m), 1.73−1.86(2H, m), 1.60−1.71(2H, m), 1.38−1.51(2H, m), 1.21(3H, d, J = 16 Hz); ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.4, 138.0, 128.6, 95.0, 72.1, 71.3, 70.0, 68.8, 55.6, 39.9, 31.7, 30.6, 24.8, 24.1, 23.0, 19.1; $[\alpha]^{20}_D$ +44 (c 0.125, $CHCl_3$); IR (KBr) ν_{max} 3404, 2925, 1733, 1450, 1032 cm^{-1}; HRMS (ESIMS) m/z $[M + H]^+$ calcd for $C_{16}H_{27}O_5$ 299.1853, found 299.1850.

(+)-Aspergillide B. A solution of 3.8 mg (0.013 mmol) of the lactone **17** and 13 mg (0.13 mmol) of $LiBF_4$ in 2 mL of CH_3CN containing 80 μL of water was heated at 72 °C for 5 h. After the mixture was cooled to room temperature, it was poured into 4 mL of water and the aqueous layer was extracted with EtOAc (3 × 5 mL). The combined organic layers were washed with water and brine, dried over Na_2SO_4, filtered, and concentrated in vacuo. The residue was purified by flash column chromatography (25% EtOAc in PE) to afford (+)-**2b** (2.6 mg, 77% yield) as a colorless oil: ^{1}H NMR (400 MHz, d-benzene) δ 6.19 (1H, dddd, J = 15.6 Hz, 10.8 Hz, 4.8 Hz, 1.6 Hz), 5.38 (1H, dd, J = 15.6 Hz, 4.4 Hz), 5.09 (1H, m), 4.31 (1H, m), 4.08 (1H, d, J = 11.2 Hz), 3.21 (1H, d, J = 10 Hz), 2.71 (1H, dd, J = 13.6 Hz, 11.6 Hz), 2.12 (1H, dd, J = 13.6 Hz, 2.0 Hz), 2.04 (1H, dddd, J = 13.6 Hz, 10.8 Hz, 4.8 Hz, 2.4 Hz), 1.85 (1H, d, J = 10.4 Hz), 1.73−1.78 (2H, m), 1.52−1.60 (3H, m), 1.31−1.38 (3H, m), 1.07 (3H, d, J = 6.4 Hz), 0.99 (1H, m); ^{13}C NMR (100 MHz, d-benzene) δ 169.8, 138.2, 129.1, 71.6, 69.9, 69.6, 67.3, 39.9, 32.1, 30.8, 27.9, 25.3, 22.7, 19.2; $[\alpha]^{20}_D$ +84 (c 0.12, MeOH) (lit.[1a] $[\alpha]^{31}_D$ −97.2 (c 0.27, MeOH)); IR (KBr) ν_{max} 3380, 2921, 1723, 1255, 1181, 1093, 1028, 918 cm^{-1}; HRMS (ESIMS) m/z $[M + NH_4]^+$ calcd for $C_{14}H_{26}NO_4$ 272.1856, found 272.1859.

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Supporting Information Available: Experimental procedures, spectral data, and copies of ^{1}H and ^{13}C NMR spectra. This material is available free of charge via the Internet at http://pubs.acs.org.

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