# Suberitenones A and B: Sesterterpenoids of an Unprecedented Skeletal Class from the Antarctic Sponge *Suberites* sp.

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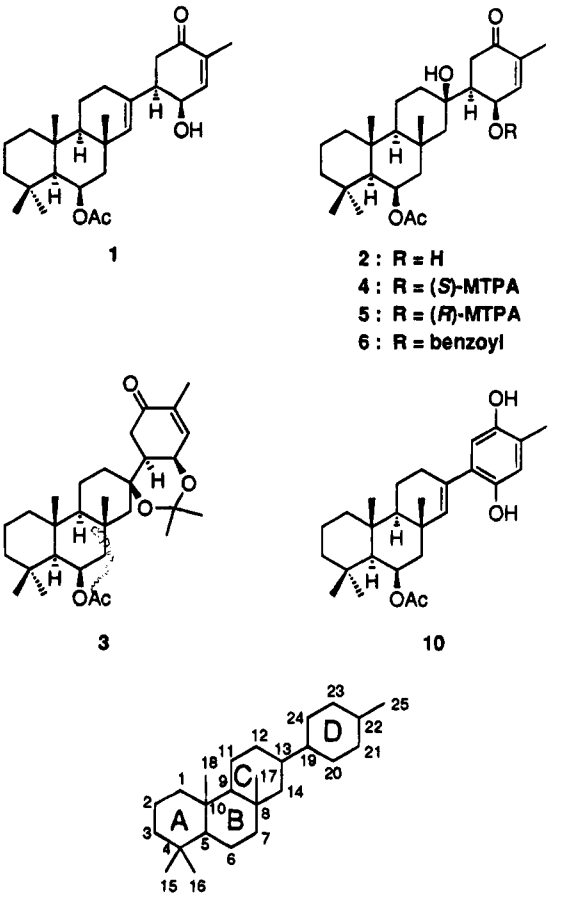
Suberitenones A (**1**) and B (**2**), sesterterpenoids of an unprecedented skeletal class, have been isolated from the Antarctic sponge *Suberites* sp. Structures of these compounds have been determined by combined spectral and chemical studies. Absolute stereochemistry has been assigned on the basis of a combination of the Kusumi and Kakisawa modification of Mosher's method and CD measurement. Suberitenone B inhibited the cholesteryl ester transfer protein (CETP), which mediates the transfer of cholesteryl ester and triglyceride between high-density lipoproteins and low-density lipoproteins. In addition, suberitenone A has been chemically transformed to suberiquinol (**10**), a hydroquinone derivative.

Sponges (phylum Porifera) are recognized as a very prolific source of both biologically active and structurally unique secondary metabolites.[1] However, chemical investigation of these animals has been mainly focused on the tropical and temperate ones, while sponges habitating cold waters have attracted much less attention. In our search for novel bioactive substances from marine organisms, we collected specimens of the sponge *Suberites* sp. from Antarctica. In this paper, we report the isolation and structure elucidation of suberitenones A (**1**) and B (**2**), sesterterpenoids of an unprecedented skeletal class. Suberitenone B inhibited the cholesteryl ester transfer protein (CETP), which mediates the transfer of cholesteryl ester and triglyceride between high-density lipoproteins (HDL) and low-density lipoproteins (LDL).[2] In addition, we report chemical transformation of suberitenone A to suberiquinol (**10**), a derivative containing the hydroquinone moiety (Chart 1).

The brown encrusting sponge (specimen number 91A-15) was collected along the offshore of Weaver Peninsula, King George Island, Antarctica.[3] Freshly collected specimens were immediately frozen and stored in a freezer until chemically investigated. The defrosted animals were exhaustively extracted with MeOH and $CH_2Cl_2$. The combined extract was partitioned between 10% aqueous MeOH and hexane. Each layer was dried under vacuum and was subjected to silica vacuum flash chromatography using sequential mixtures of hexane and EtOAc as eluants. Silica HPLC of moderately polar fractions (30–50% EtOAc in hexane) gave pure suberitenones.

**Chart 1**




Suberitenone A (**1**) was isolated as a gum which had the composition $C_{27}H_{40}O_4$ by high-resolution mass and $^{13}C$ NMR spectroscopic methods. The presence of an $\alpha,\beta$-unsaturated ketone was readily recognized by a carbon signal at $\delta$ 199.76 (s) in the $^{13}C$ NMR spectrum (Table 1) and a strong absorption band at 1680 $cm^{-1}$ in the IR spectrum. Examination of the $^1H$ and $^{13}C$ NMR and IR spectra revealed that the remaining three oxygens formed an ester and a secondary hydroxyl group. This interpretation was supported by acetylation of **1** in which the only

[⊗] Abstract published in *Advance ACS Abstracts,* October 15, 1995.

(1) (a) Fusetani, N.; Matsunaga, S. *Chem. Rev.* **1993**, *93*, 1793. (b) Faulkner, D. J. **1995**, *12*, 223 and references cited therein.

(2) (a) Zilversmit, D. B.; Hughes, L. B.; Balmer, J. *Biochim. Biophys. Acta* **1975**, *409*, 393. (b) Bilheimer, D. W.; Goldstein, J. L.; Grundy, S. M.; Brown, M. S. *N. Engl. J. Med.* **1984**, *311*, 1658. (c) Swenson, T. L. *Diabetes/Metab. Rev.* **1991**, *7*, 139. (d) Rye, K.-A.; Barter, P. J. In *Structure and Function of Apolipoprotein*; Rosseneu, M., Ed.; CRC Press: Boca Raton, FL, **1992**; pp 401–426. (e) Lagrost, L. *Biochem. Biophys. Acta* **1994**, *1215*, 209.

(3) Taxonomical identification of the sponge specimens was kindly provided by Professor Patricia R. Bergquist, School of Biological Sciences, University of Auckland, New Zealand. The specimens (code number 92A-15) have been deposited in the sponge collection, KORDI.

0022-3263/95/1960-7582$09.00/0 

**Table 1. $^1H$ and $^{13}C$ NMR Assignments for Compounds 1, 2, 3, and 10[a]**

| | suberitenone A (1) | | suberitenone B (2) | | suberitenone B-ketal (3) | | suberiquinol (10) | |
|---|---|---|---|---|---|---|---|---|
| no. | H[b] | C[c] | H[b] | C[c] | H[b] | C[c] | H[b] | C[c] |
| 1 | 1.72 (m) | 41.46 | 1.75 (m) | 41.83 | 1.75 (brd, 12.7) | 41.98 | 1.77 (brd) | 41.51 |
| | 0.87 (ddd, 13.2, 13.2, 3.4) | | 0.84 (m) | | 0.83 (m) | | 0.89 (m) | |
| 2 | 1.72 (m) | 18.47 | 1.72 (m) | 18.53 | 1.69 (m) | 18.53 | 1.72 (m) | 18.50 |
| | 1.46 (m) | | 1.43 (m) | | 1.46 (brd, 14.2) | | 1.46 (m) | |
| 3 | 1.38 (m) | 44.23 | 1.35 (m) | 44.23 | 1.36 (brd, 13.2) | 44.20 | 1.36 (brd, 12.7) | 44.24 |
| | 1.17 (m) | | 1.12 (m) | | 1.17 (m) | | 1.18 (m) | |
| 4 | | 34.00 | | 34.01 | | 34.03 | | 34.05 |
| 5 | 1.04 (d, 2.0) | 56.80 | 1.02 (d, 2.4) | 56.66 | 1.01 (d, 2.4) | 56.62 | 1.07 (d, 2.4) | 56.90 |
| 6 | 5.49 (brd, 2.9) | 70.59 | 5.45 (brd, 2.9) | 70.69 | 5.44 (brd, 2.9) | 70.69 | 5.51 (brd, 2.4) | 70.66 |
| 7 | 1.94 (dd, 14.6, 2.4) | 44.23 | 1.94 (dd, 14.4, 2.7) | 46.90 | 1.88 (dd, 14.9, 2.7) | 47.05 | 1.93 (dd, 14.7, 2.4) | 43.83 |
| | 1.38 (dd, 14.6, 3.9) | | 1.24 (dd, 14.4, 3.6) | | 1.17 (m) | | 1.45 (dd, 14.7, 3.4) | |
| 8 | | 34.86 | | 34.24 | | 34.68 | | 35.11 |
| 9 | 1.12 (brd, 13.2) | 56.13 | 0.88 (m) | 58.76 | 0.88 (m) | 59.43 | 1.25 (dd, 12.2, 2.0) | 55.51 |
| 10 | | 37.18 | | 37.14 | | 37.13 | | 37.26 |
| 11 | 1.72 (m) | 17.49 | 1.68 (m) | 16.89 | 1.65 (ddd, 12.9, 12.9, 2.7) | 16.98 | 1.84 (brdd, 13.2, 6.3) | 17.89 |
| | 1.57 (m) | | 1.58 (m) | | 1.53 (m) | | 1.62 (m) | |
| 12 | 2.12 (m) | 30.10 | 2.02 (m) | 37.87 | 1.90 (m) | 39.17 | 2.31 (brdd, 18.1, 6.8) | 31.68 |
| | 2.02 (m) | | 1.11 (m) | | 1.11 (m) | | 2.25 (m) | |
| 13 | | 131.32 | | 73.46 | | 74.47 | | 130.16 |
| 14 | 5.18 (brs) | 138.92 | 1.85 (dd, 13.5, 2.7) | 53.55 | 2.14 (dd, 13.9, 2.7) | 53.62 | 5.45 (brs) | 141.03 |
| | | | 1.07 (d, 13.5) | | 0.86 (d, 13.9) | | | |
| 15 | 0.91 (s) | 32.85 | 0.90 (s) | 32.92 | 0.91 (s) | 32.90 | 0.91 (s) | 32.89 |
| 16 | 1.00 (s) | 22.95 | 0.99 (s) | 23.04 | 1.00 (s) | 23.02 | 1.00 (s) | 22.99 |
| 17 | 1.12 (s) | 23.22 | 1.33 (s) | 22.54 | 1.31 (s) | 22.54 | 1.20 (s) | 23.47 |
| 18 | 1.19 (s) | 17.32 | 1.18 (s) | 17.19 | 1.20 (s) | 17.50 | 1.20 (s) | 17.37 |
| 19 | 2.64 (brd, 12.4) | 45.75 | 1.72 (m) | 47.99 | 1.71 (ddd, 12.5, 4.2, 2.4) | 42.58 | | 126.81 |
| 20 | 4.30 (brd, 5.4) | 63.75 | 4.65 (dd, 5.5, 2.9) | 64.25 | 4.54 (brdd, 5.9, 2.4) | 61.27 | | 145.62 |
| 21 | 6.74 (brd, 5.4) | 142.13 | 6.67 (dq, 5.5, 1.5) | 141.55 | 6.67 (dq, 5.9, 1.5) | 140.17 | 6.65 (brs) | 117.35 |
| 22 | | 137.21 | | 137.27 | | 139.14 | | 123.83 |
| 23 | | 199.76 | | 200.87 | | 200.54 | | 147.03 |
| 24 | 2.70 (dd, 15.1, 12.4) | 36.89 | 2.81 (dd, 16.8, 13.4) | 32.89 | 2.76 (dd, 16.4, 12.5) | 34.90 | 6.47 (s) | 114.20 |
| | 2.33 (dd, 15.1, 2.9) | | 2.50 (dd, 16.8, 3.0) | | 2.41 (dd, 16.4, 4.2) | | | |
| 25 | 1.80 (brs) | 15.58 | 1.79 (brs) | 15.61 | 1.81 (brs) | 15.67 | 2.16 (s) | 15.66 |
| OAc | 2.04 (s) | 170.30 | 2.04 (s) | 170.67 | 2.04 (s) | 170.49 | 2.04 (s) | 170.43 |
| | | 21.82 | | 21.87 | | 21.85 | | 21.87 |
| ketal | | | | | | 99.45 | | |
| | | | | | 1.55 (s) | 31.75 | | |
| | | | | | 1.40 (s) | 25.80 | | |
| OH(20) | | | | | | | 5.10 (brs) | |

[a] Assignments were aided by $^1H$ COSY, HMQC, and HMBC experiments. [b] 500 MHz, $CDCl_3$. [c] 125 MHz, $CDCl_3$.

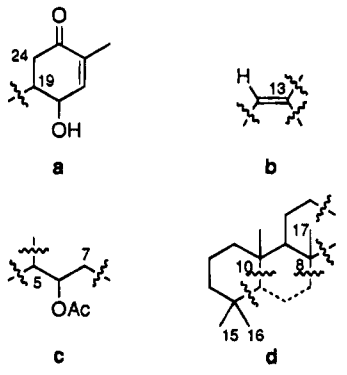



**Figure 1.** Partial structures of suberitenone A (1).

significant difference in the $^1H$ NMR spectrum was the downfield shift of a methine proton from $\delta$ 4.30 (brd, $J$ = 5.4 Hz) to $\delta$ 5.47. Thus, functionalities of all of the oxygen-bearing carbons were confidently assigned.

Combination of the $^1H$ and $^{13}C$ NMR, $^1H$ COSY, and HMQC experiments determined partial structures **a**–**c** (Figure 1). Due to the overlapping of upfield signals in the $^1H$ NMR spectrum, however, structure of the remaining hydrocarbon part was unable to be determined directly by NMR methods. Comparison of spectral data with known compounds suggested that **1** possesses conjunctured cyclohexane moieties with bridgehead methyl groups. Chemical shifts of the quarternary carbons and methine carbons were very similar to those of terpenoids possessing conjunctured cyclohexane rings.[4] Consideration of the molecular formula revealed that the hydrocarbon part must be **d**.

Confirmation of the partial structures and determination of their connectivities were aided by HMBC experiments (Table 2). Long range correlations between the $\beta$-acetoxy carbon at $\delta$ 56.80 (C-5) and methyl protons at $\delta$ 1.00 (H-16) and 0.91 (H-15) and a correlation between the quarternary carbon at $\delta$ 37.18 (C-10) and the $\alpha$-acetoxy proton at $\delta$ 5.49 (H-6) confirmed the presence of **d** in compound **1**. Also, connection of **c** with **d** was determined by these couplings. This interpretation was further supported by a correlation between the other $\beta$-acetoxy carbon at $\delta$ 44.23 (C-7) and methyl protons at $\delta$ 1.12 (H-17). Thus, **c** was assigned to be connected to all of the three quarternary centers of **d**. Similarily, connection of **b** with **d** was also determined by couplings between the olefinic proton at $\delta$ 5.18 (H-14) and carbons

(4) For recent examples, see: (a) De Rosa, S.; Puliti, R.; Crispino, A.; De Giulio, A.; Mattia, C. A.; Mazzarella, L. *J. Nat. Prod.* **1994**, *57*, 256. (b) Lal, A. R.; Cambie, R. C.; Rickard, C. E. F.; Bergquist, P. R. *Tetrahedron Lett.* **1994**, *35*, 2603. (c) He, H.; Kulanthaivel, P.; Baker, B. J. *Tetrahedron Lett.* **1994**, *35*, 7189.

**Table 2. Results of HMBC Experiments with Compounds 1, 2, 3, and 10[a]**

| | C | | | |
|---|---|---|---|---|
| H[b] | 1 | 2 | 3 | 10 |
| 6 | 8, 10 | 5, 8, 10 | 8 | |
| 14 | 7, 8, 9, 12, 19 | | | 7, 8, 9, 12, 19 |
| 15 | 3, 4, 5, 16 | 3, 4, 5 | 3, 4, 5, 16 | 3, 4, 5, 16 |
| 16 | 3, 4, 5, 15 | 3, 4, 5 | 3, 4, 5, 15 | 3, 4, 5, 15 |
| 17 | 7, 8, 9, 14 | 7, 8, 14 | 7, 8, 9, 14 | 7, 8, 9,[c] 14 |
| 18 | 1, 10 | 1, 5, 9, 10 | 1, 5, 9, 10 | 1, 9,[c] 10 |
| 19 | 13, 23 | | 19, 21 | |
| 20 | 21, 22 | 21, 22, 24 | 20, 22 | |
| 21 | | 19, 20, 23, 25 | 19, 23, 25 | 19, 20, 23 |
| 24 | 13, 19, 20, 22, 23 | 13, 19, 20, 23 | 13, 23 | 13, 20, 22, 23 |
| 25 | 21, 22 | 21, 22 | 21, 22, 23 | 21, 22, 23 |
| Ac | 6 | | 6 | |
| OH(20) | | | | 19, 20, 21 |

[a] Parameters were optimized for couplings of 8 Hz. [b] Numbers of protons exhibiting long-range couplings. [c] Due to the overlapping of the H-17 and H-18 protons, couplings were not clear.

at $\delta$ 56.13 (C-9), 44.23 (C-7), and 34.86 (C-8). Finally, connection of **a** with **b** was determined by couplings between the olefinic carbon at $\delta$ 131.32 (C-13) and protons at $\delta$ 2.70 (H-24), 2.64 (H-19), and 2.33 (H-24). Thus, the structure of suberitenone A was unambiguously determined as a sesterterpenoid. To the best of our knowledge, the carbon skeleton of suberitenone A is an unprecedented one.[5] The biosynthetic pathway of suberitenone A is discussed later.

Compound **1** possessed several asymmetric carbon centers. Relative configurations of the five asymmetric centers in rings A–C were determined by comparison of NMR data with related terpenoids.[4] Downfield carbon chemical shifts and upfield proton chemical shifts of the C-5 and C-9 carbons, together with the upfield chemical shifts of the bridgehead methyl carbons at C-17 and C-18, assigned *trans,trans* orientations for the A/B and B/C ring junctions. The small couplings ($J$ = 3.9, 2.4, and 2.0 Hz) of H-6 proton with adjacent ones revealed that the attachment of the C-6 acetoxy group to ring B was axial. Thus, the relative configurations of asymmetric centers in rings A–C were assigned as 5*S**, 6*R**, 8*S**, 9*S**, and 10*R**.

The remaining problem was the stereochemistry of two additional asymmetric carbon centers in ring D of **1**. Analysis of the vicinal coupling constants between the H-19 methine proton and H-24 methylene protons ($J_{19,24}$ = 12.4 and 2.9 Hz) revealed that the H-19 proton is pseudoaxial on the cyclohexenone ring. The very small coupling constant between the H-19 and H-20 protons fixed the H-20 proton in a pseudoequatorial position. Thus, the H-19 and H-20 protons are *syn* oriented. However, this information was insufficient to relate the configurations of these isolated asymmetric carbon centers to other centers in rings A–C. This problem was solved by combination of NOESY, ROESY, and NOEDS experiments with suberitenone B (**2**) and a synthetic ketal derivative (**3**), as discussed later.

Suberitenone B (**2**) was isolated as a white solid of composition $C_{27}H_{42}O_5$ as determined by high-resolution mass and $^{13}C$ NMR spectroscopic methods. The spectral data of **2** were highly comparable with those derived from **1**. However, there were significant differences in the $^{13}C$ NMR spectrum. The olefinic carbon signals at $\delta$ 138.92 (d) and 131.32 (s) were replaced by upfield signals at $\delta$ 73.46 (s) and 53.55 (t). Corresponding differences were found in the $^1H$ NMR spectrum in which the olefinic proton at $\delta$ 5.18 (brs) was replaced by upfield protons. These differences were accommodated by a hydration of the C-13 double bond of suberitenone A. A combination of $^1H$ COSY, HMQC, and HMBC experiments fully supported this interpretation (Tables 1 and 2). Thus, the structure of suberitenone B was determined as a 14-hydro-13-hydroxy derivative of suberitenone A.

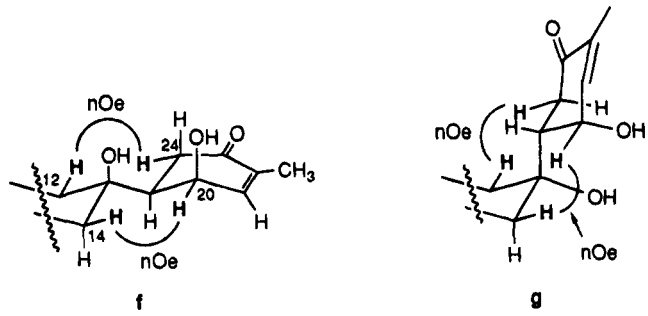



**Figure 2.** Possible configurations of suberitenone B from the results of NOESY experiments.

Suberitenone B possessed all of the asymmetric carbon centers of **1** and an additional center at C-13. Comparison of the $^1H$ and $^{13}C$ NMR data revealed that **2** and **1** possessed identical stereochemistry at the corresponding positions. Assignments of the stereochemistry of asymmetric centers in ring D (C-19 and C-20) and the additional center (C-13) were approached by NOESY experiments in which correlations were found between the H-12$\beta$ and one of the H-24 protons and between the H-14$\beta$ and H-20 protons. However, NOESY results were insufficient to determine the stereochemistry of these carbon centers since two configurations were possible for **2** at C-19 (Figure 2, **f** and **g**).

This problem was solved by ROESY and NOEDS experiments on a synthetic derivative. Treatment of **2** with 2,2-dimethoxypropane and PPTS in acetone yielded compound **3**. The structure of **3**, a cyclic ketal, and full assignments of its carbons and protons were made by combination of the $^1H$ and $^{13}C$ NMR, $^1H$ COSY, HMQC, and HMBC experiments (Tables 1 and 2). Several correlations were found by ROESY experiment. The key correlations were those between the ketal methyl protons at $\delta$ 1.55 and H-14$\beta$, H-17, and H-20. Each of these correlations was confirmed by proton NOEDS experiments. Irradiation of the ketal methyl protons significantly enhanced these protons, while irradiation of the H-20 proton enhanced the H-14$\beta$, H-17, H-19, and H-21 protons. In addition, proximities between the H-16 and H-5, H-12$\beta$ and H-24$\alpha$, and H-17 and H-18 protons were found by ROESY and NOEDS experiments. Thus, the relative configurations of asymmetric centers of **2** were assigned as 5*S**, 6*R**, 8*S**, 9*S**, 10*R**, 13*R**, 19*S**, and 20*R** (Figure 3). The relative configurations of **1** were assigned as 5*S**, 6*R**, 8*S**, 9*S**, 10*R**, 19*R**, and 20*R**.

The absolute stereochemistry of suberitenone B was approached by the Kusumi and Kakisawa modification of Mosher's method.[6] Treatment of **2** with (−)-(*S*)- and (+)-(*R*)-MTPA chloride gave esters **4** and **5**, respectively. Combination of $^1H$ NMR, $^1H$ COSY, and HMQC experi-

(5) We propose the name "suberitane" for this new carbon skeleton. Numberings are shown in Scheme 1.

(6) (a) Ohtani, I.; Kusumi, T.; Kashman, Y.; Kakisawa, H. *J. Org. Chem.* **1991**, *56*, 1296. (b) Tanaka, J.; Higa, T.; Suwanborirux, K.; Kokpol, U.; Bernardinelli, G.; Jefford, C. W. *J. Org. Chem.* **1993**, *58*, 2999.

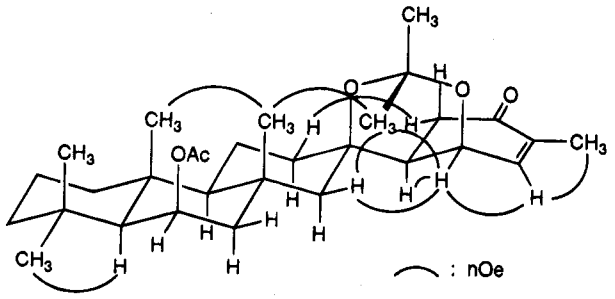



**Figure 3.** Stereochemistry of compound **3**.

**Table 3. $^1$H NMR Chemical Shifts ($\delta$) and Their Differences ($\Delta\delta$) for Selected Protons of (*S*)- and (*R*)-MTPA Esters[a]**

| | $\delta$ | | | | $\delta$ | | |
|---|---|---|---|---|---|---|---|
| C no. | **4** | **5** | $\Delta\delta$ | C no. | **4** | **5** | $\Delta\delta$ |
| 5 | 0.944 | 1.004 | −0.060 | 17 | 0.789 | 1.240 | −0.451 |
| 6 | 5.381 | 5.467 | −0.086 | 18 | 1.105 | 1.179 | −0.074 |
| 7$\beta$ | 1.694 | 1.877 | −0.183 | 19 | 1.982 | 2.000 | −0.018 |
| 9 | 0.749[b] | 0.854 | −0.105 | 20 | 5.484 | 5.554 | −0.070 |
| 12$\alpha$ | 1.063[b] | 1.079 | −0.076 | 21 | 7.025 | 6.944 | +0.081 |
| 12$\beta$ | 1.938 | 2.023 | −0.085 | 24$\alpha$ | 2.582 | 2.574 | +0.008 |
| 14$\alpha$ | 1.008[b] | 1.138 | −0.130 | 24$\beta$ | 2.796 | 2.721 | +0.075 |
| 14$\beta$ | 1.061[b] | 1.393 | −0.332 | 25 | 1.853 | 1.810 | +0.043 |
| 15 | 0.898 | 0.919 | −0.021 | OAc | 2.069 | 2.064 | +0.005 |
| 16 | 0.982 | 1.000 | −0.018 | | | | |

[a] Chemical shifts were measured in $CDCl_3$ solutions at 500 MHz by using $Me_4Si$ as internal standard. Difference of the chemical shifts of internal $CHCl_3$ between **4** and **5** was 0.002 ppm. [b] Due to the partial overlapping with other proton signals, chemical shifts might be different within the range of ±0.005 ppm.

ments unambiguously assigned all of the key protons of both compounds. However, comparison of the proton chemical shifts showed that suberitenone B was not an ideal target for the application of Mosher's method. All of the key protons in A−C rings except the acetoxy methyl protons and the H-19 proton of **4** appeared at lower field than the corresponding protons of **5**, while the H-21 and H-25 protons appeared at higher field. However, the results for the H-24 methylene protons were opposite of what was expected. The $\Delta\delta$ values of the H-24 methylene protons were positive, while those for other protons located at left side of the MTPA group were negative (Table 3). Three-dimensional model study (Alchemy III) revealed that the phenyl group of **4** (the methoxy group of **5**) was very proximal (almost overlapped) to the H-17 methyl protons. This would explain the unusually large difference of chemical shift ($\Delta\delta$ = ~−226 Hz) of the H-17 protons between **4** and **5**. Further investigation of the three-dimensional model revealed that, to prevent the spatial crowding, the MTPA group was tilted toward the C-21 carbon, and thus extension of the MTPA plane reaches a point between the C-19 and C-24 carbons instead of the C-23 carbonyl carbon as expected from the ideal conformation. Hence, the H-24 protons might be located at the right side of the MTPA plane instead of the left side of the ideal conformation. Although not conclusive, the uniform sign of $\Delta\delta$ of protons in the A−C rings and C-19, together with positive $\Delta\delta$ of the C-21 and C-25 protons, suggested a 20*R* configuration. Kakisawa and co-workers reported that their modification of Mosher's method had limited application for the compounds possessing sterically hindered secondary hydroxy groups.[6] In contrast to the irregularly dispersed $\Delta\delta$ of other sterically hindered compounds, the

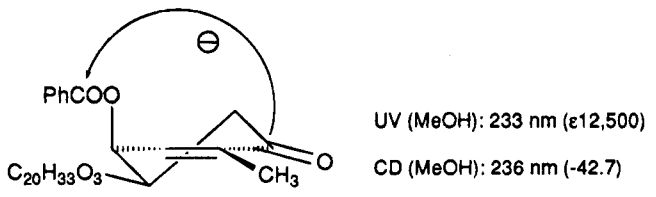



**Figure 4.** Absolute stereochemistry of suberitenone B benzoate (**8**) by CD methods.

regular pattern of $\Delta\delta$ of suberitenone B would be noteworthy.

The absolute stereochemistry of suberitenone B was confirmed by a circular dichroism (CD) measurement on a synthetic derivative. The 4-hydroxycyclohexenone moiety of suberitenone B was analogous with that in (+)-dehydrovomifoliol, the absolute stereochemistry of which was determined by CD measurement.[7] Treatment of **2** with benzoyl chloride in pyridine/DMAP gave benzoate **6** as a major product. The UV spectrum (MeOH) of **6** showed an absorption maximum at 233 nm ($\epsilon$ 12 500). The CD spectrum (MeOH) of **6** exhibited a minimum at 236 nm ($\Delta\epsilon$ −42.7) corresponding to the first Cotton effect. However, the second Cotton effect, which was the weaker, was buried in a strong negative background ellipticity.[8] Since the position (236 nm) of the first Cotton effect was very near to that expected (235 nm), the CD of **6** was assigned as a negative split Cotton effect. On the basis of these observations, the absolute stereochemistry of the C-20 was assigned as *R*, identical to that obtained from the application of Mosher's method (Figure 4). Therefore, the overall configurations of suberitenone B were assigned as 5*S*, 6*R*, 8*S*, 9*S*, 10*R*, 13*R*, 19*S*, and 20*R* (Figure 3). Suberitenone A has absolute configurations of 5*S*, 6*R*, 8*S*, 9*S*, 10*R*, 19*R*, and 20*R*. Thus, structures of suberitenones were confidently determined as sesterterpenoids of a new skeletal class.

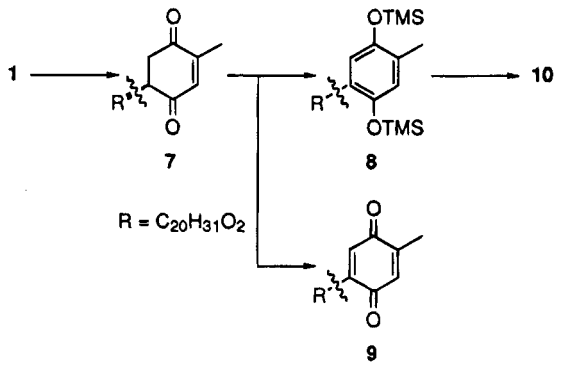
Suberitane, the carbon skeleton of suberitenones, is an unprecedented one. This carbon skeleton is distinguished from other sesterterpene skeletons by possessing an isolated cyclohexane system (ring D). Biosynthetically, suberitane is thought to be diverged from the common pathway by cyclization involving the methyl or an equivalent group (probably an exo-methylene) instead of trisubstituted double bond at the stage of ring-C formation.

As a part of our efforts to develop bioactive substances from marine organisms, we measured the inhibitory activity of suberitenones against cholesteryl ester transfer protein (CETP). CETP, a hydrophobic glycoprotein with a molecular mass of 74 kDa, is a lipid transfer protein found in plasma which mediates the transfer of cholesterol ester and triglyceride between high-density-lipoproteins (HDL) and very-low-density-lipoproteins (VLDL) or low-density lipoproteins (LDL).[2] Many studies have found an inverse correlation between levels of HDL and the incidence of atherosclerotic cardiovascular diseases.[9,10] Therefore, CETP inhibition is considered to be a good target for the development of an effective agent for atherosclerotic diseases. Recently, PD140195, a

(7) Koreeda, M.; Harada, N.; Nakanishi, K. *J. Am. Chem. Soc.* **1974**, *96*, 266.

(8) It is not unusual for CD spectra of 4-hydroxycyclohexenones to show very disproportionate extrema or only one extremum. For examples, see: (a) Harada, N.; Nakanishi, K. *Circular Dichroic Spectroscopy, Exciton Coupling in Organic Spectroscopy*; University Science Books: Mill Valley, CA, 1983; pp 93 and 255. (b) Shin, J.; Fenical, W. *Tetrahedron* **1993**, *49*, 9277.

**Scheme 1**




synthetic cholesterol ester mimic, has been reported to inhibit CETP.[10] In addition, wiedendiol-A and -B and related compounds are reported to possess the same activity.[11] In our measurement of inhibitory activity against CETP, suberitenone B was moderately active ($LC_{50}$ 10 $\mu$mol/mL).

Bioactivity tests of suberitenones showed that these compounds possessed neither cytotoxicity nor antiviral activity. However, the structures and functionalities of these compounds bear resemblances to some sponge metabolites possessing shikimate-derived quinone or hydroquinone functionalities at the terminus of the polyprenyl moiety.[1b] Avarol, avarone, ilimaquinone, and strongylin A exhibited potent antiviral, cytotoxic, and/or antimicrobial activities, which made these compounds attractive targets for synthetic and medicinal study.[12-17] This prompted us to convert suberitenones to derivatives possessing similar functionalities.

Attempts to convert suberitenone A to quinone- or hydroquinone-containing derivatives directly did not succeed.[18] However, we oxidized suberitenone A (**1**) to a diketone (**7**), which was then converted to suberiquinol (**10**) via a disilane (**8**) (Scheme 1).[19] The structure of suberiquinol was unambiguously determined by a combination of NMR methods (Tables 1 and 2). Despite the functionality similar to other polyprenylhydroquinones, however, suberiquinol failed to exhibit significant activity in cytotoxicity or antiviral activity tests. A literature survey revealed that some marine natural products were composed of the polyprenyl part and cyclohexenone or cyclohexedione moieties as suberitenones.[1b,20,21] Although suberiquinol did not exhibit significant bioactivity, chemical transformation of these compounds to quinone- or hydroquinone-containing derivatives by a similar process might produce new bioactive compounds.

## Experimental Section

**General.** Melting points are uncorrected. NMR spectra were measured at 500 MHz for $^1$H and 125 MHz for $^{13}$C. All of the chemical shifts were recorded with respect to internal $Me_4Si$. Mass measurements were supplied by the Mass Spectrometry Facility, Department of Chemistry, University of California, Riverside. CD measurements were made by using a 1 cm cell. Optical rotations were measured by using a 5 cm microcell. All solvents used were spectral grade or were distilled from glass prior to use.

**Collection, Extraction, and Isolation.** *Suberites* sp. (sample number 92A-15)[3] was collected by hand using SCUBA at 20–25 m depth in Jan 1992 along the offshore of Weaver Peninsula, King George Island, Antarctica. The immediately frozen samples were sent to the laboratory and kept in the freezer until they were chemically investigated. The sponge was defrosted and repeatedly extracted with MeOH and $CH_2Cl_2$. The combined extracts were partitioned between water and *n*-butanol. The *n*-butanol layer was dried (6.4 g) and repartitioned between *n*-hexane and 10% aqueous MeOH. Each layer was dried and separated by using silica vacuum flash chromatography eluting sequential mixtures of EtOAc and hexane. Moderately polar fractions (30–50% EtOAc in hexane) were combined and separated by silica HPLC.

**Cholesteryl Ester Transfer Protein (CETP) assay.** CETP assays were carried out using an Amersham scintillation proximity assay (SPA) kit. The $d$ > 1.21 g/mL fraction was isolated from human plasma and dialyzed against 50 mM Tris-HCl buffer (pH 7.4, 150 mM NaCl, 2 mM EDTA). Aliquots were stored at −20 °C and used as a source of the CETP. The assays were carried out in 1 mL Eppendorf tubes. The reaction mixture, containing 10 $\mu$L of test sample or control vehicle ($H_2O$ or MeOH), 10 $\mu$L of 50 mM Hepes buffer (pH 7.4, 140 mM NaCl, 0.1% (w/v) $NaN_3$), 10 $\mu$L of [$^3$H]-cholesteryl ester–HDL, 10 $\mu$L of biotin-LDL, was thoroughly mixed. The reaction was initiated by the addition of 10 $\mu$L of CETP. After 4 h of incubation at 37 °C, the reaction was terminated by the addition of 200 $\mu$L of stretavidin SPA beads formulated in an assay-terminated buffer. The terminated Eppendorf tubes were incubated at room temperature for 1 h to allow the assay to reach equilibrium. Transfer was measured after counting cpm value in a scintillation counter (Packard Delta-2000) with window settings fully open. Background values were obtained by the addition of $H_2O$ instead of CETP. Percent inhibition of CETP activity was calculated by substrating the background values from both control and test sample values.

**Suberitenone A (1).** Suberitenone A (186 mg, 2.9% of the crude extract) was isolated as a gum by silica HPLC (25% EtOAc in hexane). Compound **1** displayed the following spectral features: $[\alpha]_D$ −152.8° (c 0.5, $CHCl_3$); HRCIMS $(M + H)^+$ obsd 429.2990, $C_{27}H_{41}O_4$ requires 429.3004; LREIMS $m/z$ (relative intensity) 428 (8), 411 (8), 368 (31), 350 (39), 260 (52), 243 (100), 187 (19), 133 (20), 98 (42); IR (KBr) 3450, 2950, 2920, 1735, 1680, 1390, 1365, 1245, 1030, 940, 690 cm$^{-1}$; UV (methanol) $\lambda_{max}$ 230 nm ($\epsilon$ 11 000); $^1$H and $^{13}$C NMR data, see Table 1.

**Suberitenone B (2).** Suberitenone B (49 mg, 0.8% of the crude extract) was isolated as a white solid by silica HPLC (35% EtOAc in hexane), mp 232–234 °C. Compound **2** exhibited the following spectral features: $[\alpha]_D$ −15.9° (c 0.7, $CHCl_3$); HRCIMS $(M + NH_4)^+$ obsd 464.3380, $C_{27}H_{46}NO_5$ requires 464.3375; LREIMS $m/z$ (relative intensity) 431 (1),

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(18) All of the attempts to directly convert **1** to quinone (hydroquinone) or dehydrogenate **7** by DDQ, $SeO_2$, PhSeCl, and $(PhSeO)_2O$ resulted in rapid decomposition of the reactant.

(19) The quinone **9** was synthesized as a major product by treatment of **7** with TMSCl. However, **9** was highly unstable and decomposed during the purification by silica HPLC. For NMR data, see the Experimental Section.

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(21) Shin, J.; Fenical, W. *Tetrahedron* **1993**, *49*, 9277.

410 (2), 353 (2), 321 (7), 261 (20), 243 (14), 191 (9), 108 (100), 95 (8); IR (KBr) 3470, 3350, 2920, 2850, 1730, 1670, 1650, 1390, 1365, 1250, 1030, 930, 690 $cm^{-1}$ ; UV (methanol) $\lambda_{max}$ 226 nm ($\epsilon$ 14 000); $^1H$ and $^{13}C$ NMR data, see Table 1.

**Ketal Formation of Suberitenone B.** To a stirred solution of 11.2 mg (0.025 mmol) of suberitenone B in 5 mL of dry acetone were added 0.2 mL of 2,2-dimethoxypropane and 3.5 mg of PPTS. The mixture was refluxed under $N_2$ for 30 min. To quench the reaction, 0.2 mL of $Et_3N$ was added and the resulting mixture refluxed for 15 min. The mixture was filtered by using a silica Sepak column. The cyclic ketal (**3**) was purified by silica HPLC (25% EtOAc in hexane), 8.7 mg (0.018 mmol, 71% yield). Compound **3**, a gum, exhibited the following spectral features: $[\alpha]_D$ −10.0° (*c* 0.3, $CHCl_3$); HRFABMS: $(M + Na)^+$ obsd 509.3241, $C_{30}H_{46}O_5Na$ requires 509.3242; LREIMS *m/z* (relative intensity) 486 (0.2), 471 (8), 369 (6), 351 (15), 321 (12), 261 (14), 243 (9), 163 (8), 108 (100), 69 (8); IR (liquid film) 2920, 2830, 1735, 1680, 1360, 1245, 1190, 1030, 920 $cm^{-1}$; UV (methanol) $\lambda_{max}$ 224 nm ($\epsilon$ 14 500); $^1H$ and $^{13}C$ NMR data, see Table 1.

**Esterification of Suberitenone B(2) with (−)-(*S*)-α-Methoxy-α-(trifluoromethyl)phenylacetyl (MTPA) Chloride.** To a solution of 2.1 mg of **2** in 100 μL of dry pyridine was added 20 μL of (−)-(*S*)-MTPA chloride. The mixture was allowed to stand under $N_2$ at room temperature for 2 h. After the consumption of starting material was confirmed by TLC, 50 μL of $H_2O$, 100 μL of $CH_2Cl_2$, and MeOH were added. The solvents were removed under vacuum, and the residue was separated by silica HPLC (20% EtOAc in hexane) to give 1.5 mg of (*S*)-MTPA ester **4**. Compound **4**, a gum, exhibited the following spectral features: HRDCIMS $(M + NH_4)^+$ obsd 680.3737, $C_{37}H_{53}NO_7F_3$ requires 509.3774; LRCIMS *m/z* (relative intensity) 680 (52), 448 (45), 411 (18), 353 (26), 338 (72), 278 (19), 261 (33), 252 (100), 189 (69), 108 (47); $^1H$ NMR ($CDCl_3$) δ 7.546 (2H, m), 7.410 (3H, m), 7.025 (1H, dq, 5.9, 1.5), 5.484 (1H, dd, 5.9, 2.9), 5.381 (1H, brdd, 2.9, 2.9), 3.555 (3H, brs), 2.796 (1H, dd, 17.3, 13.4), 2.582 (1H, dd, 17.3, 3.7), 2.070 (3H, s), 1.982 (1H, ddd, 13.4, 3.7, 2.9), 1.938 (1H, brdd, 13.7, 2.9), 1.853 (3H, d, 1.0), 1.694 (1H, dd, 14.7, 2.4), 1.689 (1H, m), 1.666 (1H, m), 1.503 (1H, m), 1.445 (2H, m), 1.348 (1H, brd, 12.5), 1.135 (1H, m), 1.104 (3H, s), 1.063 (1H, m), 1.061 (1H, m), 1.008 (1H, m), 0.999 (1H, m), 0.983 (3H, s), 0.944 (1H, d, 2.0), 0.898 (3H, s), 0.789 (3H, s), 0.767 (1H, m), 0.749 (1H, dd, 11.7, 2.9).

**Esterification of Suberitenone B(2) with (+)-(*R*)-MTPA Chloride.** To a solution of 2.2 mg of **2** in 100 μL of dry pyridine was added 20 μL of (+)-(*R*)-MTPA chloride. The mixture was allowed to stand under $N_2$ at room temperature for 2 h. After the consumption of starting material was confirmed by TLC, 50 μL of $H_2O$, 100 μL of $CH_2Cl_2$, and MeOH were added. The solvents were removed under vacuum, and the residue was separated by silica HPLC (20% EtOAc in hexane) to give 1.3 mg of (*R*)-MTPA ester **5**. Compound **5**, a gum, exhibited the following spectral features: HRDCIMS $(M + NH_4)^+$ obsd 680.3786, $C_{37}H_{53}NO_7F_3$ requires 509.3774; LRCIMS *m/z* (relative intensity) 680 (4), 448 (3), 353 (18), 338 (31), 278 (10), 261 (45), 252 (19), 170 (35), 110 (25), 91 (62), 77 (100); $^1H$ NMR ($CDCl_3$) δ 7.561 (2H, m), 7.450 (3H, m), 6.944 (1H, dq, 5.9, 1.5), 5.554 (1H, dd, 5.9, 2.5), 5.467 (1H, brdd, 2.9, 2.9), 3.542 (3H, s), 2.721 (1H, dd, 17.1, 13.2), 2.574 (1H, dd, 17.1, 3.4), 2.065 (3H, s), 2.023 (1H, brdd, 13.6, 2.9), 2.000 (1H, ddd, 13.2, 3.4, 2.5), 1.877 (1H, dd, 14.6, 2.4), 1.810 (3H, d, 1.5), 1.750 (1H, brd, 14.2), 1.720 (1H, m), 1.653 (1H, m), 1.539 (1H, m), 1.450 (1H, m), 1.393 (1H, dd, 13.7, 2.4), 1.351 (1H, m), 1.241 (3H, s), 1.181 (1H, m), 1.179 (3H, s), 1.138 (1H, d, 13.7), 1.115 (1H, dd, 14.6, 2.9), 1.079 (1H, ddd, 13.6, 13.6, 4.4), 1.004 (1H, d, 2.9), 1.000 (3H, s), 0.918 (3H, s), 0.854 (1H, dd, 12.2, 2.4), 0.817 (1H, m).

**Esterification of Suberitenone B (2) with Benzoyl Chloride.** To a stirred solution of 4.5 mg (0.01 mmol) of **2** in dry pyridine with catalytic amount of 4-(dimethylamino)-pyridine (DMAP) was added 50 μL of benzoyl chloride. The mixture was stirred under $N_2$ for 3 h at 40 °C. After 2 drops of $H_2O$ were added, the mixture was stirred for 2 h at room temperature. Pyridine and $H_2O$ were removed under vacuum, and the residue was subjected to silica HPLC (20% EtOAc in hexane) to give 3.9 mg (0.007 mmol) of **6** in 71% yield. Compound **6**, a gum, displayed the following spectral features: $[\alpha]_D$ −170.63° (*c* 0.1, $CHCl_3$); LRFABMS *m/z* (relative intensity) 551 (M + H, 2), 533 (3), 443 (4), 351 (8), 321 (23), 261 (9), 219 (6), 154 (100); IR (KBr) 3500, 2920, 1720, 1680, 1450, 1360, 1260, 1100, 1020, 920 $cm^{-1}$; UV (methanol) $\lambda_{max}$ 233 nm ($\epsilon$ 12 500); $^1H$ NMR ($CDCl_3$) δ 8.00 (2H, dd, 8.3, 1.5), 7.61 (1H, td, 7.3, 1.5), 7.48 (2H, brdd, 8.3, 7.3), 6.93 (1H, dq, 5.9, 1.5), 5.80 (1H, dd, 5.9, 2.9), 5.42 (1H, brdd, 2.9, 2.9), 3.00 (1H, dd, 17.1, 13.2), 2.68 (1H, dd, 17.1, 2.9), 2.10 (1H, ddd, 13.2, 2.9, 2.9), 2.05 (1H, dd, 13.2, 2.9), 1.98 (3 H, s), 1.87 (1H, dd, 14.7, 2.40, 1.82 (3H, d, 1.50), 1.75−1.56 (4H, m), 1.45 - 1.40 (2H, m), 1.35 (1H, brd, 12.7), 1.25 - 1.15 (2H, m), 1.20 (3H, s), 1.14 (3H, s), 0.97 (3H, s), 0.96 (1H, d, 2.4), 0.89 (3H, s), 0.88 - 0.80 (2H, m)

**Oxidation of Suberitenone A (1).** To a stirred solution of 45.9 mg (0.11 mmol) of **1** in dry $CH_2Cl_2$ was added 21.5 mg (0.13 mmol) of PCC. The mixture was stirred for 3 h at room temperature. Filtering through silica column gave 35.8 mg (0.084 mmol) of pure compound **7** in 78% yield. Compound **7**, a gum, displayed the following spectral features: $[\alpha]_D$ −47.1° (*c* 0.2, $CHCl_3$); HRDCIMS $M^+$ obsd 426.2778, $C_{27}H_{38}O_4$ requires 426.2770; LRDCIMS *m/z* (relative intensity) 444 $(M + NH_4$, 25), 427 (M + H, 42), 426 (45), 384 (11), 367 (100), 243 (60), 227 (10), 203 (23), 159 (11); IR (KBr) 3030, 2920, 2845, 1735, 1475, 1390, 1245, 1030, 680 $cm^{-1}$; UV (methanol) $\lambda_{max}$ 239 nm ($\epsilon$ 7000); $^1H$ NMR ($CDCl_3$) δ 6.53 (1H, q, 1.5), 5.47 (1H, brdd, 2.9, 2.9), 5.14 (1H, brs), 3.38 (1H, dd, 6.8, 6.4), 2.95 (1H, dd, 16.1, 6.8), 2.89 (1H, dd, 16.1, 6.4), 2.04 (3H, s), 1.99 (2H, m), 1.98 (3H, d, 2.0), 1.87 (1H, dd, 14.7, 2.9), 1.76−1.68 (3H, m), 1.56 (1H, m), 1.46 (1H, m), 1.36 (1H, brd, 12.2), 1.34 (1H, dd, 14.2, 3.4), 1.17 (3H, s), 1.16 (1H, m), 1.13 (3H, s), 1.08 (1H, brd, 10.7), 1.03 (1H, d, 2.4), 1.00 (3H, s), 0.90 (3H, s), 0.85 (1H, ddd, 14.2, 13.2, 3.9); $^{13}C$ NMR ($CDCl_3$) δ 198.35 (C), 198.29 (C), 170.63 (C), 150.30 (C), 139.33 (CH), 137.89 (CH), 130.27 (C), 70.95 (CH), 57.00 (CH), 55.74 (CH), 54.76 (CH), 44.48 ($CH_2$), 43.87 ($CH_2$), 42.35 ($CH_2$), 41.66 ($CH_2$), 37.37 (C), 35.23 (C), 34.25 (C), 33.09 ($CH_3$), 29.07 ($CH_3$), 23.39 ($CH_3$), 23.21 ($CH_3$), 22.09 ($CH_3$), 18.71 ($CH_2$), 17.77 ($CH_2$), 17.58 ($CH_3$), 16.34 ($CH_3$).

**Silylation of 7.** To a stirred solution of 35.0 mg (0.08 mmol) of compound **7** in 10 mL of dry DMF were added 0.2 mL of TMSCl and 0.3 mL of $Et_3N$. The mixture was stirred at 80 °C under $N_2$ for 1 h. The reaction mixture was partitioned between $H_2O$ and hexane. The hexane layer was dried under vacuum, and the residue was separated by reversed-phase HPLC (100% methanol) to give 11.2 mg (0.02 mmol) of **8** and 16.9 mg (0.04 mmol) of **9** in 24 and 49% yield, respectively. Compound **8**, a white solid (mp 82−83 °C), displayed the following spectal features: $[\alpha]_D$ −48.1° (*c* 0.2, $CHCl_3$); HRCIMS $(M + H)^+$ obsd 571.3631, $C_{33}H_{55}O_4Si_2$ requires 571.3638; LRDCIMS *m/z* (relative intensity) 571 (71), 499 (100), 439 (68), 425 (13), 209 (11), 109 (14), 73 (83); IR (KBr) 2960, 2920, 1735, 1710, 1250, 1200, 1025, 840 $cm^{-1}$; UV (methanol) $\lambda_{max}$ 296 nm ($\epsilon$ 4000), 209 nm ($\epsilon$ 16 500); $^1H$ NMR ($CDCl_3$) δ 6.51 (1H, brs), 6.47 (1H, s), 5.53 (1H, ddd, 3.4, 2.4, 2.4), 5.34 (1H, brd, 1.0), 2.48 (1H, dd, 17.6, 5.9), 2.30 (1H, dddd, 17.6, 11.6, 6.8, 2.4), 2.09 (3H, brs), 2.06 (3H, s), 1.94 (1H, dd, 14.7, 2.4), 1.80 (2H, m), 1.74 (1H, m), 1.61 (1H, ddd, 12.2, 12.2, 5.9), 1.49 (1H, dd, 14.7, 3.4), 1.48 (1H, m), 1.38 (1H, brd, 12.7), 1.26 (1H, dd, 12.2, 1.5), 1.22 (3H, s), 1.21 (3 H, s), 1.20 (1H, m), 1.09 (1H, d, 2.4), 1.03 (3H, s), 0.94 (3H, s), 0.90 (1H, ddd, 13.2, 13.2, 3.4), 0.23 (9H, s), 0.19 (9H, s); $^{13}C$ NMR ($CDCl_3$) δ 170.46 (C), 147.53 (C), 146.23 (C), 139.32 (CH), 132.78 (C), 132.56 (C), 127.51 (C), 121.88 (CH), 119.85 (CH), 71.00 (CH), 56.96 (CH), 55.72 (CH), 44.32 ($CH_2$), 43.96 ($CH_2$), 41.58 ($CH_2$), 37.20 (C), 35.01 (C), 34.05 (C), 32.90 ($CH_3$), 30.48 ($CH_2$), 23.39 ($CH_3$), 23.03 ($CH_3$), 21.89 ($CH_3$), 18.55 ($CH_2$), 17.95 ($CH_2$), 17.41 ($CH_3$), 16.33 ($CH_3$), 0.45 ($CH_3$ × 6). Compound **9** displayed the following NMR data: $^1H$ NMR ($CDCl_3$) δ 6.53 (1H, q, 1.7), 6.52 (1H, s), 6.05 (1H, s), 5.53 (1H, brdd, 2.9, 2.9), 2.04 (3H, s), 2.01 (3H, brs), 1.21 (3H, s), 1.20 (3H, s), 1.02 (3H, s), 0.93 (3H, s); $^{13}C$ NMR ($CDCl_3$) δ 188.54 (C), 187.47 (C), 170.36 (C), 147.68 (CH), 146.74 (C), 144.80 (C), 134.46 (CH), 129.84 (CH), 126.92 (C), 70.70 (CH), 56.75 (CH), 54.81 (CH), 44.22 ($CH_2$), 43.33 ($CH_2$), 41.41 ($CH_2$), 37.22 (C), 35.70 (C), 34.00 (C), 32.87

($CH_3$), 28.96 ($CH_2$), 22.96 ($CH_3$), 22.56 ($CH_3$), 21.85 ($CH_3$), 18.46 ($CH_2$), 17.50 ($CH_2$), 17.39 ($CH_3$), 15.20 ($CH_3$).

**Desilylation of 8.** To a stirred solution of 9.2 mg of **8** in 1 mL of THF was added 1 drop of 1 N HCl at 0 °C. After the mixture was stirred for 10 min, solvent was removed under vacuum. The residue was separated by reversed-phase HPLC (100% MeOH) to give 6.5 mg of suberiquinol (**10**) in 94% yield. Compound **10**, a white solid (mp 105–106 °C), displayed the following spectral features: $[\alpha]_D$ −39.8° (*c* 0.1, $CHCl_3$); HRD-CIMS $M^+$ obsd 426.2751, $C_{27}H_{38}O_4$ requires 426.2770; LRD-CIMS *m/z* (relative intensity) 444 (M + $NH_4$, 7), 427 (M + H, 35), 426 (40), 367 (100), 351 (11), 109 (10), 91 (14); IR (KBr) 3420, 2920, 2850, 1735, 1710, 1650, 1460, 1420, 1390, 1250, 1200, 1030, 880 $cm^{-1}$; UV (methanol) $\lambda_{max}$ 301 nm ($\epsilon$ 4250), 208 nm ($\epsilon$ 20 000); $^1H$ and $^{13}C$ NMR data, see Table 1.

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**Supporting Information Available:** Proton NMR spectra of compounds **1-8** and **10**, carbon NMR spectra of **1-3**, **7**, **8**, and **10**, HMQC and HMBC spectra of **1-3** and **10**, NOESY spectrum of **2**, and ROESY spectrum of **3** (33 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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