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Two new oligostilbenes with dihydrobenzofuran from the stem bark of *Vateria indica*

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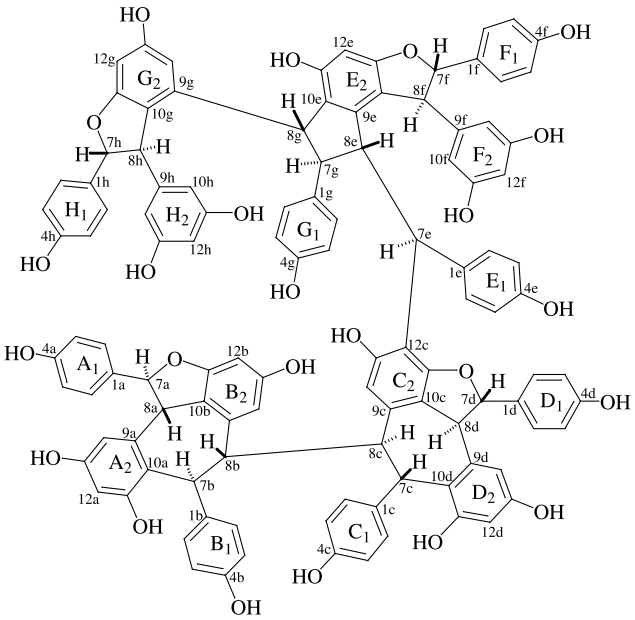
Abstract—Two new stilbenoids, vateriaphenols A (**1**) and B (**2**), were isolated from the stem bark of *Vateria indica* along with known 10 stilbenoids (**3**–**12**) and bergenin (**13**). The structures of isolates were established based on spectroscopic analysis. The structures of vateriaphenols A and B were characterized as an octamer and a tetramer of resveratrol, respectively. The spectral properties of the highly condensed vateriaphenol A were also discussed. © 2003 Elsevier Science Ltd. All rights reserved.

1. Introduction

Dipterocarpaceous plants are well known to rich resource of various resveratrol (3,5,4′-trihydroxystilbene) oligomers,[1–20] some of which have multi-functional bioactivities such as cytotoxic,[3,5] antibacterial[16] and anti-HIV effect.[5] A genus *Vateria* comprising three species belongs to the largest subfamily Dipterocarpoideae in Dipterocarpaceae.[21]



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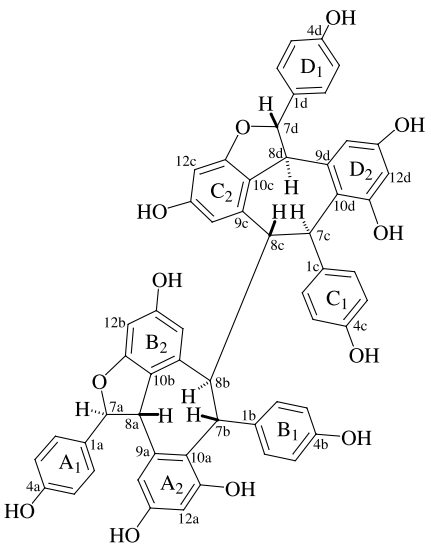

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Scheme 1.

Keywords: resveratrol octamer; resveratrol tetramer; dipterocarpaceae; *Vateria indica*.
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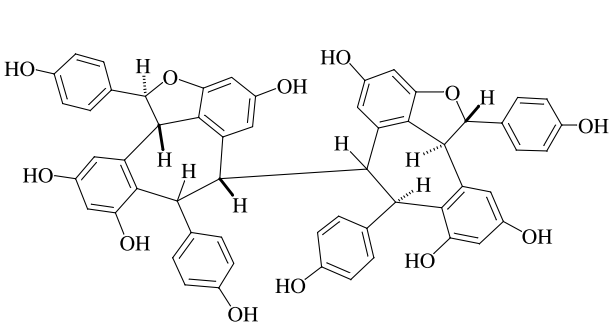
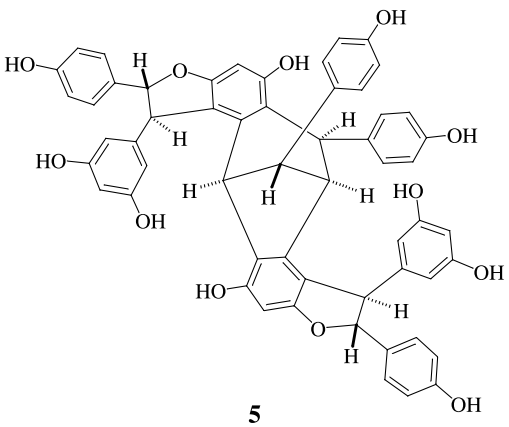


3 : H-7b = α, H-8c = β
4 : H-7b = β, H-8c = α



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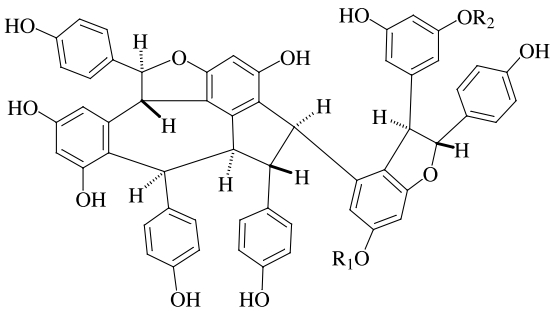
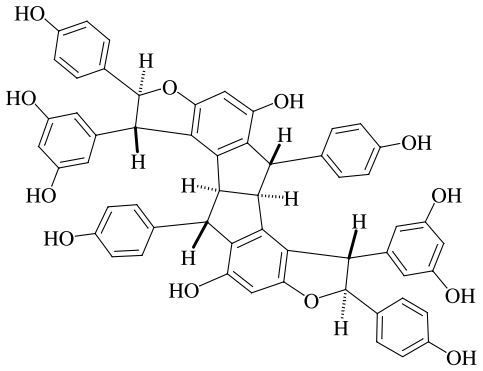


6 : $R_1 = R_2 = H$
7 : $R_1 = H$, $R_2 = glc$
8 : $R_1 = glc$, $R_2 = H$



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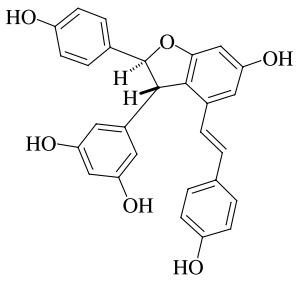

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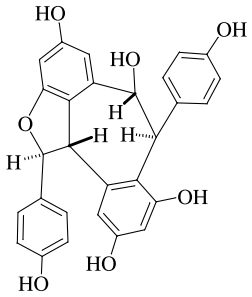

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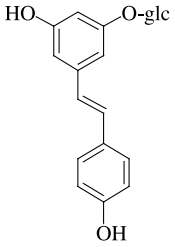

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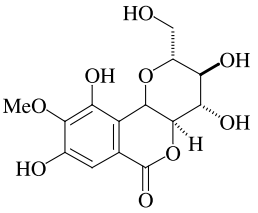

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Scheme 1 (*continued*)

A species *V. indica* L. which distributes in Seychelles and Southern area of India is a large tree, the bark, the seed and the resin have been used for many medicinal purposes in India.[22] Although some phytochemicals in the genus were mentioned,[9,10,13,23] the detail examination of phenolic constituents has not been reported yet. The structural elucidation and the distinctive cytotoxicity due to apoptosis based on the resveratrol oligomers[24] in Dipterocarpaceous plants [*Hopea*,[25,26] *Vatica*,[27–30] and *Shorea*[31–33]] were discussed in our previous research works. In relation to the phytochemical interest in this family, the chemical constituents in the stem bark of *V. indica* were examined and two new resveratrol oligomers were isolated along with ten known resveratrol cognates and bergenin. We report herein the spectral properties of vateriaphenol A (**1**) and the structure elucidation of vateriaphenol B (**2**).

2. Results and discussion

An acetone extract of the stem bark of *V. indica* was subjected to open column chromatography on silica gel and Sephadex LH-20. Further repeated purification by preparative TLC and reversed-phase column chromatography under

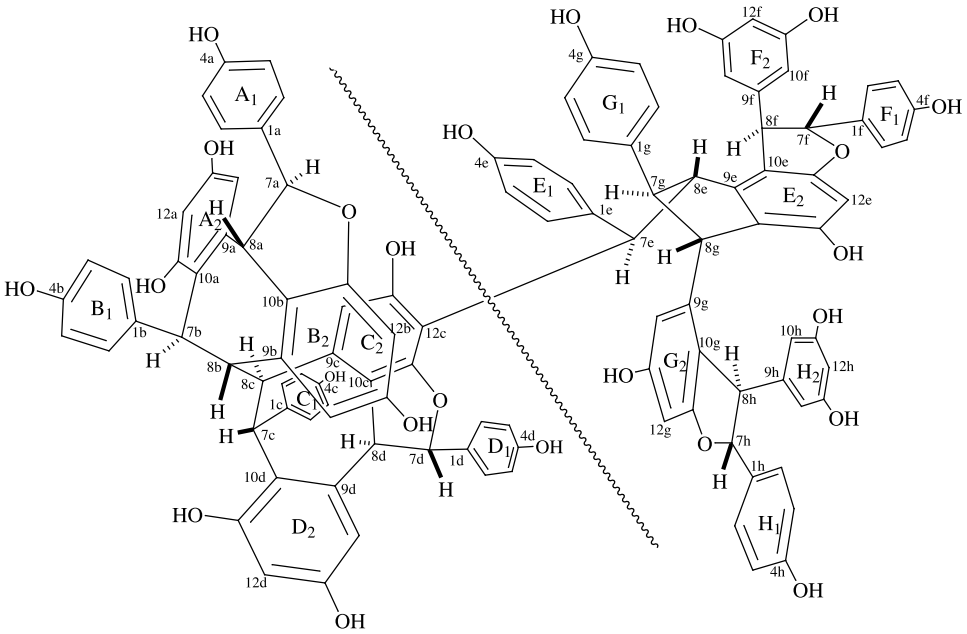
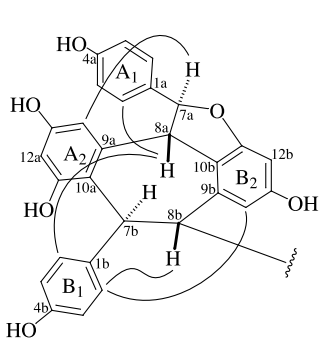


Figure 1. Relative stereostructure of **1**.

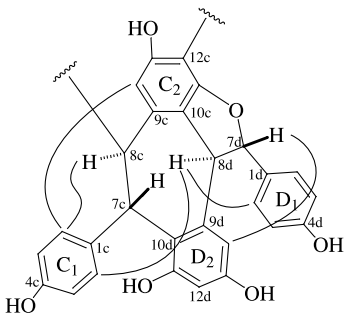
medium pressure achieved the isolation of vateriaphenols A (**1**) and B (**2**), and known compounds (**3**–**13**) (Scheme 1).

Vateriaphenol A (**1**), the structure and the brief spectral data of which have been mentioned in our previous communication,[34] is a first instance of a resveratrol octamer from nature. The structure is composed of two resveratrol tetramer units (tetramers 1 and 2) (Fig. 1). The tetramer 1 is composed of resveratrols A–D [(resveratrol A: ring A_1-7a-8a-ring A_2)] and the tetramer 2 is of resveratrols E–H. The detail stereochemical elucidation was carried out as follows. Significant rotating frame NOEs (ROE) (Fig. 2) in the ROESY experiment were observed between H-8a/H-2a(6a) and H-7a/H-14a, which suggested that the orientation of a dihydrobenzofuran ring (C-7a–C-8a–C-10b–C-11b–O) was *trans*. The methine hydrogen signals (H-8a and H-8b) also showed ROE interactions with the aromatic protons [H-2b(6b)] on ring B_1 (**1A** in Figure 2). Small value of the vicinal coupling constant of methine protons (H-7b and H-8b) indicated the dihedral angle of them to be near 90°. When the difference in the conformation of dibenzo-[2,1]heptadiene ring (C-8a/C-9a/C-10a/C-7b/C-8b/C-9b/C-10b) in **1A** was considered (Fig. 3), the pseudo-boat conformation (left figure) and pseudo-chair conformation (right figure) were supported. It was found that the pseudo-boat conformation of the ring system satisfied the ROEs [H-2b(6b)/H-8a and H-2b(6b)/H-8b] and 90° angle of *trans* H-7b/H-8b, while the pseudo-boat conformation did not satisfied them as shown in Figure 3. Then the relative configuration of a partial structure (resveratrols A and B) was shown as **1A** in Figure 2. The stereochemistry of another partial unit was deduced as **1B** in Figure 2 by the results of same ROE interactions as found in **1A**. When the C–C bond (C-8b/C-8c) and the respective ROE correlations (H-14b/H-7c, H-14b/H-7d, H-14b/H-14d and H-14c/H-7a, H-14c/H-14a, H-14c/H-7b) observed in **1A** and **1B** are considered, the relative stereochemistry of the tetrameric unit (tetramer 1: **1C**) can be depicted as Fig. 2. This structure reasonably explained the anisotropic effect that rings D_2 and A_2 caused upper field shift of H-14b (δ_H 4.93) and H-14c (δ_H 5.04).

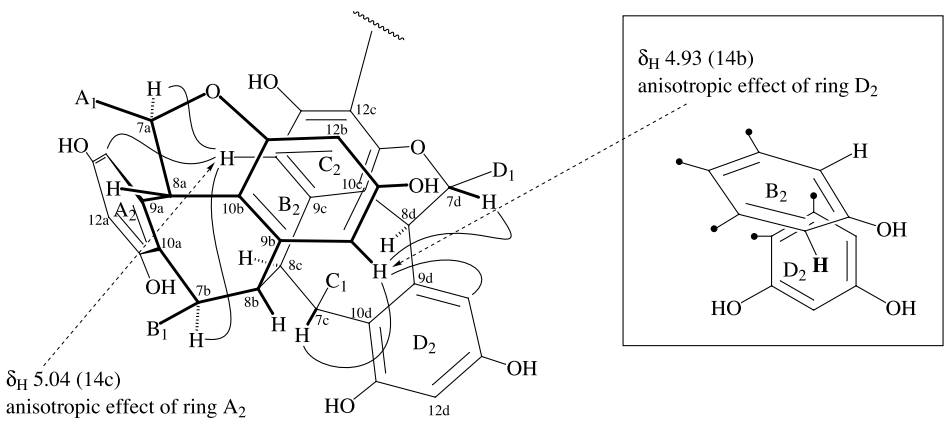
ROE interactions between H-7f/H-10f(14f), H-8f/H-2f(6f), H-7h/H-10h(14h) and H-8h/H-2h(6h) indicated that the orientation of two dihydrobenzofuran rings (C-10e–C-11e–O–C-7f–C-8f and C-10g–C-11g–O–C-7h–C-8h) were *trans* shown as **1D** in Figure 4. Small coupling constant values of three vicinal methine protons (H-8e, H-7g and H-8g) on the benzocyclopentane ring (C-8e–C-9e–C-14e–C-8g–C-7g) suggested that all the protons were equatorial and all the dihedral angles to be near 90°. The signal patterns due to these methine protons were similar to those of davidiol B[35] which has the identical partial structure as **1D** including the benzocyclopentane moiety. Further ROEs were observed between H-2g(6g)/8e, H-2g(6g)/H-8g and H-7g/H-14g. These results lead to the conclusion that the relative stereochemistry of the benzocyclopentane ring was as same as that of davidiol B [H-8e(β), H-7g(α) and H-8g(β)]. The relationship between the benzocyclopentane ring and the two dihydrobenzofuran rings was confirmed by NOEs [H-10f(14f)/H-2g(6g), H-7g/H-14g and H-8g/H-8h], where rings F_2, G_1 and H_2 are situated in β-configuration. The relationship between H-7e and H-8e is *trans* on the basis of *J* value [12.0 Hz (at rt),[34] 11.8 Hz (at −20°C)].[36,37] Then the relative stereochemistry of **1D** was elucidated as shown in Figure 4. The relative structure between **1C** and **1D** was characterized. However, the stereo relation between these units still remains to be clarified. In the previous communication,[34] the orientation of four methine protons (H-7e, H-8e, H-7g and H-8g) was deduced to be β, α, β and α, respectively, which is corresponding to that of vaticanol C. The stereochemistry of these proton should be corrected



1A
dimer 1 (resveratrols A and B)



1B
dimer 2 (resveratrols C and D)



1C
tetramer 1 (resveratrols A - D)

Figure 2. ROESY interactions and anisotoropic effects in partial structures (**1A**–**1C**).

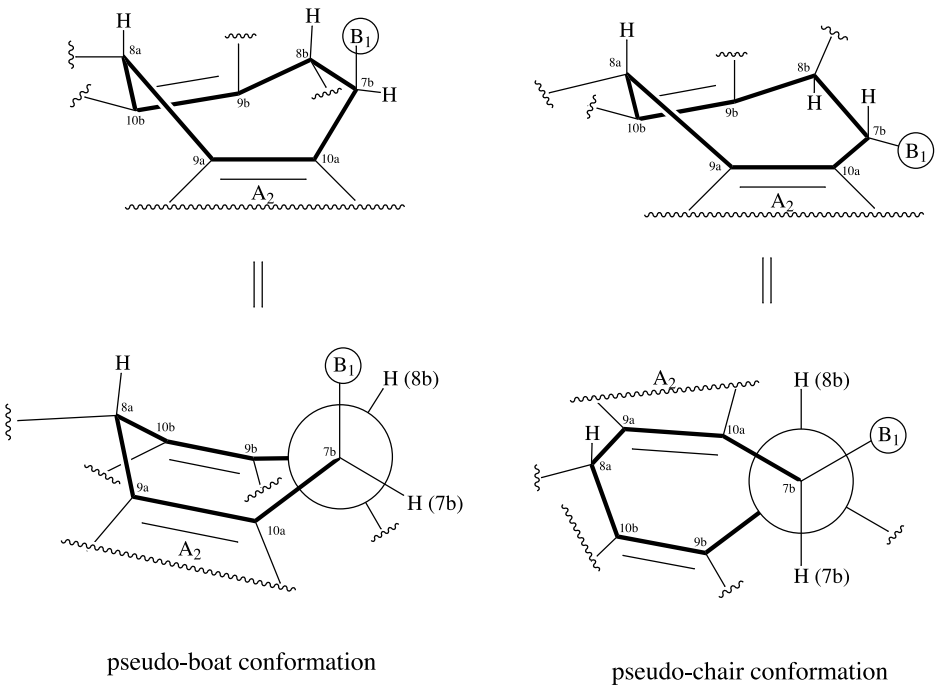


Figure 3. Possible conformation of **1A**.

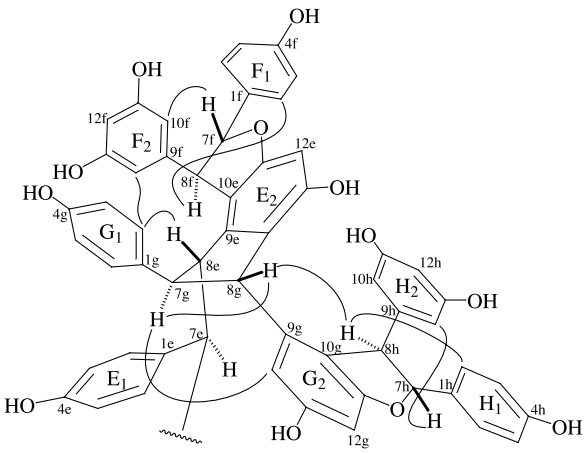
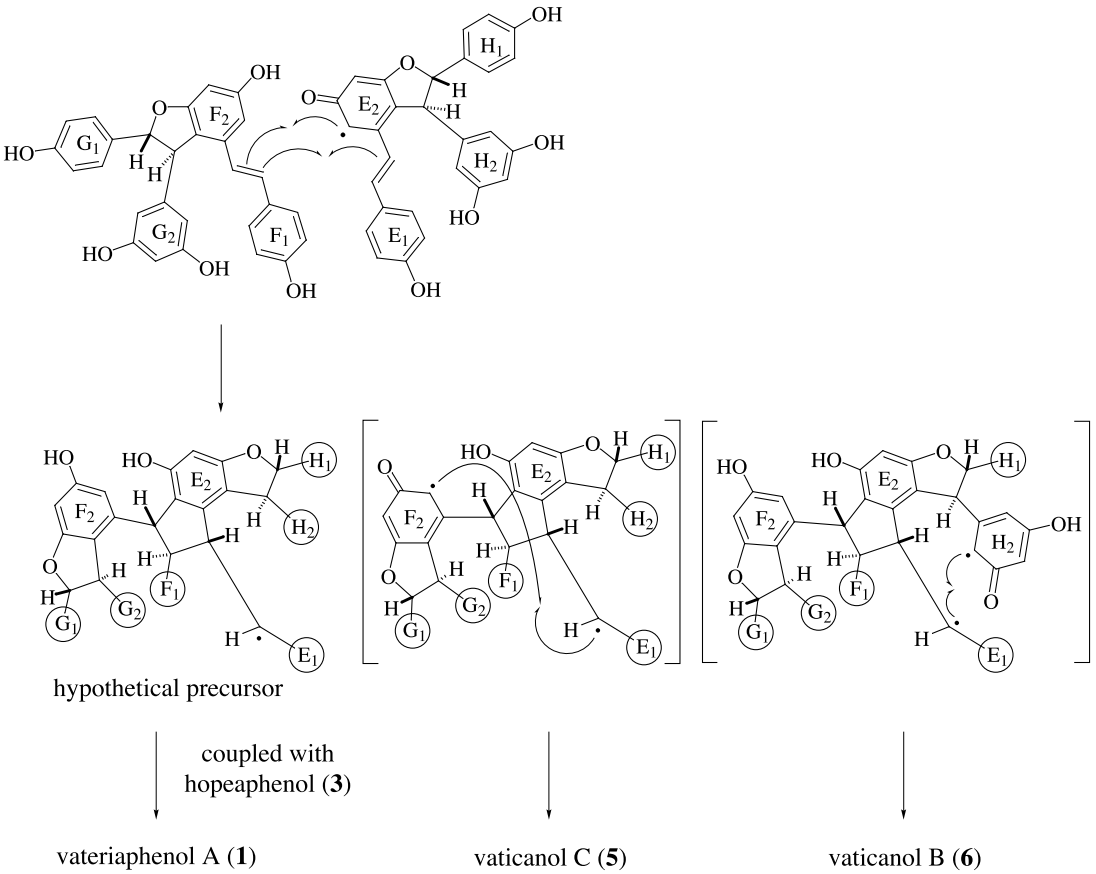


Figure 4. ROESY interactions in tetramer 2 (resveratrols E–H, **1D**).

[H-7e(α), H-8e(β), H-7g(α) and H-8g(β)] as shown in Figure 4 by consideration of the skeleton of benzocyclopentane ring and the relation of hypothetical biosynthetic pathway (Scheme 2).

In the ^{1}H NMR spectrum of **1** at rt,[34] four aromatic protons on ring E_1 (H-2e, H-3e, H-5e and H-6e) appeared as broad singlet (Fig. 5(a)), while the other aromatic protons on rings A_1–D_1 and F_1–H_1 appeared as a set of doublet. These differences can be explained as follows. In the relative stereo structure of **1**, ring E_1, 4-hydroxyl phenyl group, is situated between two large substituents of the tetramer 1 and the tetramer 2 except for ring E_1. The strong steric hindrance caused by two tetramers extensively inhibits the free rotation of ring E_1, which resulted in four broad singlets of proton signals. Huang et al. reported the similar phenomenon in resveratrol oligomers (amurensins C–F).[38] In the case of amurensin D, H-2a(6a) and H-3a(5a) on ring A_1 (4-hydroxyl phenyl group) had same chemical shifts, because the steric hindrance could be overcome at 0°C and the ring A_1 rotates quickly with increasing temperature. On the contary, the steric hindrance of ring E_1 of **1** caused by two large tetramers could not be overcome even at rt and the ring E_1 could rotate little. H-2e, H-6e, H-3e and H-5e had the different chemical shifts as the results, and appeared as four independent broad singlets. At different temperature measurement of ^{1}H NMR spectrum of **1**, the above broad signals gradually became split into doublet of doublets with lower temperature, the phenomenon of which was also observed in vaticanol G.[30] The spectrum at −20°C (Table 1) is shown in Figure 5(b). The strong steric hindrance besides the decrease in molecular movement much intensively fix the ring E_1 in lower temperature, which might cause the split of signals.

The relative structure of **1C** (tetramer 1, Fig. 2) is a same as that of hopeaphenol (**3**)[18] which is one of the major components of this plant. Only half numbers of signals comparing with atom numbers are observed in the ^{1}H and



Scheme 2. Biosynthetic formation of vateriaphenol A (**1**) and vaticanols C (**5**) and B (**6**).

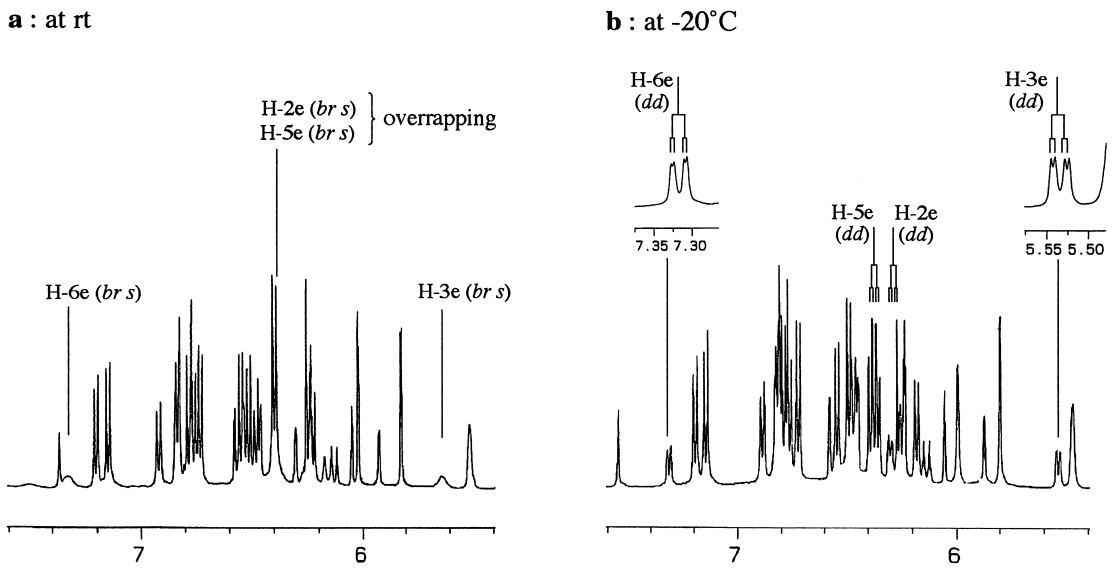


Figure 5. ^{1}H NMR spectra at 0°C and −20°C of **1** (Measured in CD_3COCD_3, 500 MHz).

^{13}C NMR spectrum of **3**, because **3** has a symmetrical plane in the molecule.[39] The symmetrical plane is collapsed in **1C**, the original numbers of signals were observed here, which enabled the detail analysis of stereochemistry between **1A** and **1B**. The plausible biosynthetic formation of resveratrol tetramers is drawn in Scheme 2. The relative structure of the two dihydrobenzofuran rings and the benzocyclopentane ring in tetramer 2 (**1D**, Fig. 4) is as same as that of hypothetical precursor of vaticanols B (**6**) and C (**5**), which are also major components of this plant. The occurrence of three tetramers (**3**, **5** and **6**) as major constituent suggests that a resveratrol octamer, vateriaphenol A (**1**), might be biologically synthesized by coupling of these tetramers.

Table 1. ^{1}H NMR spectral data in −20°C of **1**

No.	δ_H	No.	δ_H
2a, 6a	7.19 (d, 8.8)	7e	4.99 (d, 11.8)
3a, 5a	6.81 (d, 8.8)	8e	4.11 (d, 11.8)
7a	6.13 (d, 11.9)	12e	6.27 (s)
8a	4.08 (d, 11.9)	2f, 6f	6.84 (d, 8.8)
12a	6.45 (d, 2.0)	3f, 5f	6.77 (d, 8.8)
14a	6.26 (br)	7f	4.87 (d, 2.0)
2b, 6b	6.88 (d, 8.8)	8f	1.91 (d, 2.0)
3b, 5b	6.54 (d, 8.8)	10f, 14f	5.80 (d, 2.2)
7b	5.47 (br)	12f	6.28 (t, 2.2)
8b	4.07 (br s)	2g, 6g	6.47 (d, 8.8)
12b	5.32 (d, 2.0)	3g, 5g	6.36 (d, 8.8)
14b	4.91 (d, 2.0)	7g	3.18 (s)
2c, 6c	6.84 (d, 8.8)	8g	3.59 (s)
3c, 5c	6.39 (d, 8.8)	12g	6.27 (br s)
7c	5.47 (br)	14g	6.49 (br s)
8c	4.01 (br s)	2h, 6h	7.14 (d, 8.8)
14c	5.02 (s)	3h, 5h	6.72 (d, 8.8)
2d, 6d	6.16 (d, 8.8)	7h	5.15 (d, 4.2)
3d, 5d	6.48 (d, 8.8)	8h	4.99 (d, 4.2)
7d	5.10 (d, 12.3)	10h, 14h	6.00 (br s)
8d	3.88 (d, 12.3)	12h	6.06 (t, 0.9)
12d	6.58 (d, 2.0)	OH	8.94, 8.88, 8.83 (2H),
14d	5.87 (br)		8.73, 8.66, 8.63,
2e	6.30 (dd, 8.8, 2.0)		8.60, 8.55, 8.47 (2H),
3e	5.53 (dd, 8.8, 2.2)		8.44, 8.32 (2H), 8.29,
5e	6.37 (dd, 8.8, 2.2)		8.09, 8.06, 7.86,
6e	7.32 (dd, 8.8, 2.0)		7.56, 6.26

Measured in CD_3COCD_3, 500 MHz.

Vateriaphenol B (**2**), a brown amorphous powder, showed a positive reaction to the Gibbs test. The absorption band in the UV spectra showed the presence of aromatic rings (283 nm). The molecular weight was determined to be 906 by a peak of $[M-H]^-$ ion at *m/z* 905 in the negative ion FABMS. The empirical formula of $C_{56}H_{42}O_{12}$ was established by means of the high resolution FABMS ($[M-H]^-$ ion at *m/z* 905.2609) and the ^{13}C NMR spectrum which showed 56 carbon signals. The analysis of ^{1}H, ^{13}C NMR (Table 2) and ^{1}H–^{1}H COSY (Fig. 6) spectral data indicated the presence of eight oxygenated aromatic rings which form four 4-hydroxyphenyl groups (rings A_1–D_1) and four 1,2,3,5-tetrasubstituted benzene rings (rings A_2–D_2). The spectrum also exhibited two sets of mutually coupled aliphatic protons (H-7a/H-8a and H-7d/H-8d) and a sequence of four aliphatic protons in this order (H-7b/H-8b/H-8c/H-7c) as drawn in bold line in Figure 6. The presence of 10 hydroxyl groups and two ether linkages was deduced after considering the molecular formula and 10 broad signals due to hydroxyl groups in the ^{1}H NMR spectrum. All carbon signals attributed to eight methine carbons and 48 aromatic carbons in the ^{13}C NMR spectral data were assigned by analyzing the HMQC and HMBC spectrum (Table 2). In the HMBC spectrum (Fig. 6), significant ^{3}J long range correlations were observed between H-7a/C-2a(6a), H-7b/C-2b(6b), H-7c/C-2c(6c), H-7d/C-2d(6d), H-8a/C-14a, H-8b/C-14b, H-8c/C-14c and H-8d/C-14d, indicating that eight rings (A_1–D_1 and A_2–D_2) and eight methine units formed four resveratrols A–D. Long range correlations were further observed between the aliphatic methine protons and the quaternary carbons on the four tetra-substituted benzene rings (rings A_2–D_2) as follows; H-8a/C-11b, H-7b/C-9a, H-7c/C-9d and H-8d/C-11c, which indicated the connection between C-8a/C-10b, C-7b/C-10a, C-7c/C-10d and C-8d/C-10c, respectively. Although no long-range correlation between H-7a/C-11b and H-7d/C-11c was observed, the presence of two dihydrobenzofuran rings [C-7a–C-8a–C-10b–C-11b–O and C-7d–C-8d–C-10c–C-11c–O] was deduced by considering the presence of two ether linkages. The planar structure of **2** was then determined as shown in Figure 6. The structure is

Table 2. ^{1}H and ^{13}C NMR spectral data of **2**

No.	δ_H	δ_C	HMBC
1a		134.54	
2a, 6a	7.50 (d, 8.8)	130.33	1a, 3a (5a), 4a, 7a
3a, 5a	6.91 (d, 8.8)	116.42	1a, 2a (6a), 4a
4a (OH)	8.54 (br s)	158.43	3a (5a), 4a
7a	5.71 (d, 8.8)	93.73	2a (6a), 4a, 8a, 9a, 11b
8a	5.42 (d, 8.8)	53.50	4a, 7a, 9a, 10a, 14a, 9b, 10b, 11b
9a		141.68	
10a		119.94	
11a (OH)	7.81 (br s)	158.23	10a, 11a, 12a
12a	6.35 (d, 2.0)	102.69	10a, 11a, 13a, 14a
13a (OH)	8.11 (br s)	156.88	12a, 13a, 14a
14a	6.39 (d, 2.0)	106.59	10a, 12a, 13a
1b		138.06	
2b, 6b	6.31 (d, 8.8)	114.47	1b, 3b (5b), 4b, 7b
3b, 5b	6.35 (d, 8.8)	129.93	1b, 2b(6b), 4b
4b (OH)	7.92 (br s)	154.99	3b (5b), 4b
7b	4.71 (d, 4.4)	45.13	9a, 10a, 11a, 1b, 2b (6b), 8b, 9b, 8c
8b	2.62 (dd, 10.7, 4.4)	59.18	10a, 1b, 7b, 9b, 10b, 14b, 7c, 8c, 9c
9b		140.38	
10b		116.84	
11b		160.20	
12b	5.87 (d, 2.2)	94.93	10b, 11b, 13b, 14b
13b (OH)	7.69 (br s)	157.96	12b, 13b, 14b
14b	4.99 (d, 2.2)	112.66	8b, 10b, 12b, 13b
1c		133.92	
2c, 6c	6.91 (d, 8.5)	128.93	1c, 3c (5c), 4c, 7c
3c, 5c	6.54 (d, 8.5)	115.43	1c, 2c (6c), 4c
4c (OH)	7.64 (br s)	155.70	3c (5c), 4c
7c	5.05 (d, 5.1)	41.78	8b, 1c, 2c (6c), 8c, 9c, 9d, 10d, 11d
8c	4.29 (dd, 10.7. 5.1)	45.91	7b, 8b, 1c, 7c, 9c, 10c, 14c, 14d
9c		141.96	
10c		116.18	
11c		160.15	
12c	6.01 (d, 2.0)	95.98	10c, 11c, 13c, 14c
13c (OH)	7.51 (br s)	157.87	12c, 13c, 14c
14c	5.89 (d, 2.0)	111.68	8c, 10c, 12c, 13c
1d		130.79	
2d, 6d	7.24 (d, 8.5)	130.42	1d, 3d (5d), 4d, 7d
3d, 5d	6.82 (d, 8.5)	116.04	1d, 2d (6d), 4d
4d (OH)	8.48 (br s)	158.55	3d (5d), 4d
7d	5.82 (d, 12.7)	88.81	2d (6d), 4d, 8d, 9d, 11c
8d	4.39 (d, 12.7)	50.73	4d, 7d, 9d, 10d, 14d, 9c, 10c, 11c
9d		141.08	
10d		118.70	
11d (OH)	7.52 (br s)	158.92	10d, 11d, 12d
12d	6.29 (d, 2.0)	101.82	10d, 11d, 13d, 14d
13d (OH)	8.01 (br s)	157.17	12d, 13d, 14d
14d	6.19 (d, 2.0)	105.92	10d, 12d, 13d

Measured in CD_3COCD_3, 500 MHz (^{1}H) and 125 MHz (^{13}C).

corresponding to a tetramer coupling with two resveratrol dimers (dimers 1 and 2, Fig. 6).

For confirmation of the relative stereochemistry, NOESY experiments were conducted (Fig. 6). The clear cross peaks between H-7a/H-14a, H-8a/H-2a(6a), H-2a(6a)/H-14a and H-7d/H-14d, H-8d/H-2d(6d), H-2d(6d)/H-14d were observed. These cross peaks and the coupling constant values [J=8.8 Hz (H-7a/H-8a) and J=12.7 Hz (H-7d/H-8d)] indicated that the relative stereochemistry of the two dihydrobenzofuran rings (H-7a/H-8a and H-7d/H-8d) is *trans*. The relationship between four methine protons (H-7b, H-8b, H-8d and H-7d) and the two dihydrobenzofuran rings was determined as follows. NOEs between H-8d/H-2c(6c) indicated that the methine protons (H-7c) on the dibenzocycloheptadiene ring (C-7c–C-8c–C-9c–C-10c–C-8d–C-9d–C-10d) were oriented in α-configuration. Furthermore the configuration of H-8b was confirmed to be α by following considerations. Distinct NOEs, H-8b/H-14b, H-8a/H-7c and H-8a/H-8c, were observed, all of which can be explained only when H-8a and the dimer 2 are situated in a same configuration. The remaining stereo centers are C-7b and C-8c. When the difference in the orientation of H-8c was considered under a qualification that H-8b and H-8c were oriented in *anti* due to their coupling constant (10.7 Hz) (Fig. 7), two molecular models (left figure, H-8c: β; right figure, H-8c: α) were supported. It was found that β-conformation of H-8c (left figure) could satisfy the NOEs [H-7b/H-14c H-8a/H-7c and H-8a/H-8c] and the upper field shift of H-14b (δ_H 4.99) which was caused by anisotropic effect of ring C_2. On the other hand, α-conformation of H-8c (right figure) could satisfy partly [H-8a/H-7c and H-8a/H-8c]. As the result, H-7b are situated in β-configuration. The upper field shift of H-2b(6b) (δ_H

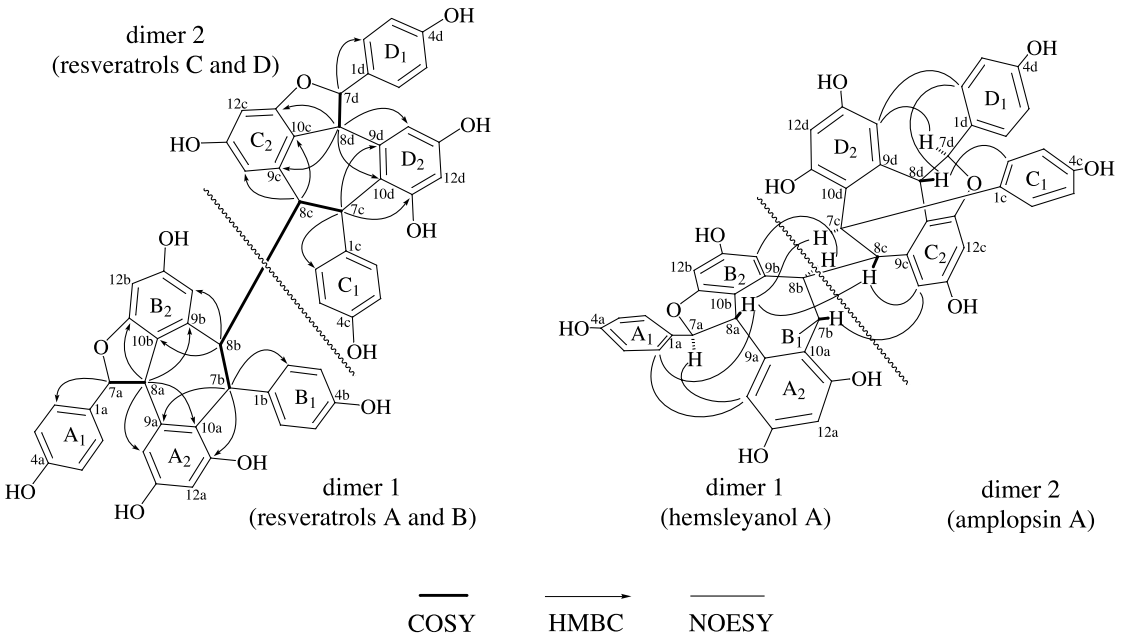


Figure 6. Correlations observed in 2D NMR of **2** (COSY and HMBC: left Figure, NOESY: right Figure).

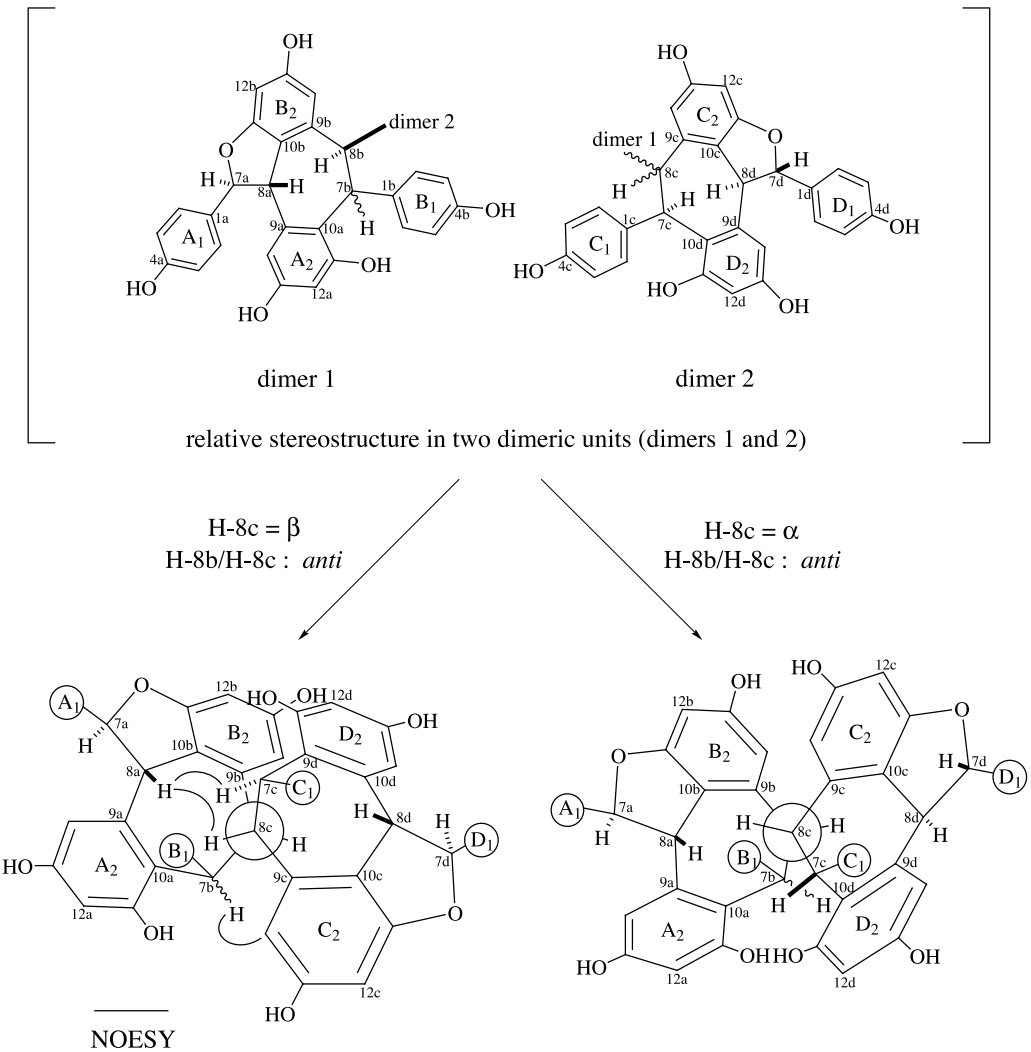


Figure 7. Two possible stereostructures of **2** with a difference in orientation of C-8c.

6.31) can be explained as a result of anisotropy by ring B_2. On the basis of these results, the relative stereo structure of **2** was confirmed as shown in Figure 6.

The planar structure of **2** is identical to those of known resveratrol tetramers such as hopeaphenol (**3**) and isohopeaphenol (**4**). Both the tetramers (**3** and **4**) were also isolated from this plant (Scheme 1).[26,32] These three diastereomers can be regarded as a resveratrol tetramer composed of two resveratrol dimers. The dimmer units (1 and 2) are shown in Figure 6. In the case of **3** and **4**, two identical dimers (two ampelopsin As' (**11**)[40] for **3**, two balanocarpols[12] for **4**) are coupled through the linkage of C-8b/C-8c. The resulting tetramers have a symmetrical plane in the molecule,[39,41] which reduces the number of signals to half number in the ^1H and ^{13}C NMR spectrum.[39] A tetramer of **2** is composed of two diastereomeric dimers of hemsleyanol A[31] and **11**. The coupling ways of different resveratrol dimers add the variation of tetramers and the stereo structures.

In addition to **1** and **2**, 11 known compounds were isolated and their structures were identified as (−)-hopeaphenol (**3**),[20,39] (+)-isohopeaphenol (**4**),[31,39] vaticanols B (**6**) and C (**5**),[27] vaticasides B (**7**) and C (**8**),[29] (−)-ampelopsin H (**9**),[33,42] (−)-ε-viniferin (**10**),[11] (+)-ampelopsin A (**11**),[25,40] piceid (**12**),[27] and bergenin (**13**),[3] respectively, by spectral analysis and comparison with respective authentic samples.

3. Experimental

3.1. General procedures

The following instruments were used: FABMS spectra, JEOL JMS-DX-300 instrument; ^1H and ^{13}C NMR spectra, JEOL JNM A-500, EX-400 and LA-300 (Chemical shift values are presented as δ values with TMS as internal standard); UV spectra, Shimadzu UV-2200 spectrophotometer (in methanol solution); optical rotations, JASCO P-1020 polarimeter. The following adsorbents were used for purification: analytical TLC, Merck Kieselgel 60 F_{254} (0.25 mm); preparative TLC, Merck Kieselgel 60 F_{254} (0.5 mm); column chromatography, Merck Kieselgel 60, Pharmacia Fine Chemicals AB Sephadex LH-20 and Fuji Silysia Chemical Chromatorex; vacuum liquid chromatography (VLC), Merck Kieselgel 60; Medium-pressure column chromatography, Nacalai Tesque Silica Gel 60-C_{18} (250–350 mesh).

3.2. Plant material

Stem bark of *Vateria indica* was collected in India in August, 1999.

3.3. Extraction and isolation

The dried and ground stem bark (1.7 kg) of *V. indica* was extracted successively with acetone (10 L×24 h×3), MeOH (10 L×24 h×3) and 70% MeOH (10 L×24 h×2) at rt. The extract was concentrated to yield respective residues; 188 g (acetone), 123 g (MeOH) and 27 g (70% MeOH). The acetone extract (185 g) was suspended into acetone (2 L) and left at rt over night. An acetone soluble part of the extract (130 g) was subjected to column chromatography (CC) on silica gel eluted with a mixture of $CHCl_3$–MeOH increasing in the polarity to give 18 fractions (Fr. 1–18). Fr. 4 [$CHCl_3$–MeOH (10:1), 1.2 g] was further subjected to CC on Sephadex LH-20 (acetone) to give **10** (510 mg). Compounds **11** (80 mg) and **12** (2 g) were obtained from Fr. 8 [$CHCl_3$–MeOH (10:1), 1.3 g] and Fr. 9 [$CHCl_3$–MeOH (10:1), 5.2 g], respectively, after repeated purification with CC over Sephadex LH-20 (MeOH and acetone–MeOH=5:1). A part (8 g) of Fr. 12 [$CHCl_3$–MeOH (8:1), 28 g] was further subjected to Sephadex LH-20 CC eluted with MeOH to give seven fractions (Fr. 12A–Fr. 12G). The third fraction (Fr. 12C, 200 mg) was further purified by Sephadex LH-20 (MeOH) to give **2** (10 mg). Compounds **9** (12 mg), **5** (60 mg) and **6** (5.2 g) were obtained from Fr. 12D (120 mg), Fr. 12E (115 mg) and Fr. 12G (5.5 g), respectively. A part (50 mg) of Fr. 14 [$CHCl_3$–MeOH (5:1), 25 g] were purified by PTLC (EtOAc–$CHCl_3$–MeOH–H_2O=15:8:4:1) to give **4** (12 mg). Compound **3** (19 g) was obtained from Fr. 15 [$CHCl_3$–MeOH (5:1), 25 g] after repeated purification over Sephadex LH-20 CC (MeOH). Purification of the 17th fraction [$CHCl_3$–MeOH (5:1), 480 mg] by Sephadex LH-20 CC (MeOH), reversed-phase medium pressure CC (H_2O–MeOH gradient system) and PTLC (EtOAc–$CHCl_3$–MeOH–H_2O=20:10:11:5) achieved the isolation of **1** (96 mg), **7** (6 mg) and **8** (6 mg). An acetone insoluble part (55 g) was dissolved in acetone–MeOH (1:1) mixture (1 L) and left to give **13** (30 g) as powder.

3.3.1. Vateriaphenol A (1)

A brown amorphous powder; $[\alpha]_D^{25}=-210°$ (c=0.1, MeOH); UV λ_{max} (MeOH): 225, 284 nm; negative ion FAB-MS m/z: 1811 $[M-H]^-$; positive ion FAB-MS m/z: 1813 $[M+H]^+$; positive ion HRFAB-MS m/z: 1813.5420 $[M+H]^+$ (calcd 1813.5430 for $C_{112}H_{85}O_{24}$); the ^1H and ^{13}C NMR spectral data at rt: Lit.,[34] The ^1H NMR spectral data at −20°C: see Table 1.

3.3.2. Vateriaphenol B (2)

A brown amorphous powder; $[\alpha]_D^{25}=-323°$(c=0.1, MeOH); UV λ_{max} (MeOH): 214, 283 nm; negative ion FAB-MS m/z: 905 $[M-H]^-$; negative ion HRFAB-MS m/z: 905.2609 (calcd 905.2598 for $C_{56}H_{41}O_{12}$); the ^1H and ^{13}C NMR spectral data: see Table 2.

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