Resveratrol Derivatives from *Upuna borneensis*

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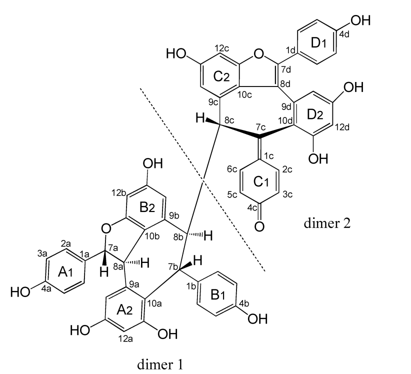
Four new resveratrol derivatives, upunaphenols B (1), C (4), D (5) (resveratrol tetramer) and E (6, resveratrol dimer with a C_6–C_1 unit), together with nine known resveratrol oligomers and resveratrol were isolated from an acetone soluble part of stem of *Upuna borneensis* (Dipterocarpaceae). The structures of new compounds were determined by spectral analysis including 1D and 2D NMR experiments.

Key words *Upuna borneensis*; Dipterocarpaceae; resveratrol oligomer; upunaphenol; structure elucidation

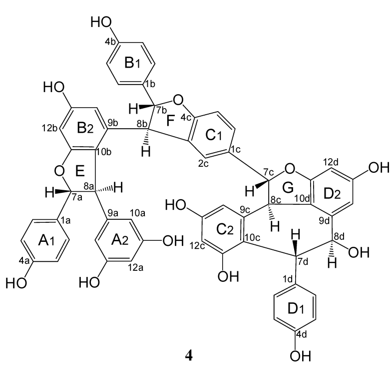
Upuna borneensis (Dipterocarpaceae) is a monotypic genus distributed in Malaysia.[1)] In previous papers, we reported the isolation and structure determination of new compounds of a resveratrol hexamer (upunaphenol A), resveratrol *O*-glucosides and acetophenone *C*-glucosides together with four known resveratrol oligomers from an acetone extract of stem of this plant.[2,3)] We report in this paper the isolation and structure elucidation of 14 resveratrol derivatives including four new compounds, upunaphenols B (**1**), C (**4**)—E (**6**).

Upunaphenols B (**1**) ($[\alpha]_D^{25}$ $-530°$), C (**4**) ($[\alpha]_D^{25}$ $-175°$), D (**5**) ($[\alpha]_D^{25}$ $-229°$) and E (**6**) ($[\alpha]_D^{25}$ $-147°$) were purified from an acetone-soluble part of stem of *U. borneensis* by column chromatography over silica gel, Sephadex LH-20, ODS, and preparative TLC. All compounds showed positive reactions to the Gibbs reagent.

Upunaphenol B (**1**) was obtained as a yellow amorphous powder. In the high resolution (HR) FAB-MS, an $[M-H]^-$ ion peak was observed at *m/z* 901.2297 suggesting the molecular formula of $C_{56}H_{38}O_{12}$ corresponding to the molecule of an oxidative tetramer of resveratrol. The ^{1}H- and ^{13}C-NMR spectral data (Tables 1, 2) together with ^{1}H–^{1}H shift correlation spectroscopy (COSY), ^{13}C–^{1}H COSY and ^{1}H detected heteronuclear multiple bond connectivity (HMBC) spectrum showed the presence of *ortho*-coupled aromatic protons assignable to three 4-hydroxylphenyl groups (rings A_1, B_1, D_1),



1
2 : H-7d; H-8d: dihydro (H-7d: α; H-8d: β)
3 : H-7d; H-8d: dihydro (H-7d: α; H-8d: β), ring C1: *p*-hydroxyphenyl, H-7c: α



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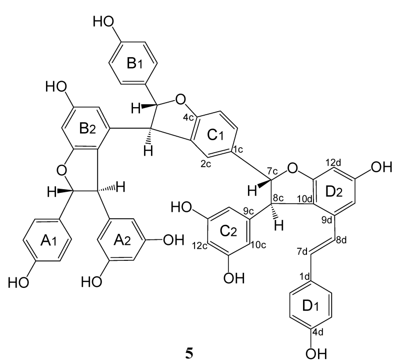

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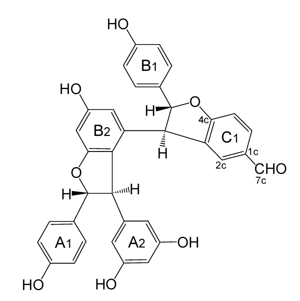

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Chart 1

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Table 1. ^{1}H-NMR Spectral Data of **1**, **4**—**6**

No.	**1**	**4**	**5**	**6**
2a, 6a	7.18 (d, 8.7)	7.04 (d, 8.6)	7.01 (d, 8.6)	7.03 (d, 8.5)
3a, 5a	6.81 (d, 8.7)	6.82 (d, 8.6)	6.82 (d, 8.6)	6.82 (d, 8.5)
7a	5.81 (d, 12.1)	5.29 (d, 5.3)	5.21 (d, 5.0)	5.27 (d, 5.0)
8a	4.28 (d, 12.1)	3.80 (d, 5.3)	3.69 (d, 5.0)	3.74 (d, 5.0)
10a		6.06 (d, 2.2)	5.96 (d, 2.2)	5.99 (d, 2.4)
12a	6.58 (d, 2.0)	6.27 (t, 2.2)	6.24 (t, 2.2)	6.19 (t, 2.4)
14a	6.42 (br d, 2.0)	6.06 (d, 2.2)	5.96 (d, 2.2)	5.99 (d, 2.4)
2b, 6b	6.76 (d, 8.8)	7.06 (d, 8.6)	7.08 (d, 8.6)	7.11 (d, 8.4)
3b, 5b	6.54 (d, 8.8)	6.76 (d, 8.6)	6.76 (d, 8.6)	6.78 (d, 8.4)
7b	5.11 (d, 4.7)	5.34 (d, 9.5)	5.27 (d, 9.3)	5.45 (d, 9.4)
8b	3.75 (dd, 10.0, 4.7)	4.37 (d, 9.5)	4.42 (d, 9.3)	4.49 (d, 9.4)
12b	5.86 (d, 2.1)	6.32 (d, 2.0)	6.29 (br s)	6.35 (d, 2.0)
14b	5.22 (d, 2.1)	6.20 (d, 2.1)	6.20 (br d, 2.0)	6.20 (d, 2.0)
2c	7.38 (dd, 10.1, 2.6)	6.87 (d, 2.5)	6.86 (br s)	7.27 (br d, 2.0)
3c	6.16 (dd, 10.1, 2.6)			
5c	6.13 (dd, 10.3, 2.6)	6.63[a]	6.78 (d, 8.3)	6.98 (d, 8.3)
6c	7.27 (dd, 10.3, 2.6)	6.63[a]	7.13 (br d, 8.3)	7.79 (dd, 8.3, 2.0)
7c		5.68 (d, 11.2)	5.37 (d, 5.1)	9.77 (br s)
8c	4.65 (d, 10.0)	4.18 (d, 11.2)	4.45 (d, 5.1)	
10c			6.20—6.30 (br s)	
12c	6.65 (d, 2.0)	6.43 (d, 2.0)	6.19 (br s)	
14c	5.80 (d, 2.0)	6.15 (br d, 2.0)	6.20—6.30 (br s)	
2d, 6d	7.61 (d, 8.7)	6.88 (br d, 8.6)	7.19 (d, 8.6)	
3d, 5d	6.96 (d, 8.7)	6.64 (d, 8.6)	6.75 (d, 8.6)	
7d		5.43 (br d, 6.8)	6.91 (d, 16.3)	
8d		5.41 (br d, 6.8)	6.69 (d, 16.3)	
12d	6.41 (d, 2.3)	6.10 (d, 2.0)	6.32 (s)	
14d	7.00 (d, 2.3)	6.59 (d, 2.0)	6.20—6.30 (br s)	
OH	8.43 (br s, OH-13a) 8.00 (br s, OH-4b) 7.61 (br s, OH-13b) 8.16 (br s, OH-13c) 8.66 (br s, OH-13d) 8.05, 8.49, 8.82, 8.95 (1H each, br s)	3.41 (br s, OH-8d) 8.17, 8.29, 8.32, 8.42, 8.45, 8.55 (1H each, br s) 8.51 (3H, br s)		8.44 (br s, OH-4a) 8.23 (br s, OH-11a,13a) 8.55 (br s, OH-4b) 8.44 (br s, OH-13b)

Measured in acetone-d_6 (300 MHz). All protons were assigned by ^{1}H–^{1}H, ^{1}H–^{1}H long-range, ^{13}C–^{1}H COSY, COLOC and HMBC spectrum. *a*) Obscured by overlapping with H-3d(5d).

four sets of *meta*-coupled aromatic protons on a 1,2,3,5-tetrasubstituted benzene ring (rings A_2—D_2). The NMR spectral data also disclosed the presence of a set of aliphatic signals characteristic for a 2,3-diaryldihydrobenzofuran moiety (H-7a, H-8a)[4] in addition to a sequence of three aliphatic methine protons successively coupled in this order (H-7b/H-8b/H-8c). The ^{1}H-NMR spectrum further showed the signals of nine phenolic OH groups (δ 7.61—8.95), which disappeared upon addition of D_2O. Considering the molecular formula, the remaining unit in the molecule corresponds to C_9H_4O. In the ^{1}H-NMR spectrum, the other signals of four olefinic protons [δ_H 7.38 (H-2c), 6.16 (H-3c), 6.13 (H-5c), 7.27 (H-6c)] are corresponding to the C_9H_4O, two of which (H-2c, H-6c) were correlated with a carbonyl carbon (δ_C 187.3: C-4c) in the HMBC spectrum. An existence of partial structure of *para*-quinoid unit (C_7H_4O: C-1—C-7) was confirmed by correlations observed between H-2c/C-7c, H-3c/C-1c, H-5c/C-1c and H-6c/C-7c. The remaining carbon signals [δ_C 152.8 (C-7d), 114.9 (C-8d)] were assigned to the quaternary olefinic carbons, and the chemical shifts observed in **1** were similar to those of a benzofuran moiety in malibatol A (δ_C 151.2, 117.3) isolated from *Hopea malibato*.[5] The connection of these partial structures was determined as follows. In the HMBC spectrum (Fig. 1), correlations *via* ^3J were observed between H-7a/C-2a(6a), H-8a/C-10a, H-7b/C-2b(6b), H-8b/C-10b, H-8c/C-10c, H-2d(6d)/C-7d and H-14d/C-8d, indicating that the rings A_1, A_2, B_1, B_2, C_2, D_1 and D_2 were attached at C-7a, C-8a, C-7b, C-8b, C-8c, C-7d and C-8d, respectively. Then the expanded partial unit formed by resveratrols A, B and D [(resveratrol A: ring A_1–C-7a–C-8a–ring A_2)] was established. Four C–C bonds of C-8a/C-10b, C-7b/C10a, C-7c/C-8c and C-7c/C-10d were further deduced by correlations of H-8a/C-11b, H-7b/C-11a, H-8b/C-7c and H-8c/C-10d. Although no long-range correlation between H-7a/C-11b was observed, the presence of a dihydrobenzofuran ring (C-7a–C-8a–C-10b–C-11b–O) and a benzofuran ring (C-7d–C-8d–C-10c–C-11c–O) was clear after considering the carbon chemical shifts and the molecular formula. The planar structure of upunaphenol B was then concluded to be **1**. The other correlations in the HMBC spectrum summarized in Fig. 1 and experimental section were in accordance with the proposed planar structure. The structure of **1** is an oxidative tetramer of four resveratrol units (resveratrols A—D) and one of the 4-hydroxylphenyl groups is changed to a *para*-quinoid form (ring C_1) in resveratrol C. The stereo structure of **1** was determined by analysis of the nuclear Overhauser spectroscopy (NOESY) spectrum (Fig. 2). The *trans* relationship of H-7a/H-8a on the dihydrobenzofuran ring was confirmed by the distinctive NOEs between H-7a/H-14a, H-8a/H-2a(6a) and H-2a(6a)/H-14a. The large

Table 2. ^{13}C-NMR Spectral Data of **1**, **4**—**6**

No.	**1**	**4**	**5**	**6**
1a	130.4	133.3	133.4	133.4
2a, 6a	130.3	128.2	128.1	128.1
3a, 5a	116.1	116.2	116.0	116.1
4a	158.7	158.4[g]	158.1[d]	158.2
7a	88.7	93.8	93.9	93.9
8a	50.1	56.1	55.9	56.1
9a	142.5	147.4	147.0	147.2
10a	118.5	107.0	106.6	106.7
11a	157.8[a]	159.4	159.5	159.9
12a	102.4	102.2	102.0	102.2
13a	157.8[a]	159.4	159.5	159.9
14a	107.5	107.0	106.6	106.7
1b	132.9	131.6	131.7	130.9
2b, 6b	128.9	128.4	128.6	128.7
3b, 5b	115.5	116.2	116.2	116.3
4b	155.8	158.3[g]	158.3	158.7
7b	41.3	94.4	94.3	95.1
8b	49.9	54.5	54.8	53.8
9b	138.6	140.3	140.3	139.5
10b	117.9	121.7	121.4	121.6
11b	159.8	162.0	162.3	162.3
12b	96.0	96.7	96.6[e]	96.9
13b	157.8[a]	159.9	159.5[f]	160.2
14b	111.4	107.7	107.6	107.8
1c	132.6	132.6[c]	135.7	132.5
2c	135.6	127.2	123.9	127.5
3c	128.6	131.3	131.1	133.4
4c	187.3	161.2	160.9	165.8
5c	129.0	109.9	109.9	110.6
6c	140.5	127.6	126.7	132.8
7c	156.9	88.1	93.8	190.8
8c	54.6	49.3	56.8	
9c	136.8	143.1	147.1	
10c	119.6	118.7[h]	106.4	
11c	155.5	159.03[i]	159.5[f]	
12c	96.5	101.6	102.1	
13c	156.1[b]	156.9	159.5[f]	
14c	112.5	104.8	102.1	
1d	123.0	132.6[c]	129.9	
2d, 6d	131.0	128.7	128.7	
3d, 5d	116.4	115.5	116.1	
4d	159.2	156.1	158.1[d]	
7d	152.8	43.8	130.1	
8d	114.9	71.0	123.4	
9d	133.8	140.5	136.3	
10d	116.0	118.8[h]	119.6	
11d	156.1[b]	160.2	162.1	
12d	103.0	97.1	96.6[e]	
13d	159.4	158.98[i]	159.5[f]	
14d	109.6	110.5	103.9	

Measured in acetone-d_6 (75 MHz). *a—f*) Overlapping. *g—i*) Interchangeable. All carbons were assigned by ^{13}C–^{1}H COSY, COLOC and HMBC spectrum.

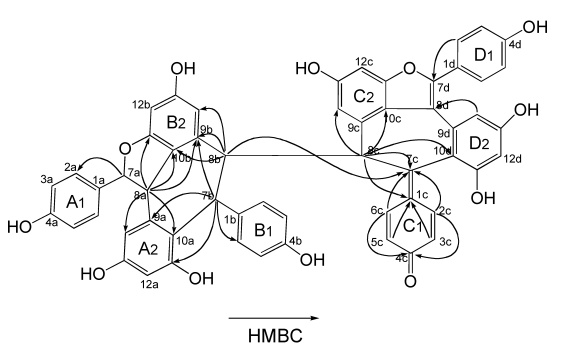

Fig. 1. Selected Correlations Observed in the HMBC Spectrum of **1**

Other correlations: see Experimental.

coupling constant values of H-7a and H-8a (J=12.1 Hz) also supported the stereo relationships.[6] In addition, the *syn* orientation of ring B_1, H-8a and H-8b was supported by NOEs between H-2b(6b)/H-8a and H-2b(6b)/H-8b. An NOE enhancement between H-7b/H-8c was further observed in **1**, indicating that these two protons were co-facial and the *trans* relationship of H-8b/H-8c. The large coupling constant (10.0 Hz)[7] and the lack of NOE enhancement between H-8b/H-8c supported the stereo relationships. Considering the cycloheptadiene ring (C-7c–C-8c–C-9c–C-10c–C-8d–C-9d–C-10d) in **1**, two conformers based on the bond of H-8c/C-8c (left figure: equatorial, right figure: axial) were proposed. The equatorial form (left figure) can reasonably explain the NOEs (H-6c/H-8c, H-8c/H-14c). The conformer was reinforced by the fact that the protons of H-14b (δ_H 5.22) and H-14c (δ_H 5.80) were shielded due to the anisotropic effects caused by rings C_2 to B_2 and *vice versa*. Therefore, the structure of upunaphenol B can be presented as **1** including relative stereochemistry [*rel*-(7a*R*, 8a*R*, 7b*R*, 8b*S*, 7c*R*, 8c*R*, 7d*R*, 8d*S*)], which is the same as those of stenophyllol A (**2**)[8] and hopeaphenol (**3**).[9] Hopeaphenol is known to present both in (+)- or (−)-form in Vitaceae and Dipterocarpaceae, respectively.[6] As **1** had an $[\alpha]_D$ of −530°, the structure of **1** was concluded to be an oxidative derivative of stenophyllol A (**2**) and (−)-hopeaphenol (**3**).

Upunaphenol C (**4**) was obtained as a pale yellow amorphous powder. HR-FAB-MS ($[M-H]^-$ *m/z* 921.2559) showed a molecular formula of $C_{56}H_{42}O_{13}$. The ^{1}H- and ^{13}C-NMR spectral data of **4** together with ^{1}H–^{1}H COSY, ^{13}C–^{1}H COSY and HMBC spectrum (Tables 1, 2) indicated the presence of eight oxygenated aromatic rings which form three 4-hydroxyphenyl groups (rings A_1, B_1, D_1), a 1,2,4-trisubstituted benzene ring (ring C_1), a 3,5-dihydroxyphenyl group (ring A_2) and three 1,2,3,5-tetrasubstituted benzene rings (rings B_2—D_2). The ^{1}H-NMR spectrum exhibited signals of 10 hydroxyl groups [δ_H 3.41 (d, J=6.8 Hz, alcoholic-OH at C-8d); 8.17, 8.29, 8.32, 8.42, 8.45, 8.55, 8.51 (×3) (each br s, phenolic-OH)] which became sharp when measured in DMSO-d_6 (δ_H 4.84, 8.85—9.50, see Experimental) and disappeared upon addition of D_2O. The spectrum also showed the signals attributed to three sets of mutually coupled aliphatic protons on 2,3-diaryldihydrobenzofuran moieties (H-7a/H-8a, H-7b/H-8b, H-7c/H-8c) and a set of aliphatic protons (H-7d/H-8d). The proton (H-8d) was correlated with the hydroxyl proton at δ_H 3.41, which indicated that the alcoholic hydroxyl group was located at C-8d. The significant ^{3}J long range correlations were observed between H-7a/C-2a(6a), H-7b/C-2b(6b), H-7c/C-2c, H-7d/C-2d(6d), H-8a/C-10a(14a), H-8b/C-10b, H-8c/C-10c and H-8d/C-10d in the HMBC spectrum (Fig. 3), which indicated that eight rings (A_1–D_1, A_2–D_2) and eight methine units form four resveratrols A—D. Long range correlations were further observed between the aliphatic methine protons and the quaternary carbons on rings A_2–D_2 as follows; H-8a/C-11b, H-8b/C-2c, H-8c/C-9d and H-7d/C-11c, which supported the C–C bonds between C-8a/C-10b, C-8b/C-3c, C-8c/C-10d and C-7d/C-10c, respectively. Further cross peaks observed between H-7a/C-11b showed the presence of an ether linkage (C-7a–O–C-11b) which forms a dihydrobenzofuran ring (ring E) (C-7a–C-8a–C-10b–C-11b–O). The presence of other two dihydrobenzofuran rings (ring F) (C-7b–C-8b–C-3c–C-4c–O)

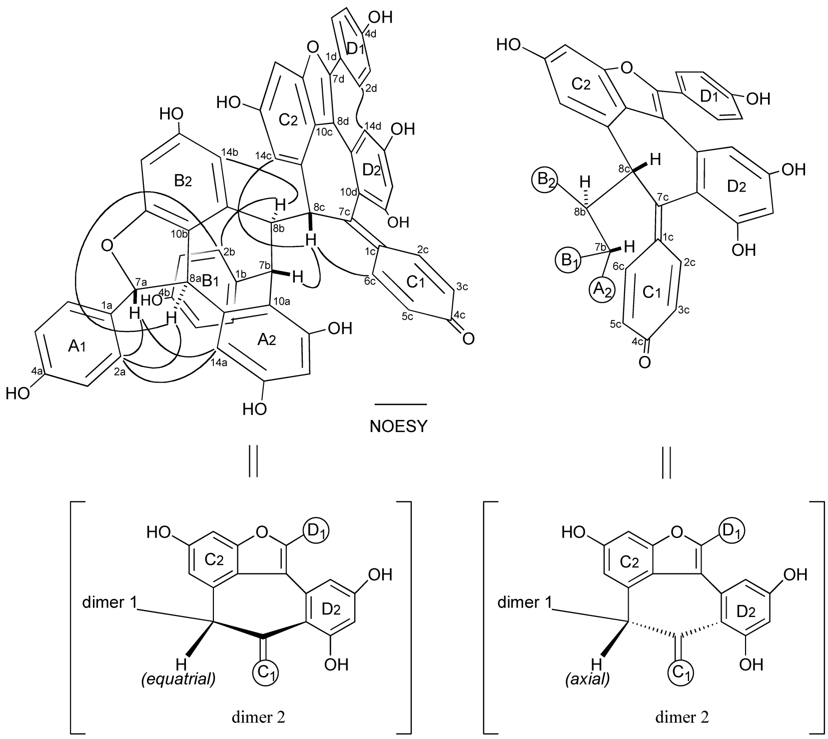

Fig. 2. Two Possibilities of Conformers Due to H-8c of **1** Left: *Equatrial* Conformation of H-7c; Right: *Axial* Conformation of H-7c and NOEs Observed in the NOESY Spectrum

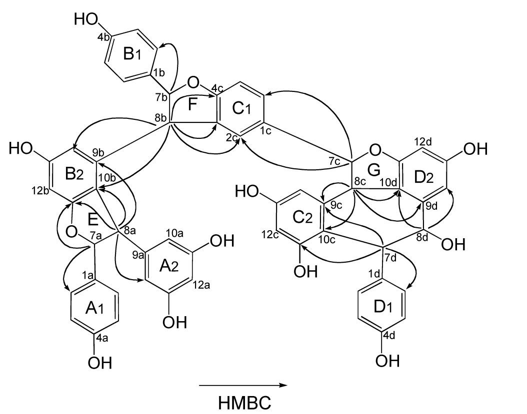

Fig. 3. Selected Correlations Observed in the HMBC Spectrum of **4**
Other correlations: see Experimental.

and (ring G) C-7c–C-8c–C-10d–C-11d–O) was deduced after considering the molecular formula. The planar structure of upunaphenol C was concluded to be **4**. For the confirmation of the relative stereochemistry, NOESY experiments were conducted (Fig. 4). The clear cross peaks observed between H-7a/H-10a(14a), H-8a/H-2a(6a) and H-2a(6a)/H-14a confirmed the *trans* relationship of H-7a and H-8a on ring E. *trans* relationship of rings F (H-7b/H-8b) and ring G (H-7c/H-8c) were also confirmed by the same correlations as in ring E. The stereo relationship among rings E—G was determined as follows. The methine proton (H-8b) displayed NOEs with H-8a and H-10a(14a), which will be observed in both orientation of ring E (Fig. 4A: α-orientation of H-8a, Fig. 4B: β-orientation of H-8a). The point was differentiated by an NOE between H-10a(14a)/H-2c. The orientation of H-7a and H-8a was determined to be β and α, respectively (Fig. 4A). Further NOEs observed H-10a(14a)/H-7c and H-10a(14a)/H-14c substantiated H-7c to be β-orientation, because ring A_2 is situated above the plane of ring C_2 in such stereo relationship between rings E and F (Fig. 5). Therefore, the structure of upunaphenol C including relative stereochemistry can be presented as **4**. The dimeric unit of resveratrols C and D in the structure of **4** is found to be identical to those of ampelopsin A.[10]

Upunaphenols D (**5**) and E (**6**), were obtained as yellow amorphous powders. Each composition was deduced to be $C_{56}H_{42}O_{12}$ and $C_{35}H_{26}O_8$ by the $[M-H]^-$ ion peaks observed at *m/z* 905.2609 (**5**) and 573.1552 (**6**) in the HR-FAB-MS. The patterns of NMR spectral data of **5** and **6** (Tables 1, 2) were closely similar to those of **4**, in particular, in the partial structure of resveratrols A and B including ring C_1. By detail analysis of 2D-NMR spectra (Fig. 6: **5**; Fig. 7: **6**), they were found to have the identical partial structure in the molecule. The structural differences between **4** and **5** were attributable to resveratrols C and D units, presenting ε-viniferin[11] in **5** instead of ampelopsin A. The HMBC spectrum and NOESY spectrum well explained the structure of **5** including its stereochemistry. By the same reasons described in the stereo structure of **4**, the relative stereo structure of upunaphenol D was elucidated to be **5**. The structure of upunaphenol E, which was analyzed by ^{13}C–^{1}H shift correlation spectroscopy involving long-range coupling (COLOC) and NOESY spectrum, was also determined to be **6**. C-1c on ring C_1 is substituted with an aldehyde group.

Most of the resveratrol oligomers in Dipterocarpaceous plants usually form a dihydrobenzofuran ring after oxidative condensation to a resorcin moiety of resveratrol. The appearance of dihydrobenzofuran ring condensed to a 4-hydroxyphenyl group such as **4** and **5** is a rare case in stilbene com-

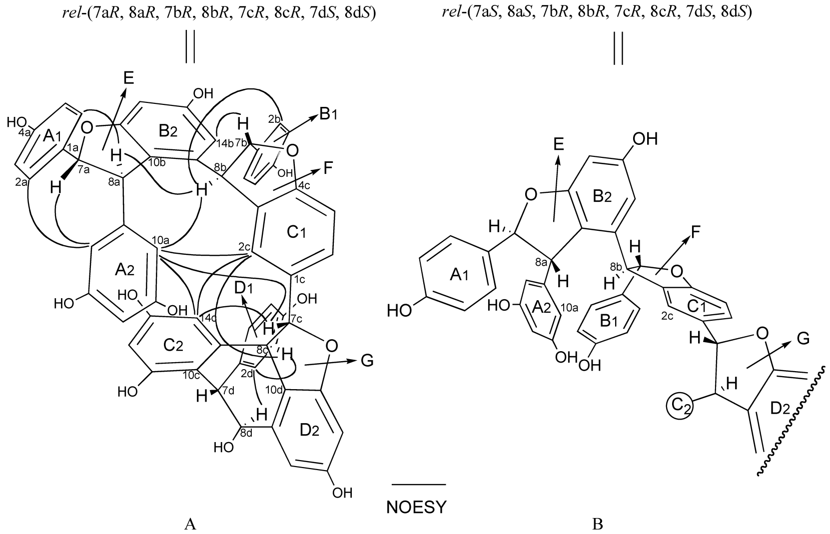

Fig. 4. Two Possiblities of the Stereo Chemical Relation between Rings E and F (Left: *rel-R* Configuration of C-7a and C-8a; Right: *rel-S* Configuration of C-7a and C-8a) and Key NOE Correlations[a] for Differenciation of Them

a) Other correlations: see Experimental.

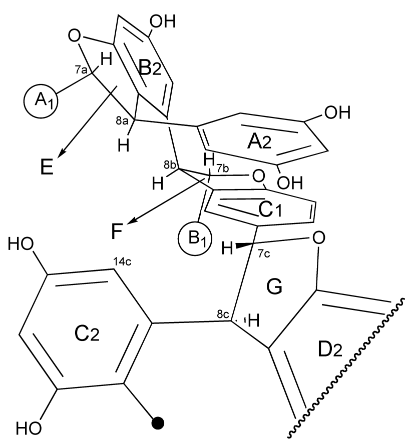

Fig. 5. Spatial Relationship among Rings E—G in **4**

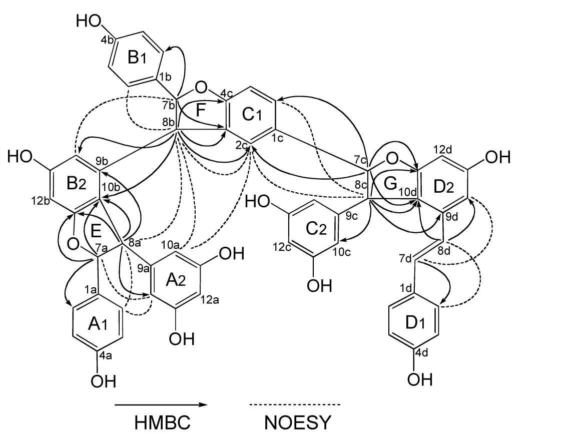

Fig. 6. Selected Correlations Observed in the HMBC and NOESY Spectra of **5**

Other correlations: see Experimental.

ponents of this family.

In addition to these four compounds (**1**, **4**—**6**), nine known resveratrol oligomers were also isolated together with resveratrol. Their structures were identified as stenophyllol A (**2**),[8]

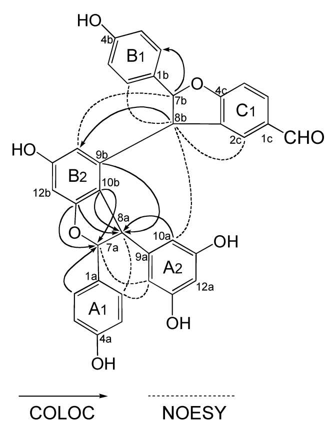

Fig. 7. Selected Correlations Observed in the COLOC and NOESY Spectra of **6**

Other correlations: see Experimental.

(−)-hopeaphenol (**3**),[9] stenophyllol C,[8] isovaticanol B,[12] pauciflorol B,[12] ampelopsin E,[13] (−)-ε-viniferin,[11] *cis*-ε-viniferin[14] and (−)-ampelopsin A,[10] by spectral analysis and comparison with respective authentic samples. Among known compounds, stenophyllols A and C, and *cis*-ε-viniferin are the first to be reported of resveratrol oligomers from the plant of the Dipterocarpaceae.

Experimental

The following instruments were used: optical rotations, JASCO P-1020 polarimeter; UV spectra, Shimadzu UV-2200 spectrophotometer (in methanol solution); ^{1}H- and ^{13}C-NMR spectra, JEOL JNM LA-300 (chemical shift values in ^{1}H-NMR spectra are presented as δ values with TMS as internal standard); EI-MS and FAB-MS, JEOL JMS-DX-300 instrument. 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.

Upuna borneensis Sym. was cultivated in Bogor Botanical Garden, Bogor, Indonesia, and its stems were collected in May 2000 and identified by one of co-authors (D.D.). A voucher specimen number DP-012 has been deposited in Gifu Prefectural Institute of Health and Environmental Sciences, Kakamigahara, Gifu, Japan.

Extraction and Isolation of Compounds (1—6, Nine Known Compounds and Resveratrol) The dried and ground stems (820 g) of *U.*

borneensis were extracted successively with acetone, MeOH and 70% MeOH at rt. A part (172 g) of the acetone extract (175 g) was fractionated by column chromatography (CC) over silica gel with a mixture of $CHCl_3$–MeOH by increasing polarity into 12 fractions (Fr. 1—Fr. 12) by visualization of TLC after Gibbs test. Resveratrol (160 mg) was obtained from Fr. 2 ($CHCl_3$–MeOH, 15 : 1) by further purification through CC over Sephadex LH-20 (acetone). Compound **6** (8 mg) was purified from Fr. 3 ($CHCl_3$–MeOH, 10 : 1) by PTLC (EtOAc–$CHCl_3$–MeOH–H_2O, 80 : 40 : 11 : 2). Fr. 4 ($CHCl_3$–MeOH, 10 : 1) was further subject to Sephadex LH-20 CC (MeOH) to give five fractions (Fr. 5a—Fr. 5e). (−)-ε-Viniferin (540 mg) and *cis*-ε-viniferin (12 mg) were purified from the fraction Fr. 5b after CC over ODS (MeOH–H_2O, 1 : 1). Fr. 6 ($CHCl_3$–MeOH, 9 : 1) was divided into seven parts (Fr. 6a—Fr. 6g) in the same way as that of Fr. 4. Compounds ampelopsin E (8 mg), (−)-ampelopsin A (5 mg) and **5** (7 mg) were purified by PTLC (EtOAc–$CHCl_3$–MeOH–H_2O, 15 : 8 : 4 : 1, ampelopsin E and (−)-ampelopsin A; EtOAc–$CHCl_3$–MeOH–H_2O, 10 : 8 : 4 : 1, **5**) from the sub-fractions Fr. 6d (ampelopsin E), Fr. 6e [(−)-ampelopsin A] and Fr. 6f (**5**). Fr. 8 ($CHCl_3$–MeOH, 8 : 1) was fractionated into seven parts (Fr. 8a—Fr. 8g) by Sephadex LH-20 CC (MeOH). Sub fraction of Fr. 8c gave pauciflorol B (420 mg) and stenophyllol C (5 mg) after purification by PTLC (EtOAc–$CHCl_3$–MeOH–H_2O, 15 : 8 : 4 : 1). Compounds **1** (24 mg), **2** (11 mg) and **4** (11 mg) were purified from fractions Fr. 8f, 8e and Fr. 8g, respectively. Compounds **3** (8 g) and isovaticanol B (240 mg) were obtained from Fr. 9 ($CHCl_3$–MeOH, 7 : 1) after their CC over Sephadex LH-20 CC (MeOH) and ODS (MeOH–H_2O, 65 : 45).

Compound 1 (Upunaphenol B) A yellow amorphous powder; $[\alpha]_D^{25}$ −530° (c=0.1, MeOH); UV (MeOH) λ_{max} (log ε): 324 (3.5), 296 (3.5), 255 (s, 3.6), 230 (s, 3.7), 207 (3.9) nm; negative ion FAB-MS *m/z*: 901 $[M-H]^-$ negative ion HR-FAB-MS *m/z*: 901.2297 (Calcd for $C_{56}H_{37}O_{12}$: 901.2284); ^{1}H- and ^{13}C-NMR spectral data, See Tables 1 and 2; HMBC correlations: See Fig. 1 (selected) and H-2a(6a)/C-4a, C-7a; H-3a(5a)/C-1a,C-4a; H-7a/C-9a; H-8a/C-1a; H-12a/C-10a,C-11a,C-13a; OH-13a/C-12a,C-13a,C-14a; H-14a/C-10a,C-12a,C-13a; H-2b(6b)/C-4b,C-7b; H-3b(5b)/C-1b,C-4b; OH-4b/C-3b(5b),C-4b; H-7b/C-10a,C-1b; H-8b/C-1b; H-12b/C-10b,C-11b,C-13b,C-14b; OH-13b/C-12b,C-13b,C-14b; H-14b/C-10b,C-13b; H-8c/C-9c; H-12c/C-10c,C-11c,C-13c,C-14c; OH-13c/C-12c,C-13c,C-14c; H-14c/C-10c; H-2d(6d)/C-4d; H-3d(5d)/C-1d,C-4d; H-12d/C-11d,C-13d OH-13d/C-12d,C-13d,C-14d; H-14d/C-13b; NOESY correlations, see Fig. 2.

Compound 4 (Upunaphenol C) A pale yellow amorphous powder; $[\alpha]_D^{25}$ −175° (c=0.1, MeOH); UV (MeOH) λ_{max} (log ε): 286 (3.6), 225 (s, 3.9), 207 (4.0) nm; negative ion FAB-MS *m/z*: 921 $[M-H]^-$ negative ion HR-FAB-MS *m/z*: 921.2559 (Calcd for $C_{56}H_{41}O_{13}$: 921.2547); ^{1}H- and ^{13}C-NMR spectral data, see Tables 1 and 2; ^{1}H-NMR spectrum (300 MHz, DMSO-d_6): δ 6.91 [2H, d, J=8.6 Hz, H-2a(6a)], 6.72 [2H, d, J=8.6 Hz, H-3a(5a)], 5.16 (1H, d, J=5.0 Hz, H-7a), 3.63 (1H, d, J=5.0 Hz, H-8a), 5.82 [2H, d, J=2.0 Hz, H-10a(14a)], 6.03 (1H, t, J=2.0 Hz, H-12a), 7.00 [2H, d, J=8.6 Hz, H-2b(6b)], 6.68 [2H, d, J=8.6 Hz, H-3b(5b)], 5.22 (1H, d, J=9.5 Hz, H-7b), 4.30 (1H, d, J=9.5 Hz, H-8b), 6.20 (1H, d, J=2.0 Hz, H-12b), 6.07 (1H, d, J=2.0 Hz, H-14b), 6.98 (1H, br s, H-2c), 6.67 (1H, d, J=8.6 Hz, H-5c), 6.48 (1H, br d, J=8.6 Hz, H-6c), 5.66 (1H, d, J=10.8 Hz, H-7c), 3.98 (1H, d, J=10.8 Hz, H-8c), 6.27 (1H, br s, H-12c), 5.85 (1H, br s, H-14c), 6.76 [2H, d, J=8.6 Hz, H-2d(6d)], 6.55 [2H, d, J=8.6 Hz, H-3d(5d)], 5.16 (1H, d, J=5.4 Hz, H-7d), 5.22 (1H, br t, J=5.6 Hz, H-8d), 6.07 (1H, d, J=2.0 Hz, H-12d), 6.41 (1H, d, J=2.0 Hz, H-14d), 4.84 (1H, d, J=5.7 Hz, OH-8d), 8.85, 9.06, 9.20, 9.25, 9.25, 9.27, 9.40, 9.48, 9.50 (1H each, s, phenolic OH×9); HMBC correlations: See Fig. 3 (selected) and H-2a(6a)/C-4a,C-7a; H-3a(5a)/C-1a,C-4a; H-7a/C-9a; H-8a/C-1a; H-10a(14a)/C-8a,C-11a(13a),C-12a; H-12a/C-10a(14a),C-11a(13a); H-2b(6b)/C-4b,C-7b; H-3b(5b)/C-1b,C-4b; H-7b/C-9b; H-8b/C-1b,9b; H-12b/C-10b,C-11b,C-13b,C-14b; H-14b/C-8b,C-10b,C-12b,C-13b; H-2c/C-4c,C-7c; H-5c/C-4c; H-6c/C-4c,C-7c; H-7c/C-9c; H-8c/C-1c; H-12c/C-10c,C-11c,C-13c,C-14c; H-14c/C-8c,C-10c,C-12c,C-13c; H-2d(6d)/C-4d,C-7d; H-3d(5d)/C-1d,C-4d; H-7d/C-10c,C-1d,C-8d,C-9d; H-8d/C-10c,C-1d,C-7d; H-12d/C-10d,C-11d,C-13d,C-14d; H-14d/C-8d,C-10d,C-12d,C-13d; NOESY correlations: See Fig. 4 (selected) and H-2a(6a)/H-7a; H-8a/H-10a(14a); H-2b(6b)/H-7b; H-8b/H-14b,H-2c, H-8c; H-2c/H-7c; H-6c/H-7c,H-8c,H-14c; H-8c/H-14c; H-2d(6d)/H-7d,H-8d; H-7d/OH-8d; H-8d/H-14d; H-14d/OH-8d.

Compound 5 (Upunaphenol D) A yellow amorphous powder; $[\alpha]_D^{25}$ −229° (c=0.1, MeOH); UV (MeOH) λ_{max} (log ε): 324 (3.5), 296 (3.5), 255 (s, 3.5), 230 (s, 3.7), 207 (3.9) nm; negative ion FAB-MS *m/z*: 905 $[M-H]^-$ negative ion HR-FAB-MS *m/z*: 905.2609 (Calcd for $C_{56}H_{41}O_{12}$: 905.2597); ^{1}H- and ^{13}C-NMR spectral data, see Tables 1 and 2; HMBC correlations: See Fig. 6 (selected) and H-2a(6a)/C-4a,C-7a; H-3a(5a)/C-1a,C-4a; H-7a/C-1a,C-8a,C-9a; H-8a/C-1a,C-7a; H-10a(14a)/C-8a; H-12a/C-10a(14a),C-11a(13a); H-2b(6b)/C-4b,C-7b; H-3b(5b)/C-1b,C-4b; H-7b/C-1b, C-8b,C-9b; H-8b/C-1b,C-7b; H-12b/C-10b,C-11b,C-13b,C-14b; H-14b/C-8b,C-10b,C-12b,C-13b; H-2c/C-8b,C-4c,C-6c,C-7c; H-5c/C-1c,C-3c,C-4c; H-6c/C-2c,C-4c,C-7c; H-7c/C-1c,C-8c,C-9c; H-8c/C-1c,C-7c,C-9c; H-12c/C-10c(14c),C-11c(13c); H-2d(6d)/C-4d,C-7d; H-3d(5d)/C-1d,C-4d; H-7d/C-1d,C-8d,C-9d; H-8d/C-1d,C-7d,C-9d; H-12d/C-10d,C-11d,C-13d,C-14d; NOESY correlations: See Fig. 6 (selected) and H-2a(6a)/H-7a; H-8a/H-10a(14a); H-2b(6b)/H-7b; H-8b/H-14b; H-2c/H-7c; H-6c/H-7c; H-8c/H-7d,H-8d; H-2d(6d)/H-7d; H-8d/H-14d.

Compound 6 (Upunaphenol E) A yellow amorphous powder; $[\alpha]_D^{25}$ −147° (c=0.1, MeOH); UV (MeOH) λ_{max} (log ε): 295 (s, 3.6), 285 (3.6), 226 (4.0), 208 (4.1) nm; negative ion FAB-MS *m/z*: 573 $[M-H]^-$ negative ion HR-FAB-MS *m/z*: 573.1552 (Calcd for $C_{35}H_{25}O_8$: 573.1549); ^{1}H- and ^{13}C-NMR spectral data, see Tables 1 and 2; COLOC correlations (J=8 Hz): See Fig. 7 (selected) and C-1a/H-3a(5a),H-7a,H-8a; C-2a(6a)/H-3a(5a); C-3a(5a)/H-2a(6a); C-4a/H-2a(6a); C-7a/H-2a(6a),H-8a; C-8a/H-7a,H-10a(14a); C-9a/H-7a,H-8a; C-10a(14a)/H-12a; C-11a(13a)/H-10a(14a),H-12a,OH-11a(13a); C-12a/H-10a(14a),H-11a(13a); C-1b/H-3b(5b); C-4b/H-2b(6b); C-10b/H-12b,H-14b; C-11b/H12b; C-12b/OH-13b; C-13b/H-12b,H-14b,OH-13b; C-14b/OH-13b; C-1c/H-5c; C-2c/H-6c; C-3c/H-5c; C-4c/H-2c,H-6c, NOESY correlations: See Fig. 7 (selected) and H-2a(6a)/H-7a; H-8a/H-10a(14a); H-2b(6b)/H-7b; H-8b/H-14b.

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