Tannins and Related Compounds. XCVIII.[1] Structures of Three New Dimeric Ellagitannins, Excoecarianin and Excoecarinins A and B, Isolated from the Leaves of *Excoecaria kawakamii* HAYATA

Jer-Huei LIN,[a] Takashi TANAKA,[a] Gen-ichiro NONAKA,[a] Itsuo NISHIOKA*,[a] and Ih-Sheng CHEN[b]

Faculty of Pharmaceutical Sciences, Kyushu University,[a] 62, 3-1-1 Maidashi, Higashi-ku, Fukuoka 812, Japan and School of Pharmacy, Kaohsiung Medical College,[b] Kaohsiung, Taiwan R.O.C. *Received February 22, 1990*

Together with ten hydrolyzable tannins and related compounds (1—10), three novel dimeric ellagitannins, excoecarianin (11), and excoecarinins A (13) and B (16), possessing a dehydrohexahydroxydiphenoyl or an elaeocarpusinoyl group, have been isolated from the leaves of *Excoecaria kawakamii* HAYATA (Euphorbiaceae). The structures of these tannins were established on the basis of spectroscopic and chemical evidence.

Keywords *Excoecaria kawakamii*; Euphorbiaceae; excoecarianin; excoecarinin A; excoecarinin B; dimeric ellagitannin; dehydrohexahydroxydiphenic acid; elaeocarpusinoic acid; euphorbinic acid; tannin

As a part of chemical studies on tannins in Euphorbiaceous plants, we have investigated *Excoecaria kawakamii* HAYATA, which is indigenous to the Lutao and Lanyu Islets in Taiwan. Although no phytochemical study has so far been made on this plant, our preliminary examination revealed the existence of a large amount of tannins in the leaves, and successive large-scale extraction has now resulted in the isolation and characterization of thirteen tannins (**1**—**11**, **13** and **16**), including three novel dimeric ellagitannins named excoecarianin (**11**) and excoecarinins A (**13**) and B (**16**). This paper presents a detailed account of their isolation and structural determination.

The aqueous acetone extract of the leaves was repeatedly chromatographed over Sephadex LH-20 (H_2O–MeOH,

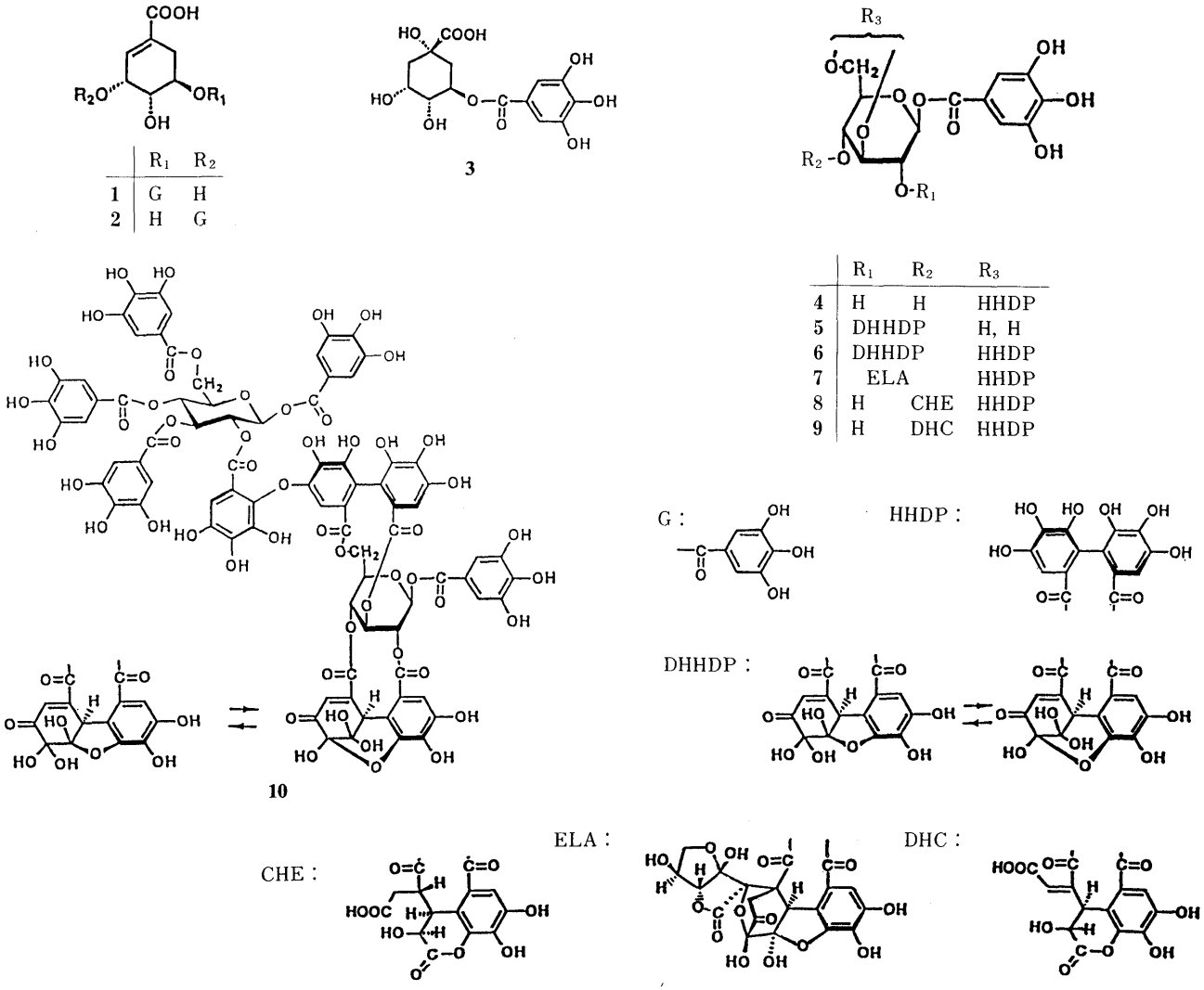


Chart 1

EtOH, MeOH–H_2O–acetone), MCI-gel CHP 20P (H_2O–MeOH) and Bondapak C_{18}/Porasil B (H_2O–MeOH) to yield compounds **1**—**11**, **13** and **16**. Among them, ten were found to be known hydrolyzable tannins and related compounds, which were identified as 3-*O*-galloyl-(−)-shikimic acid (**1**),[2] 5-*O*-galloyl-(−)-shikimic acid (**2**),[3] 3-*O*-galloylquinic acid (**3**),[4] corilagin (**4**),[5] furosin (**5**),[6] geraniin (**6**),[7] elaeocarpusin (**7**),[7] neochebulagic acid (**8**),[8] repandusinic acid A (**9**)[9] and euphorbin B (**10**),[10] by direct comparisons of their physical and spectral data with those of authentic samples.

Excoecarianin (**11**) was obtained as a yellow amorphous powder, $[\alpha]_D$ +12.2° (acetone), $C_{82}H_{56}O_{23}\cdot 2H_2O$. The presence of a dehydrohexahydroxydiphenoyl (DHHDP) group, existing as an equilibrium mixture of two hydrated cyclic hemi-ketal forms, was indicated by pairs of benzylmethine and olefin resonances [δ 4.92 and 6.24 (each 2/3H, d, J=2 Hz, five-membered form); δ 5.15 and 6.53 (each 1/3H, s, six-membered form] in the ^{1}H-nuclear magnetic resonance (^{1}H-NMR) spectrum. The observation of two lowfield doublet signals at δ 6.54 (1H, J=6 Hz) and 6.40 (1H, J=4 Hz) due to anomeric protons suggested the presence of two sugar moieties in the molecule. This is also supported by the negative fast atom bombardment mass spectrum (FAB-MS) of **11**, which showed the $[M-H]^-$ ion peak at m/z 1887.

Acid-catalyzed condensation of **11** with *o*-phenylenediamine gave a phenazine derivative (**11a**), whose ^{1}H-NMR spectrum shows three two-proton singlet signals (δ 6.97, 7.09 and 7.17) due to galloyl groups and five one-proton singlets (δ 6.41, 6.80, 6.99, 7.02 and 7.19), along with signals arising from the phenazine moiety. In the sugar region (Table I), relatively small coupling constants of each signal suggested the presence of two glucopyranose cores with a quasi-$^1C_4$ or skew boat conformation. Furthermore, the lowfield shifts of each signal implied that all the sugar hydroxyl groups are acylated. Thus, taking the above aromatic signal patterns into consideration, **11** was considered to be a dimeric ellagitannin containing geraniin (**6**) and punicafolin (**12**)[5] moieties. Actually, comparison of the ^{1}H-NMR spectra showed that the sugar signal patterns in **11a** were closely correlated with the combined signal patterns of **6** and **12** (Table I). Furthermore, in the ^{13}C-nuclear magnetic resonance (^{13}C-NMR) spectrum of **11a** (Table II), the sugar

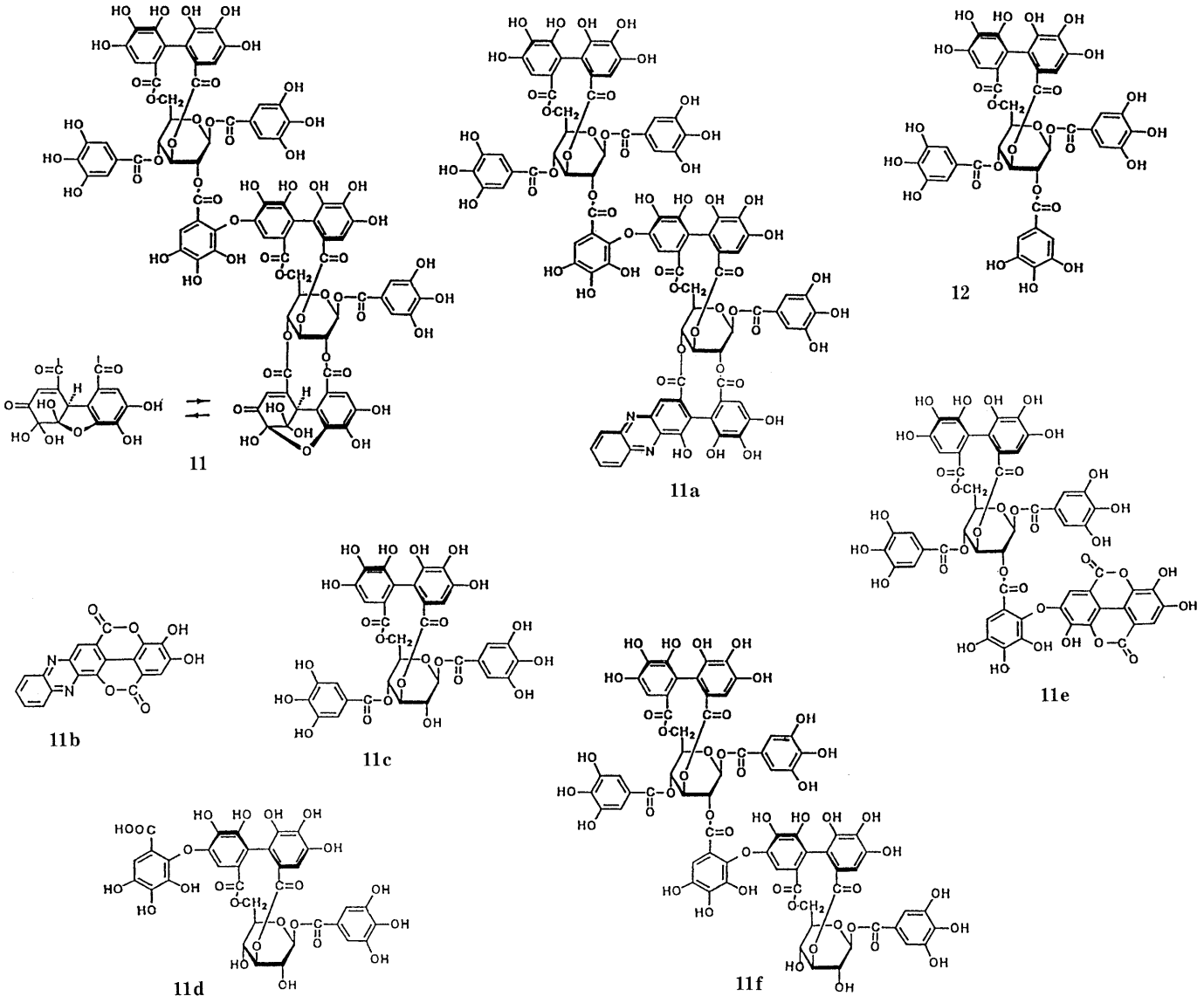
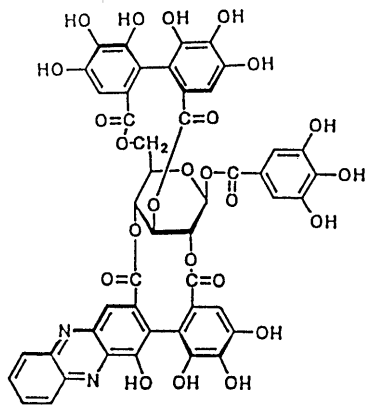


Chart 2

signals were also in line with those of **6a** plus **12**.

On heating in water, **11a** afforded a phenazine bislactone (**11b**), 1,4-di-*O*-galloyl-3,6-(*R*)-hexahydroxydiphenoyl-



6a

Chart 3

(HHDP)-β-D-glucose (**11c**),[11] isomallotinic acid (**11d**)[12] and two partial hydrolysates (**11e** and **11f**). The ^{1}H-NMR spectrum of **11e** showed signals due to two galloyl (δ 6.69 and 7.36, each 2H, s) and one HHDP (δ 6.78 and 6.95, each 1H, s) groups, together with three lowfield aromatic singlets (δ 7.10, 7.24 and 7.57, each 1H). The chemical shifts and coupling patterns of the sugar proton signals (Table I) were closely related to those of punicafolin (**12**), indicating the presence of a similar substitution system. Taking into account the observation of the $[M-H]^-$ peak at *m/z* 1237 in the negative FAB-MS an also the concomitant production of the partial hydrolysate (**11c**), **11e** was considered to be 1,4-di-*O*-galloyl-3,6-(*R*)-HHDP-2-*O*-valoneaic acid bislactonyl-β-D-glucose. Furthermore, to confirm the allocation of each acyl group, the two-dimensional nuclear Overhauser effect (NOESY) spectrum of **11e** was measured. The spectrum showed a cross peak between the anomeric signal (δ 6.31) and a galloyl signal (δ 7.36), which was thus assignable to the galloyl group attached to the C-1 hydroxyl. This galloyl signal was found to be correlated with one

TABLE I. ^{1}H-NMR (δ) Data for **11a**, **6a**, **12**, **11d**, **11e** and **11f** (δ Value, *J* Value in Hz)

	11a[a]	**6a**[b]	**12**[b]	**11d**[a]	**11e**[a]	**11f**[a]
Glucose A						
1	6.11 (d, *J*=6 Hz)	6.16 (d, *J*=6 Hz)		6.35 (d, *J*=2 Hz)		6.33 (d, *J*=3 Hz)
2	5.68 (d, *J*=6 Hz)	5.69 (d, *J*=6 Hz)		4.07 (br s)		4.05 (br s)
3	5.35 (d, *J*=4 Hz)	5.48 (br s)		4.81 (d, *J*=3 Hz)		4.76 (br s)
4	5.48 (d, *J*=4 Hz)	5.48 (br s)		4.40 (d, *J*=3 Hz)		4.38 (br s)
5	4.90 (dd, *J*=4, 8 Hz)	4.98 (dd, *J*=4, 8 Hz)		4.47 (br t, *J*=8 Hz)		4.36 (dd, *J*=8, 11 Hz)
6	4.45 (dd, *J*=8, 12 Hz)	4.79 (dd, *J*=8, 11 Hz)		4.80 (t, *J*=11 Hz)		4.66 (t, *J*=11 Hz)
6	3.93 (dd, *J*=4, 12 Hz)	4.06 (dd, *J*=4, 11 Hz)		4.06 (dd, *J*=8, 11 Hz)		3.85 (dd, *J*=8, 11 Hz)
Glucose B						
1	6.54 (d, *J*=3 Hz)		6.54 (d, *J*=5 Hz)		6.31 (d, *J*=6 Hz)	6.40 (d, *J*=2 Hz)
2	5.36 (d, *J*=3 Hz)		5.60 (d, *J*=5 Hz)		5.39 (d, *J*=6 Hz)	5.31 (d, *J*=2 Hz)
3	5.16 (d, *J*=3 Hz)		5.13 (d, *J*=3 Hz)		5.06 (d, *J*=4 Hz)	5.11 (br s)
4	5.77 (d, *J*=3 Hz)		5.86 (d, *J*=3 Hz)		5.85 (d, *J*=4 Hz)	5.75 (d, *J*=3 Hz)
5	4.60—4.73 (m)		4.40—4.80 (m)		4.62 (dd, *J*=6, 8 Hz)	4.60 (t, *J*=8 Hz)
6					4.49 (dd, *J*=8, 12 Hz)	4.72 (dd, *J*=8, 11 Hz)
6	4.40 (dd, *J*=6, 10 Hz)				4.30 (dd, *J*=6, 12 Hz)	4.34 (dd, *J*=8, 11 Hz)

a) Measured at 270 MHz. *b*) Measured at 100 MHz. (In acetone-d_6 + D_2O with tetramethylsilane (TMS) as an internal standard.)

TABLE II. ^{13}C-NMR Data for **11a**, **12** and **6a** (δ Value)

	Glucose A						Glucose B					
	1	5	2	3	4	6	1	5	2	3	4	6
11a[a]	91.6	76.6	76.5	68.7	67.8	65.4	91.9	74.9	71.0	69.1	63.8	64.4
12[b]							91.9	75.8	72.2	71.0	64.7	64.7
6a[b]	91.6	76.8	76.6	68.6	67.6	65.3						

a) Measured at 67.80 MHz. *b*) Measured at 25.05 MHz. (In acetone-d_6 with TMS as an internal standard.)

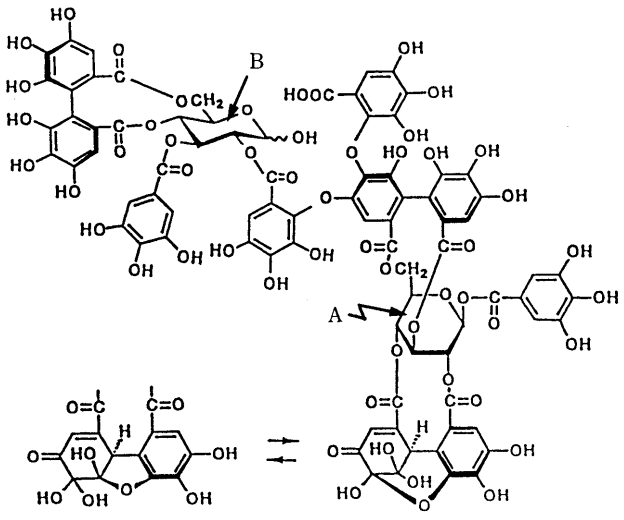
(δ 7.24) of the lowfield singlets due to the valoneaic acid bislactonyl group, indicating the valoneayl group to be located at the C-2 position.

The hydrolysate (**11f**) exhibited the $[M-H]^-$ ion peak at *m/z* 1569 in the negative FAB-MS. The ^{1}H-NMR spectrum showed the presence of three galloyl (δ 7.05, 7.11 and 7.15, each 2H, s), one HHDP (δ 6.78 and 7.01, each 1H, s) and one valoneayl (δ 6.40, 6.82 and 7.16, each 1H, s) groups. Furthermore, the chemical shifts were found to be similar to those of **11d** plus **11e** (Table I), indicating the structure to be **11f**. Thus, the locations of the DHHDP ester groups in **11** were considered to be at the glucose C-2 and C-4 positions. The orientation and the absolute configuration of the DHHDP group were deduced from a comparison of the ^{1}H-NMR spectra of **11** and **11a**. Namely, the anomeric signal (δ 6.11) in **11a** appeared at higher field than that of **11** (δ 6.53). This phenomenon was also observed on going from **6** to **6a**, and this was interpreted in terms of the anisotropic effect of the aromatic ring in the phenazine moiety.[13] Furthermore, the change of the coupling constant ($J=6$ Hz) of the anomeric proton signal in **11a** was another phenomenon analogous to that found in **6a**. From these findings, the orientation and the configuration of the DHHDP group in **11** were concluded to be the same as in the case of **6**.

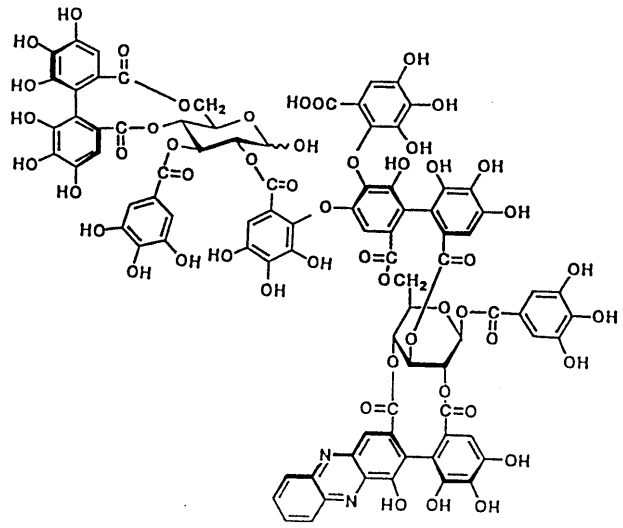
Consequently, the structure of excoecarianin was determined to be as represented by the formula **11**.

Excoecarinin A (**13**), a yellow powder (H_2O), mp 210 °C (dec.), $[\alpha]_D$ −12.2° (acetone), $C_{82}H_{56}O_{54}$, was found to have a dimeric structure by the observation of the $[M-H]^-$ ion peak at *m/z* 1903 in the negative FAB-MS. The ^{1}H-NMR spectrum was extremely complex. However, signals due to benzylmethine [δ 4.91 and 4.93 (each 1/12H, d, $J=2$ Hz), 5.13 and 5.18 (each 5/12H, s)] and olefin protons [δ 6.26 and 6.28 (each 1/12H, d, $J=2$ Hz), 6.58 and 6.59 (each 5/12H, s)] in the DHHDP group were distinguishable from others.

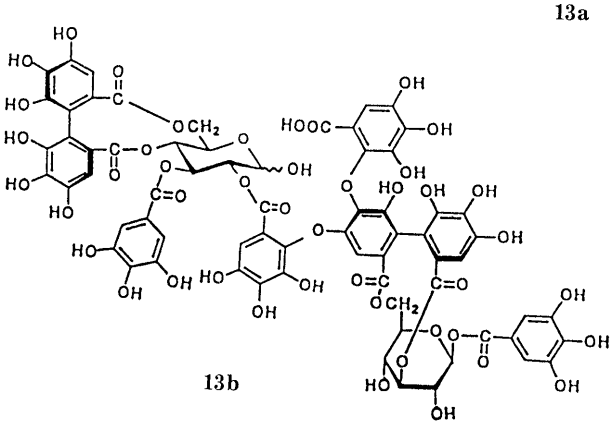
When treated with *o*-phenylenediamine, **13** yielded a phenazine derivative (**13a**), which was subsequently heated in water to give the phenazine bislactone (**11b**) and a hydrolysate (**13b**). The ^{1}H-NMR spectrum of **13b** showed signals arising from two sugar moieties (A and B). Among them, half (A-ring) [δ 6.36 (br s, H-1), 4.86 (br s, H-3), 4.74 (t, $J=11$ Hz, H-6), 4.53 (br s, H-4), 4.48 (m, H-5), 4.15 (br s, H-2) and 4.11 (t, $J=11$ Hz, H-6)] were analogous to those of corilagin (**4**), while the chemical shifts and coupling patterns of the remaining signals [δ 5.85 (t, $J=10$ Hz, H-3), 5.39 (d, $J=3$ Hz, H-1), 5.26 (dd, $J=7$, 13 Hz, H-6), 5.10 (t, $J=10$ Hz, H-4), 5.08 (dd, $J=3$, 10 Hz, H-2), 4.64 (dd, $J=7$, 10 Hz, H-5), 3.87 (d, $J=13$ Hz, H-6), each 2/3H, α-glucopyranose; δ 5.43 (t, $J=10$ Hz, H-3), 5.37 (dd, $J=7$, 13 Hz, H-6), 5.35 (dd, $J=8$, 10 Hz, H-2), 5.09 (t, $J=10$ Hz, H-4), 4.68 (d, $J=8$ Hz, H-1), 4.35 (dd, $J=7$, 10 Hz, H-5), 3.76 (d, $J=13$ Hz, β H-6), each 1/3H, β-glucopyranose] suggested the presence of α- and β-$^4C_1$-glucopyranose cores (B-ring).



13



13a



13b

Chart 4

On methylation with ethereal diazomethane, followed by alkaline hydrolysis and further methylation, **13a** yielded methyl 3,4,5-trimethoxybenzoate (**13c**), dimethyl (*S*)-hexamethoxydiphenoate (**13d**), the (*R*)-phenazine methylate (**13e**) and a phenolcarboxylic acid methylate (**13f**). The ^{1}H-NMR spectrum of **13f** showed four aromatic signals and fourteen methoxyl signals. The electron impact mass spectrum (EI-MS) exhibited the M^+ ion peak at *m/z* 870, together with fragment peaks at *m/z* 239 and 659, probably attributable to fragments A and B (Chart 5), respectively, thus, indicating **13f** to be identical with tetramethyl (*R*)-decamethyleuphorbinate, which was recently obtained by degradation of euphorbin C.[14]

Acid treatment of **13** gave a partial hydrolysate (**13g**). The ^{1}H-NMR spectrum of **13g** showed aromatic signals due to a galloyl group and an euphorbinoyl group. The sugar signal patterns were in good accord with those of 2,3-di-*O*-galloyl-D-glucose.[15] The observation of the $[M-H]^-$ ion peak at *m/z* 951 in the negative FAB-MS was consistent with the presence of a bis-lactone in **13g**. On the other hand, treatment of **13b** with phenylhydrazine hydrochloride in the presence of sodium acetate afforded **13h—j**. The ^{1}H-NMR spectrum of **13h** showed it to be a glucosazone derivative to which one galloyl (δ 7.22, 2H, s) and one HHDP (δ 6.82 and 6.53, each 1H, s) groups are attached at the C-3, C-4 and C-6 positions [δ 6.02 (1H, d,

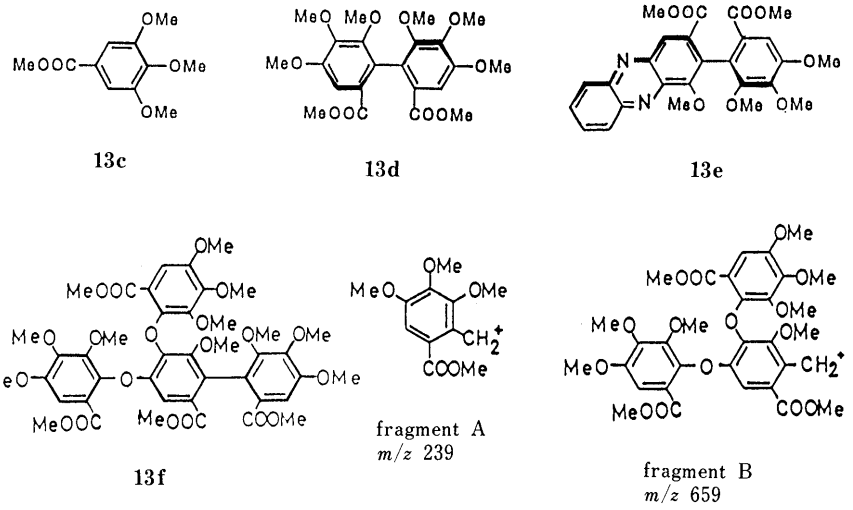
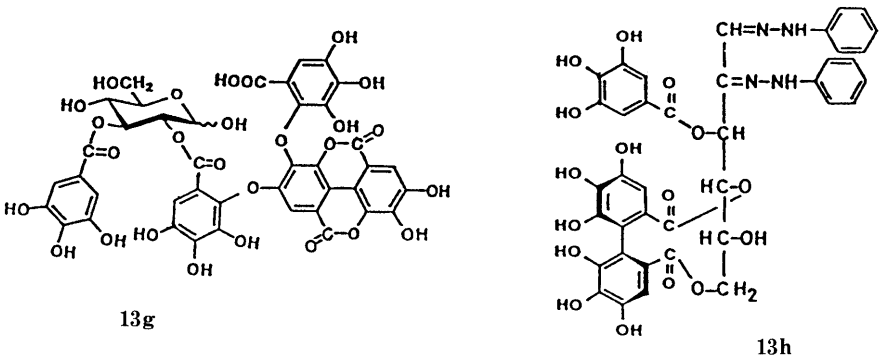


Chart 5



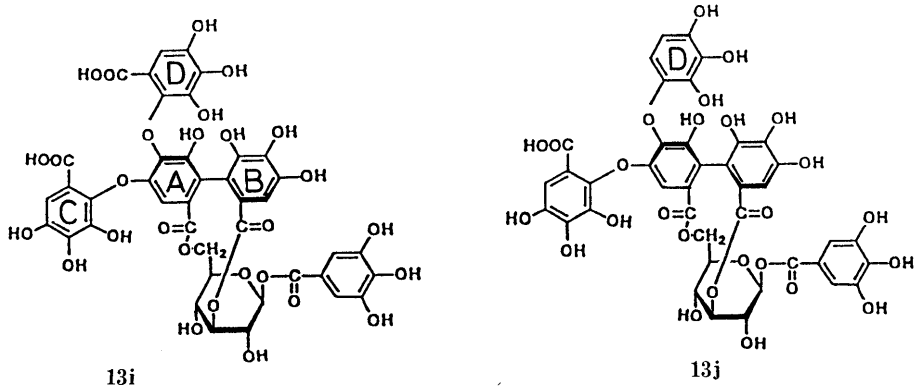


Chart 6

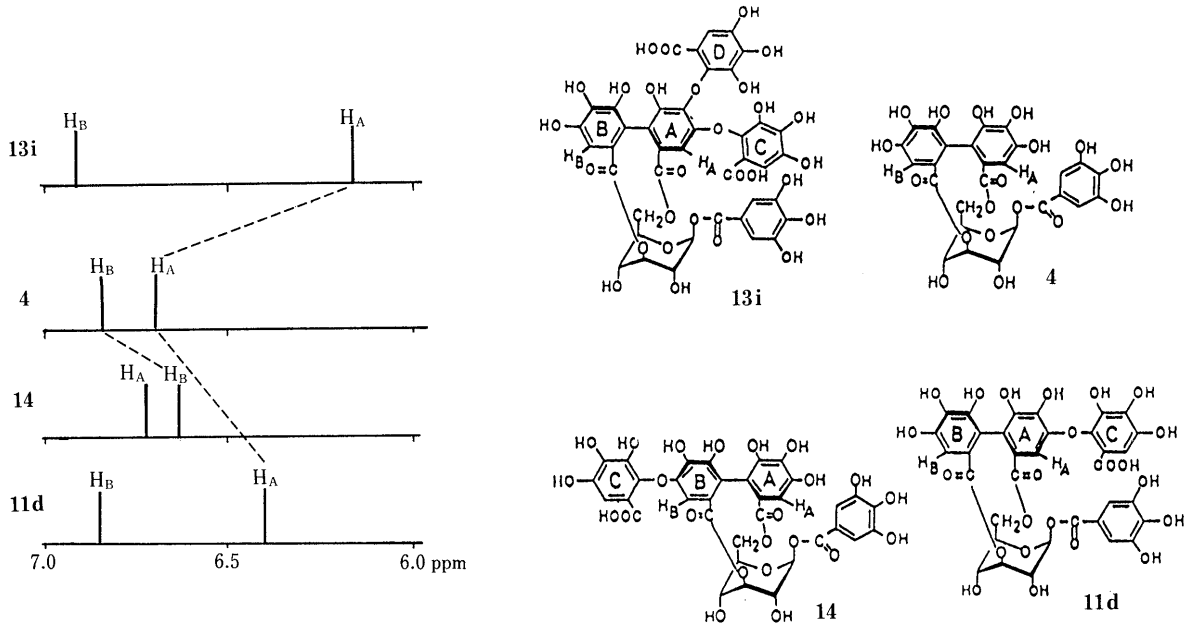


Fig. 1. ^{1}H-NMR Chemical Shifts for Aromatic Protons in **13i**, **4**, **14** and **11d** (in Acetone-d_6 + D_2O)

J=6 Hz, H-3), 5.38 (dd, J=6, 8 Hz, H-4), 4.84 (dd, J=3, 12 Hz, H-6) and 3.93 (d, J=12 Hz, H-6)]. Thus, taking into account the production of **13g** on acid hydrolysis, the locations of the galloyl and HHDP groups were concluded to be at the C-3, and C-4 and C-6 positions, respectively, in the $^4C_1$-glucopyranose (B) moiety.

The ^{1}H-NMR spectrum of **13i** showed the presence of a galloyl (δ 7.11, 2H, s) and an euphorbinoyl (δ 6.16, 6.72, 7.03 and 7.09, each 1H, s) groups in the molecule, and the glucose signal pattern resembled those of corilagin (**4**), suggesting that **13i** is 1-*O*-galloyl-3,6-(*R*)-euphorbinoyl-β-D-glucose. The orientation of the euphorbinoyl group was determined by comparison of the ^{1}H-NMR chemical shifts of the aromatic signals in **13i** with those of corilagin (**4**) (Fig. 1). In the spectrum of **4**, the aromatic one-proton singlets appeared at δ 6.84 and 6.69, and these signals were assigned as shown in Fig. 1 based on comparisons of the chemical shifts with those of mallotinic acid (**14**)[16] and isomallotinic acid (**11d**). Namely, the chemical shift of the upper field signal (δ 6.69) in **4** was almost the same as that (δ 6.72) in **14**, whereas in **11d**, a signal (δ 6.84) having the same chemical shift as that of the lowfield signal (δ 6.84) in **4** was observed, thus permitting the assignments of these signals. In the spectrum of **13i**, two aromatic signals (δ 6.16 and 6.92) arising from the A- and B-rings were observed, and the chemical shift of the lowfield signal (δ 6.92) was similar to that of H_B in **4**. Accordingly, two "additional branched" gallic acid residues (C- and D-rings) were concluded to be located at the aromatic ring attached to the glucose C-6 position. The moderate upfield shift of the H_A signal in **13i**, as compared with that of **11d**, may be interpreted in terms of the anisotropic effect of the C-ring, which is assumed to become closer to H_A owing to interaction with the D-ring.

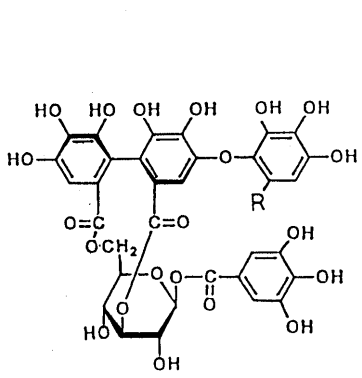
The structure of the product **13j** was determined as follows. The negative FAB-MS of **13j** exhibited the $[M-H]^-$ ion peak at m/z 925, which is smaller than that of **13i** by 44 mass units. The ^{1}H-NMR spectrum showed a pair of doublets at δ 6.26 and 6.67 (each 1H, J=9 Hz) which were coupled with each other, indicating that **13j** is a decarboxylation product of **13i**. Furthermore, the ^{1}H-NMR spectrum exhibited three aromatic singlets (δ 6.28, 6.89 and 7.14, each 1H), and the upfield signal (δ 6.28) could be assigned to H_B based on the comparison of the chemical shift with that in **13i**. Since this signal was shown to be correlated with the signal at δ 7.14 in the NOESY spectrum, the signal at δ 7.14 could be assigned to the C-ring proton rather than the D-ring proton. Therefore, it was concluded that the decarboxylation took place at the D-ring, and the structure of **13j** was established as shown in Chart 6.

To examine whether such a decarboxylation reaction occurs in other hydrolyzable tannins, we examined mallotinic acid (**14**) and mallorepanin (**15**).[17] On heating in the presence of sodium acetate, **14** and **15** yielded decarboxylated products (**14a** and **15a**) in 25 and 50% yields, respectively. Similar treatment of **13** afforded **13j**, together with 3-*O*-galloyl-4,6-(*S*)-HHDP-D-glucose (**13k**)[18] and a decarboxylated product (**13l**), which was characterized by observation of the $[M-H]^-$ peak at m/z 1541, 44 mass units less than that of **13b**, in the negative FAB-MS, and also by conversion of **13l** to **13i** on treatment with sodium acetate in the presence of phenylhydrazine hydrochloride.

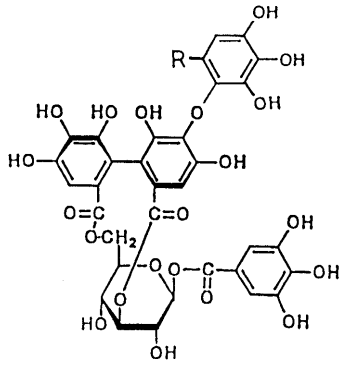
The orientation of the (*R*)-DHHDP group located at the glucose C-2 and C-4 positions was concluded to be as shown in Chart 4 by comparison of the ^{1}H-NMR spectra of **13** and **13a**; the upfield shift of the anomeric signal (H-1: δ 6.10 and 6.11, each d, J=6 Hz) in **13a**, as compared with that in **13** (H-1: δ 6.56, br s), was analogous to that found between **6a** and **6**.

On the basis of the above-mentioned chemical and spectroscopic evidence, the structure of excoecarinin A was determined to be as represented by the formula **13**.

Excoecarinin B (**16**), a tan amorphous powder, $[\alpha]_D$ +81.1° (acetone), $C_{88}H_{62}O_{59}\cdot 2H_2O$, also showed a complex signal pattern in the ^{1}H-NMR spectrum. However, in the aliphatic region, the appearance of geminally coupled

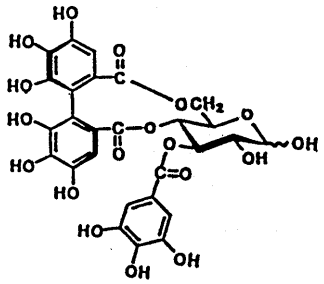


14 : R=COOH
14a : R=H

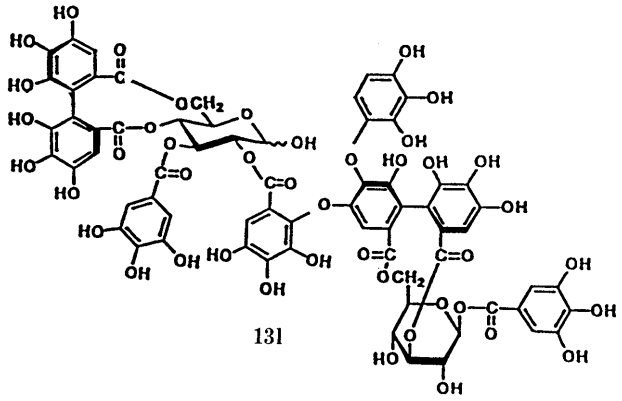


15 : R=COOH
15a : R=H

Chart 7

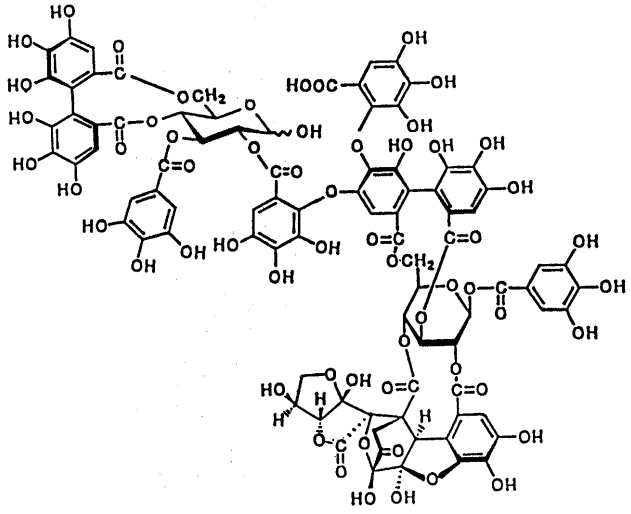


13k

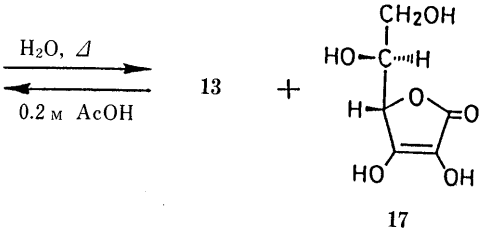


13l

Chart 8



16



17

Chart 9

methylene signals [δ 2.20 (1H, d, J=19 Hz), 3.03 (1/3H, dd, J=2, 19 Hz) and 3.08 (2/3H, br d, J=19 Hz)] and methine signals [δ 5.68 (2/3H, d J=2 Hz) and 5.72 (1/3H, d, J=2 Hz)] were diagnostic for the presence of an elaeocarpusinoyl group.[7] The dimeric structure of **16** was confirmed by the negative FAB-MS, exhibiting the $[M-H]^-$ ion peak at m/z 2061.

On heating in hot water,[7] **16** afforded ascorbic acid (**17**) and excoecarinin A (**13**), whereas treatment of a mixture of **13** and **17** in 0.2 M methanolic acetic acid[16] yielded **16**, thus establishing the structure of excoecarinin B to be as shown by the formula **16**.

Experimental

Details of the instruments and chromatographic conditions used throughout this work are the same as described in the previous paper,[19]

except for the following. High-performance liquid chromatography (HPLC) was conducted on a Toyo Soda apparatus equipped with an SP-8700 solvent delivery system and a UV-8 model II spectrophotometer.

Isolation of Tannins The dried leaves of *E. kawakamii* (1.8 kg), collected at Lanyu Islet, Taiwan, Republic of China, were cut into small pieces and extracted with 70% aqueous acetone at room temperature. After removal of acetone by evaporation under reduced pressure (*ca.* 40 °C), the resulting precipitates, consisting mainly of chloropylls and waxes, were filtered off. The filtrate was further concentrated and applied to a column of Sephadex LH-20 (10 cm i.d. × 60 cm). Elution with H_2O containing an increasing amount of MeOH and finally with 50% aqueous acetone gave five fractions; fr. I (51 g), II (16 g), III (17 g), IV (68 g) and V (33 g). Repeated chromatographies of fr. I on MCI-gel CHP 20P (H_2O–MeOH) and Sephadex LH-20 (80% MeOH) yielded 3-*O*-galloylquinic acid (**3**) (6.6 g). Fraction II was subjected to repeated chromatographies over MCI-gel CHP-20P (H_2O–MeOH), Sephadex LH-20 (80% MeOH), Fuji-gel ODS G3 (H_2O–MeOH), and Prep-PAK 500/C_{18} (H_2O–MeOH) to yield 3-*O*-galloyl-(−)-shikimic acid (**1**) (170 mg), 5-*O*-galloyl-(−)-shikimic acid (**2**) (250 mg), neochebulagic acid (**8**) (50 mg), furosin (**5**) (160 mg) and repandusinic acid (**9**) (190 mg). Fraction III was subjected to MCI-gel CHP 20P chromatography (H_2O–MeOH) to give corilagin (**4**) (1.3 g). Fraction IV was repeatedly chromatographed over MCI-gel CHP 20P and Bondapak C_{18}/Porasil B with H_2O containing increasing amounts of MeOH and over Sephadex LH-20 with 80% MeOH to afford geraniin (**6**) (20.8 g) and elaeocarpusin (**7**) (1.6 g). On similar separation, fr. V gave euphorbin B (**10**) (140 mg) and excoecarianin (**11**) (320 mg) and excoecarinins A (**13**) (1.7 g) and B (**16**) (260 mg).

Excoecarianin (11) A yellow amorphous powder, $[\alpha]_D^{25}$ +12.2° (c=0.9, acetone). Negative FAB-MS m/z: 1887 $[M-H]^-$. *Anal.* Calcd for $C_{82}H_{56}O_{53}\cdot 2H_2O$: C, 51.15; H, 3.14. Found: C, 51.10; H, 3.09. ^{1}H-NMR (acetone-d_6 + D_2O, 270 MHz) δ: 4.16, 4.34 (each 1H, dd, J=7, 10 Hz, H-6), 4.53—4.75 (4H, m, H-5, 5′, 6′), 4.92 (3/4H, d, J=2 Hz, DHHDP H-1), 5.12 (1H, br s, H-3′), 5.15 (3/4H, s, DHHDP H-1), 5.28 (1H, d, J=4 Hz, H-2′), 5.35 (3/4H, d, J=4 Hz, H-3), 5.45 (1/2H, br s, H-3, 4), 5.54—5.57 (7/4H, m, H-2, 4), 5.75 (1H, d, J=3 Hz, H-4′), 6.24 (3/4H, d, J=2 Hz, DHHDP H-3), 6.40 (1H, d, J=4 Hz, H-1′), 6.40 (1H, s, valoneayl H), 6.53 (1H, br s, H-1), 6.54 (1/4H, s, DHHDP H-3), 6.79, 7.00, 7.01, 7.12, 7.07, 7.13, 7.17, 7.21, 7.26 (5H in total HHDP, valoneayl and DHHDP H), 7.02, 7.15, 7.16 (each 2H, s, galloyl H). ^{13}C-NMR (acetone-d_6 + D_2O, 25.05 MHz) δ: 46.0, 52.0 (DHHDP C-1), 62.1, 63.3, 64.1, 66.1, 67.2, 68.3, 70.5, 72.3, 73.1, 74.2, 90.8, 91.7 (glucose), 92.4, 96.2 (DHHDP C-5, 6), 105.8, 108.3, 108.6, 109.6, 110.5 (2C), 110.9 (2C), 113.9, 114.7, 115.6, 116.2, 116.8, 117.0, 117.1, 119.4, 120.1 (2C), 120.7, 123.5, 123.7, 125.1, 125.3, 126.0, 126.1, 128.8, 136.5, 136.7 (2C), 137.4, 138.0, 139.1. 139.9, 140.0, 140.5, 140.7, 143.7, 144.4, 144.6, 144.9, 145.4, 145.6, 145.8 (2C), 146.0 (4C), 147.3, 147.7, 149.2, 154. 4 (aromatic C and DHHDP C-2, 3), 164.7, 164.9, 165.2, 165.4, 165.6, 165.7, 165.8, 166.2, 166.6, 167.9, 168.6 (COO), 191.9, 194.6 (DHHDP C-4).

Preparation of the Phenazine Derivative (11a) A solution of **11** (50 mg) and *o*-phenylenediamine (8 mg) in 20% AcOH–EtOH (3 ml) was stirred at room temperature for 2 h. After concentration, the mixture was subjected to MCI-gel CHP 20P chromatography to give **11a** (43 mg) as a tan amorphous powder, $[\alpha]_D^{21}$ −51.4° (c=0.6, acetone). *Anal.* Calcd for $C_{88}H_{58}N_2O_{51}\cdot 2H_2O$: C, 53.39; H, 3.16; N, 1.41. Found: C, 53.56; H, 3.05; N, 1.32. ^{1}H-NMR (acetone-d_6, 270 MHz) δ: 6.41, 6.80, 6.99, 7.02, 7.19 (each 1H, s, valoneayl, HHDP H), 6.97, 7.09, 7.17 (each 2H, s, galloyl H), 7.49 (1H, s, phenazine H-3), 8.30 (1H, s, phenazine H-3′), 7.97—8.07, 8.26—8.39 (each 2H, m, phenazine H), glucose proton, see Table I. ^{13}C-NMR (acetone-d_6 + D_2O, 67.8 MHz) δ: 106.1, 108.4, 110.0 (2C), 110.1 (2C), 110.4 (2C), 110.7 (2C), 113.3, 115.4, 115.8, 116.5 (2C), 116.8, 117.3, 119.7, 119.9 (2C), 120.1, 120.7, 123.5, 125.0, 125.2, 125.7, 129.9, 130.3, 132.4, 132.5, 136.1, 136.7, 136.8, 137.3, 137.4, 139.1, 139.4, 139.5, 139.8, 140.0, 140.4, 141.0, 142.8, 142.9, 143.6, 145.0 (2C), 145.1 (2C), 145.3, 145.4, 146.0 (2C), 146.1 (4C), 147.1, 152.2 (aromatic C), 164.6, 165.1, 165.5, 165.9, 166.6, 166.7, 166.8, 167.9, 168.0, 168.7 (COO), glucose carbon, see Table II.

Partial Hydrolysis of 11a in Hot Water A solution of **11a** (28 mg) in H_2O–acetone (2:1, 3 ml) was heated at 90 °C for 18 h. The resulting precipitates were collected by filtration to afford phenazine bislactone (**11b**) (4 mg), a brown powder. IR ν_{max}^{KBr} cm^{-1}: 1740, 1610, 1590. The filtrate, after concentration, was chromatographed over MCI-gel CHP 20P with H_2O–MeOH to give isomallotinic acid (**11d**) (2 mg), **11e** (4 mg) and **11f** (9 mg). **11d**: an off-white amorphous powder, $[\alpha]_D^{21}$ +26.2° (c=0.6, acetone). ^{1}H-NMR (acetone-d_6 + D_2O, 100 MHz) δ: 6.38, 6.84, 7.12 (each 1H, s, valoneayl H), 7.10 (2H, s, galloyl H), glucose proton, see Table I. **11e**: a tan amorphous powder, $[\alpha]_D^{21}$ +7.5° (c=0.7, acetone). Negative FAB-MS m/z: 1237 $[M-H]^-$. ^{1}H-NMR (acetone-d_6 + D_2O, 270 MHz) δ: 6.69, 7.36 (each 2H, s, galloyl H), 6.78, 6.95 (each 1H, s, HHDP H), 7.10, 7.24, 7.27 (each 1H, s, valoneayl H), glucose proton, see Table I. **11f**: a tan amorphous powder, $[\alpha]_D^{21}$ −46.6° (c=1.2, acetone). ^{1}H-NMR (acetone-d_6 + D_2O, 270 MHz) δ: 6.40, 6.78, 6.82, 7.01, 7.16 (each 1H, s, HHDP and valoneayl H), 7.05, 7.09, 7.15 (each 2H, s, galloyl H), glucose proton, see Table I. The presence of tercatain (**11c**) in the reaction mixture was confirmed by thin-layer chromatography [silica gel; benzene–ethyl formate–formic acid (2:14:3); Rf 0.40] and HPLC [column, UNISIL PAK Type 5C_{18}-250A, Gasukuro Industrial Co.; solvent, CH_3CH–50 mM H_3PO_4 (17:83); flow rate, 0.7 ml/min; t_R 10.5 min)].

Excoecarinin A (13) A yellow powder (H_2O), mp 210 °C (dec.), $[\alpha]_D^{26}$ +12.2° (c=0.9, acetone). *Anal.* Calcd for $C_{82}H_{56}O_{54}$: C, 51.69; H, 2.96. Found: C, 52.14; H, 2.57. Negative FAB-MS m/z: 1903 $[M-H]^-$. ^{1}H-NMR (acetone-d_6 + D_2O, 270 MHz) δ: 3.76 (1/2H, d, J=13 Hz, α H-6′), 3.86 (1/2H, d, J=13 Hz, β H-6′), 4.27 (1/2H, dd, J=6, 10 Hz, β H-5′), 4.33 (1H, m, H-6), 4.59 (1/2H, dd, J=6, 10 Hz, α H-5′), 4.67—4.79 (5/2H, m, H-5, 6, β H-1′), 4.89 (1/2H, dd, J=4, 10 Hz, α H-2), 4.91, 4.93 (each 1/12H, each d, J=2 Hz, DHHDP H-1), 5.04 (1/2H, t, J=10 Hz, β H-4′), 5.07 (1/2H, t, J=10 Hz, α H-4′), 5.13 (5/12H, s, DHHDP H-1), 5.18 (1/2H, t, J=10 Hz, β H-2′), 5.18 (5/12H, s, DHHDP H-1), 5.25 (1/2H, dd, J=7, 13 Hz, α H-6′), 5.33 (1/2H, d, J=4 Hz, α H-1′), 5.34 (1/2H, dd, J=7, 13 Hz, β H-6′), 5.41—5.55 (5/2H, m, H-3, 4, β H-3′), 5.61, 5.64 (each 1/2H, br s, H-2), 5.80 (1/2H, t, J=10 Hz, α H-3′), 6.07, 6.03 (each 1/2H, s, euphorbinoyl H_A), 6.26, 6.28 (each 1/12H, d, J=2 Hz, DHHDP H-3), 6.52 (1/2H, s, HHDP H), 6.56 (1H, br s, H-1), 6.58, 6.59 (each 5/12H, s, DHHDP H-3), 6.65, 6.66, 6.67 (each 1/2H, s, HHDP H), 6.86, 7.05, 7.06, 7.13, 7.23, 7.26 (euphorbinoyl H), 6.92, 7.04, 7.17, 7.20 (each 1H, s, galloyl H). ^{13}C-NMR (acetone-d_6 + D_2O, 25.05 MHz) δ: 46.2 (DHHDP C-1), 63.7, 64.2, 66.0, 67.1, 70.1, 71.2, 72.5, 73.0, 74.0, 74.5, 91.0, 96.5 (glucose), 92.4 (DHHDP C-6), 96.3 (DHHDP C-5), 103.5, 108.3, 109.0, 109.3, 110.3, 110.8 (euphorbinoyl C-3, 3′, 6″, 6‴, HHDP C-3, 3′, galloyl C-2, 6), 113.8, 115.8, 117.0, 119.3, 120.1, 120.3, 123.1, 123.4, 126.0, 126.5 129.0, 129.6, 130.3, 135.3, 135.5, 136.5, 137.2, 137.5, 138.4, 139.1, 139.4, 139.8, 140.0, 142.1, 143.4, 143.8, 144.4, 144.8, 145.1, 145.3, 145.7, 145.8, 149.9, 146.0, 149.6, 149.9, 151.3, 154.3 (aromatic C, DHHDP C-2, 3), 164.4, 165.0, 165.3, 166.0, 166.6, 166.8, 167.7, 167.9, 168.2, 168.3 (COO), 191.9 (DHHDP C-4).

Preparation of the Phenazine Derivative (13a) A mixture of **13** (110 mg) and *o*-phenylenediamine (10 mg) in 20% AcOH–EtOH (2.5 ml) was left standing at room temperature for 12 h. After concentration, the mixture was subjected to Sephadex LH-20 chromatography with EtOH–H_2O (1:0—8:2) to give **13a** (73 mg) as a tan amorphous powder, $[\alpha]_D^{21}$ +25.2° (c=0.5, acetone). *Anal.* Calcd for $C_{88}H_{58}N_2O_{51}\cdot 4H_2O$: C, 52.03; H, 3.27; N, 1.38. Found: C, 52.00; H, 2.98; N, 1.18. ^{1}H-NMR (acetone-d_6 + D_2O, 270 MHz) δ: 3.82, 3.86 (each d, J=12 Hz, H-6′), 4.00 (dd, J=4, 12 Hz, H-6), 4.32 (dd, J=6, 10 Hz, H-5′), 4.53 (dd, J=9, 12 Hz, H-6), 4.65—4.74 (m, H-5, 6, β H-1′), 4.95 (dd, J=4, 8 Hz, αH-2′), 5.02 (t, J=10 Hz, β H-4′), 5.08 (t, J=10 Hz, α H-4′), 5.20 (t, J=9 Hz, β H-2′), 5.32—5.37 (m, H-4, α H-1′, α, β H-6′), 5.39 (d, J=4 Hz, H-4), 5.46, 5.51 (each d, J=4 Hz, H-3), 5.68, 5.72 (each d, J=6 Hz, H-2), 6.10, 6.11 (each d, J=6 Hz, H-1), 6.13, 6.21, 6.45, 6.52, 6.65, 6.66, 6.68, 6.75, 7.01, 7.05, 7.06, 7.07 (each s, aromatic H), 6.92, 6.96, 6.97, 7.13 (each s, galloyl H), 7.49, 7.50 (each s, phanazine H-3), 8.02 (m, phenazine H), 8.25—8.40 (m, phenazine H), 8.30, 8.35 (each s, phenazine H-3′).

Partial Hydrolysis of 13a in Hot Water A solution of **13a** (460 mg) in H_2O–acetone (2:1, 12 ml) was heated at 85 °C for 8 h. The brown precipitates formed were collected by filtration (25 mg). This product was identified as the phenazine bislactone (**11b**) by IR spectral comparison. The filtrate was concentrated, and chromatographed over Sephadex LH-20 with 80% MeOH to give **13b** (215 mg) as a light brown amorphous powder, $[\alpha]_D^{21}$ −6.1° (c=1.3, acetone). *Anal.* Calcd for $C_{68}H_{50}O_{45}\cdot 2H_2O$: C, 50.32; H, 3.35. Found: C, 50.67; H, 3.53. Negative FAB-MS m/z: 1585 $[M-H]^-$. ^{1}H-NMR (acetone-d_6 + D_2O, 270 MHz) δ: 6.14 (1/3H), 6.15 (2/3H) (each s, euphorbinoyl H_A), 6.56 (1/3H), 6.67 (2/3H) (each s, HHDP H), 6.91, 6.92, 6.94, 6.95, 6.97 (4H in total, each s, euphorbinoyl and HHDP H), 7.05, 7.11, 7.12, 7.13 (4H, in total, each s, galloyl H), glucose protons, see text. ^{13}C-NMR (acetone-d_6 + D_2O, 25.05 MHz) δ: 62.0 (C-4), 63.7 (α, β C-6′), 64.7 (C-6), 67.0 (α, β C-4′), 69.0 (C-2), 71.3 (C-3, α C-2′, 5′, β C-2′), 73.1 (α C-3′), 73.2 (β C-5′), 75.3 (β C-3′), 91.0 (α C-1′), 94.5 (C-1), 96.5 (β C-1′), 104.2, 108.3, 109.4, 110.4, 110.7 (euphorbinoyl C-3, 3′, 3″, 3‴, HHDP C-3, 3′, galloyl C-2, 6), 114.0, 114.3, 115.6, 115.8, 116.5, 116.7, 117.1, 118.6, 120.3 (euphorbinoyl C-1, 1′, 1″, 1‴, HHDP C-1, 1′), 120.7 (galloyl

C-1), 124.3, 126.0, 126.4 (HHDP C-2, 2′, euphorbinoyl C-2′), 129.8, 130.4, 135.4, 135.5, 136.5, 137.4, 137.8, 138.6, 139.3, 139.5, 140.0, 140.5, 141.2, 141.5, 142.1, 143.4, 143.7, 143.9, 144.1, 144.4, 145.0, 145.3, 145.8 (galloyl C-3, 4, 5, HHDP C-4, 5, 6, 4′, 5′, 6′, euphorbinoyl C), 149.5, 149.8, 150.1, 151.1 (euphorbinoyl C-4, 6), 164.0, 164.7, 165.4, 166.6, 166.9, 167.5, 167.8, 168.0, 168.4, 168.6, 170.7 (COO).

Methylation of 13a Followed by Alkaline Methanolysis A solution of **13a** (110 mg) in MeOH (10 ml) was treated with ethereal CH_2N_2 at 0 °C for 12 h. After removal of the solvent and excess reagent by evaporation, the residue was dissolved in MeOH (5 ml) and 10% NaOH (1 ml). The mixture was heated under reflux for 1 h, and was concentrated under reduced pressure. The solution was acidified with 1 N HCl and extracted with ether. The organic layer was dried over Na_2SO_4 and concentrated to give a residue, which was treated with ethereal CH_2N_2 at room temperature for 30 min. The reaction products were separated by silica gel chromatography with benzene–acetone (24 : 1) to give methyl trimethoxybenzoate (**13c**) (20 mg) [colorless needles, mp 80—81 °C], (*S*)-dimethyl hexamethoxydiphenoate (**13d**) (20 mg) [a colorless syrup, $[\alpha]_D^{20}$ −17.6° (*c*=1.0, $CHCl_3$)], the (*R*)-phenazine methylate (**13e**) (14 mg) [a yellow amorphous powder, $[[\alpha]_D^{20}$ +24.3° (*c*=0.7, $CHCl_3$)] and **13f** (26 mg). **13f**: a white amorphous powder, $[\alpha]_D^{20}$ +16.3° (*c*=1.3, $CHCl_3$), EI-MS *m/z* (%): 870 (M^+, 100), 659 (1), 241 (13), 239 (19). ^{1}H-NMR ($CDCl_3$, 100 MHz) δ: 3.47, 3.48, 3.61 (×2), 3.63, 3.71, 3.79, 3.82, 3.84, 3.89, 3.91, 3.92, 3.93, 3.95 (each 3H, s, OMe), 6.92, 7.13, 7.23, 7.34 (each 1H, s, aromatic H).

Acid Hydrolysis of 13 A solution of **13** (200 mg) in 1 N H_2SO_4 (20 ml) was heated at 80 °C for 10 h. After cooling, the reaction mixture was directly subjected to MCI-gel CHP 20P chromatography (H_2O–MeOH) to yield **13g** (60 mg) as a light brown amorphous powder, $[\alpha]_D^{25}$ +70.7° (*c*=0.2, MeOH), *Anal.* Calcd for $C_{41}H_{28}O_{27}\cdot 1/2H_2O$: C, 51.21; H, 3.03. Found: C, 51.37; H, 2.87. Negative FAB-MS *m/z*: 951 $[M-H]^-$. ^{1}H-NMR (acetone-d_6 + D_2O, 270 MHz) δ: 3.55—4.05 (m, H-4, 5, 6), 4.88 (1/2H, d, *J*=8 Hz, β H-1), 4.93 (1/2H, dd, *J*=4, 10 Hz, α H-2), 5.06 (1/2H, dd, *J*=8, 9 Hz, β H-2), 5.20 (1/2H, t, *J*=9 Hz, β H-3), 5.41 (1/2H, d, *J*=4 Hz, α H-1), 5.69 (1/2H, t, *J*=10 Hz, α H-3), 6.83, 6.98 (each 1H, s, galloyl H), 6.99, 7.06, 7.11, 7.13, 7.15, 7.18, 7.53, 7.54 (each 1/2H, s, euphorbinoyl H). ^{13}C-NMR (acetone-d_6 + D_2O, 25.02 MHz) δ: 61.8, 69.6, 72.5, 73.1, 73.9, 77.0, 90.6, 95.4 (glucose), 158.3, 159.4, 160.1 (δ-lactone), 165.2, 167.2, 167.7, 168.1 (COO).

Treatment of 13b with Phenylhydrazine·HCl A mixture of **13b** (130 mg), phenylhydrazine·HCl (200 mg) and AcONa (300 mg) in H_2O (4 ml) was heated at 80 °C for 10 min. The reaction mixture was subjected to Sephadex LH-20 chromatography (60—80% MeOH). The 60% MeOH eluate was further purified by MCI-gel CHP 20P chromatography (20% MeOH) to afford **13i** (9 mg). The 80% MeOH eluate was further purified by chromatographies over MCI-gel CHP 20P (25—60% MeOH) and Bondapak C_{18}/Porasil B (60% MeOH) to afford **13j** (27 mg) and **13h** (4 mg). **13h**: a yellow amorphous powder, $[\alpha]_D^{25}$ +117.3° (*c*=0.2, MeOH). *Anal.* Calcd for $C_{39}H_{32}N_4O_{16}\cdot 5/2H_2O$: C, 54.61; H, 4.35; N, 6.53. Found: C, 54.89; H, 4.53; N, 6.22. ^{1}H-NMR (acetone-d_6 + D_2O, 100 MHz) δ: 3.93 (1H, d, *J*=12 Hz, H-6), 4.31 (1H, dd, *J*=3, 8 Hz, H-5), 4.84 (1H, dd, *J*=3, 12 Hz, H-6), 5.38 (1H, dd, *J*=6, 8 Hz, H-4), 6.02 (1H, d, *J*=6 Hz, H-3), 6.53, 6.82 (each 1H, s, HHDP H), 7.05—7.40 (10H, m, aromatic H), 7.22 (2H, s, galloyl H), 7.96 (1H, s, H-1). **13j**: a light brown amorphous powder, $[\alpha]_D^{25}$ +5.0° (*c*=0.8, MeOH). Negative FAB-MS *m/z*: 969 $[M-H]^-$. ^{1}H-NMR (acetone-d_6 + D_2O, 100 MHz) δ: 4.03 (1H, t, *J*=11 Hz, H-6), 4.13 (1H, br s, H-2), 4.34 (1H, br t, *J*=11 Hz, H-5), 4.45 (1H, br s, H-4), 4.80 (1H, t, *J*=11 Hz, H-6), 4.83 (1H, br s, H-3), 6.16 (1H, s, euphorbinoyl H_A), 6.36 (1H, d, *J*=2 Hz, H-1), 6.92 (1H, s, euphorbinoyl H_B), 7.03, 7.09 (each 1H, s, euphorbinoyl H_C, H_D), 7.11 (2H, s, galloyl H). ^{13}C-NMR (acetone-d_6 + D_2O, 25.05 MHz) δ: 62.0 (C-4), 64.7 (C-6), 69.1 (C-2), 71.2 (C-3), 75.3 (C-5), 94.5 (C-1), 104.5, 109.3, 109.6, 110.3, 110.6, 113.9, 115.1, 116.9, 117.7, 120.6, 124.4, 129.9, 132.1, 135.8, 137.7, 139.5, 139.7, 139.8, 140.1, 142.2, 143.5, 145.0, 145.9, 149.4, 150.4 (aromatic C), 165.7, 166.7, 167.6, 168.1, 169.1 (COO). **13j**: a light brown amorphous powder, $[\alpha]_D^{25}$ −43.6° (*c*=1.0, MeOH), *Anal.* Calcd for $C_{40}H_{30}O_{26}\cdot H_2O$: C, 50.86; H, 3.41. Found: C, 50.96; H. 3.64. Negative FAB-MS *m/z*: 925 $[M-H]^-$. ^{1}H-NMR (acetone-d_6, 100 MHz) δ: 4.06 (2H, m, H-2, 6), 4.46 (2H, m, H-4, 5), 4.80 (1H, t, *J*=11 Hz, H-6), 4.82, (1H, br s, H-3), 6.26, 6.67 (each 1H, d, *J*=9 Hz, D ring-H), 6.28 (1H, s, A ring-H), 6.35 (1H, d, *J*=2 Hz, H-1), 6.89 (1H, s, B ring-H), 7.09 (2H, s, galloyl H), 7.14 (1H, s, C ring-H). ^{13}C-NMR (acetone-d_6 + D_2O, 25.05 MHz) δ: 61.9 (C-4), 64.6 (C-6), 69.0 (C-2), 70.9 (C-3), 75.2 (C-5), 94.5 (C-1), 104.4, 106.2, 108.6, 109.8, 110.0, 110.5, 114.0, 115.8, 116.2, 117.7, 120.5, 124.6, 129.5, 130.9, 134.5, 135.5, 136.4, 136.6, 137.4, 139.5, 139.8, 141.0, 142.8, 143.3, 145.0, 145.3, 145.8, 150.8, 152.0 (aromatic C), 165.7, 167.0, 167.3, 168.3 (COO).

Decarboxylation of 13 A solution of **13** (150 mg) in 5% AcONa (5 ml) was heated at 80 °C for 1.5 h. After cooling, the resulting needles were collected by filtration (8 mg), and identified as ellagic acid. The filtrate was chromatographed over Sephadex LH-20, and elution with 60% MeOH furnished gallic acid and brevifolin carboxylic acid. The 80% MeOH eluate was purified by Avicel cellulose (2% AcOH) and MCI-gel CHP 20P (H_2O–MeOH) chromatographies to give 3-*O*-galloyl-4,6-(*S*)-HHDP-D-glucose (**13k**) (3 mg) and **13j** (12 mg). The MeOH eluate afforded **13l** (33 mg). **13k**: a light brown amorphous powder, $[\alpha]_D^{25}$ +40.6° (*c*=0.7, acetone), ^{1}H-NMR (acetone-d_6 + D_2O, 100 MHz) δ: 3.50—3.90 (2H, m, H-2, 6), 4.08, 4.55 (each 1/2H, dd, *J*=7, 10 Hz, α, β H-5), 4.74 (1/2H, d, *J*=8 Hz, β H-1), 4.95, 4.98 (each 1/2H, t, *J*=10 Hz, α, β H-4), 5.13—5.34 (2H, m, α H-1, β H-3, α, β H-6), 5.50 (1/2H, t, *J*=10 Hz, α H-3), 6.46, 6.47, 6.63, 6.64 (each 1/2H, each s, HHDP H), 7.03, 7.04 (each 1H, s, galloyl H). **13l**: a light brown amorphous powder, $[\alpha]_D^{20}$ +7.7° (*c*=0.5, acetone). Negative FAB-MS *m/z*: 1541 $[M-H]^-$. ^{1}H-NMR (acetone-d_6 + D_2O, 270 MHz) δ: 3.88 (d, *J*=13 Hz, H-6′), 4.14—4.23 (m, H-2, 6), 4.44—4.51 (m, H-4, 5), 4.58—4.69 (m, H-6, β H-1′), 5.08 (t, *J*=10 Hz, α H-4′), 5.09 (dd, *J*=4, 10 Hz, α H-2′), 5.11 (t, *J*=10 Hz, β H-4′), 5.28 (dd, *J*=6, 13 Hz, H-6′), 5.30 (dd, *J*=8, 10 Hz, β H-2′), 5.41 (d, *J*=4 Hz, α H-1′), 5.51 (t, *J*=10 Hz, β H-3′), 5.84 (t, *J*=10 Hz, α H-3′), 6.21 (s, A ring-H), 6.35 (br s H-1), 6.34, 6.37 (each d, *J*=8 Hz, D ring-H), 6.54, 6.67, 6.68, 6.90, 6.91, 6.99, 7.04 (each s, HHDP, B, C, D ring-H), 7.10, 7.11 (each s, galloyl H).

Decarboxylation of 14 A mixture of **14** (20 mg) and AcONa (40 mg) in H_2O (1 ml) was heated at 80 °C for 40 min. After cooling, the reaction mixture was directly subjected to MCI-gel CHP 20P chromatography (20—40% MeOH) to yield **14a** (4 mg) and the starting material **14** (14 mg). **14a**: a white amorphous powder, $[\alpha]_D^{22}$ −91.8° (*c*=0.6, MeOH), *Anal.* Calcd for $C_{33}H_{26}O_{21}\cdot H_2O$: C, 51.04; H, 3.63. Found: C, 51.40; H, 3.46. Negative FAB-MS *m/z*: 757 $[M-H]^-$. ^{1}H-NMR (acetone-d_6, 100 MHz) δ: 3.84 (1H, br s, H-2), 4.08 (1H, dd, *J*=9, 11 Hz, H-6), 4.43 (1H, br s, H-4), 4.63 (2H, m, H-6, OH), 4.76 (1H, br s, OH), 5.01 (1H, br s, H-3), 5.11 (2H, m, H-6, OH), 5.86, 6.09 (each 1H, d, *J*=9 Hz, aromatic H), 6.33 (1H, br s, H-1), 6.57, 6.72 (each 1H, s, aromatic H), 7.16 (2H, s, galloyl H).

Decarboxylation of 15 A mixture of **15** (20 mg) and AcONa (40 mg) in H_2O (1 ml) was heated at 80 °C for 10 min. Work-up as described above yielded **15a** (8 mg) and the starting material **15** (8 mg). **15a**: a white amorphous powder, $[\alpha]_D^{22}$ −97.8° (*c*=0.4, MeOH), *Anal.* Calcd for $C_{33}H_{26}O_{21}$: C, 52.25; H, 3.45. Found: C, 52.42; H, 3.64. Negative FAB-MS *m/z*: 757 $[M-H]^-$. ^{1}H-NMR (acetone-d_6 + D_2O, 100 MHz) δ: 4.10 (1H, br s, H-2), 4.16 (1H, dd, *J*=8, 10 Hz, H-6), 4.41 (1H, br s, H-4), 4.56 (1H, dd, *J*=8, 10 Hz, H-5), 4.89 (1H, t, *J*=10 Hz, H-6), 4.91 (1H, br s, H-3), 6.24, 6.39 (each 1H, d, *J*=9 Hz, aromatic H), 6.39 (1H, d, *J*=3 Hz, H-1), 6.74, 6.84 (each 1H, s, aromatic H), 7.15 (2H, s, galloyl H).

Treatment of 13l with Phenylhydrazine·HCl A mixture of **13l** (10 mg), phenylhydrazine·HCl (30 mg) and AcONa (40 mg) in H_2O was heated at 80 °C for 15 min. The reaction mixture was directly subjected to MCI-gel CHP 20P chromatography (30—40% MeOH) to yield **13j** (4 mg).

Excoecarinin B (16) A tan amorphous powder, $[\alpha]_D^{26}$ +81.1° (*c*=1.1, acetone), *Anal.* Calcd for $C_{88}H_{62}O_{59}\cdot 2H_2O$: C, 50.34; H, 3.17. Found: C, 50.66; H, 3.13. Negative FAB-MS *m/z*: 2061 $[M-H]^-$. ^{1}H-NMR (acetone-d_6 + D_2O, 270 MHz) δ: 2.20 (2/3H, br d, *J*=19 Hz, elaeocarpusinoyl (EL) H-3), 3.03 (1/3H, dd, *J*=2, 19 Hz, EL-3), 3.08 (2/3H, br d, *J*=19 Hz, EL-3), 3.77 (1/3H, d, *J*=12 Hz, α H-6′), 3.86 (2/3H, d, *J*=12 Hz, β H-6′), 3.93 (1H, dd, *J*=6, 10 Hz, H-6), 4.15 (4/3H, dd, *J*=4, 10 Hz, H-5, EL-6″), 4.26 (2/3H, dd, *J*=6, 12 Hz, EL-6″), 4.32 (2/3H, dd, *J*=6, 10 Hz, β H-5′), 4.40—4.62 (4H, m, H-6, β H-1′, α H-5′, EL-5″, 6″), 4.65 (1H, br s, EL-4″), 4.87 (1/3H, dd, *J*=4, 10 Hz, α H-2′), 5.01 (2/3H, t, *J*=10 Hz, β H-4′), 5.05 (1H, br s, H-3), 5.07 (1/3H, t, *J*=10 Hz, α H-4′), 5.20—5.28 (1H, m, β H-2′, α H-6′), 5.34 (1/3H, d, *J*=4 Hz, α H-1′), 5.36 (2/3H, t, *J*=10 Hz, β H-3′), 5.37 (2/3H, dd, *J*=6, 12 Hz, β H-6′), 5.46—5.49 (1H, m, H-2), 5.68, 5.72 (2/3H and 1/3H, respectively, each d, *J*=2 Hz, EL-1), 5.79 (1/3H, t, *J*=10 Hz, α H-3′), 5.96 (1H, br s, H-4), 6.49, 6.52 (2/3H and 1/3H, respectively, each d, *J*=3 Hz, H-1), 6.19, 6.21, 6.53, 6.66, 6.67, 6.88, 6.91, 6.97, 7.03, 7.05, 7.09, 7.12, 7.18, 7.19, 7.20, 7.30, 7.31 (11H in total, each s, aromatic H). ^{13}C-NMR (acetone-d_6 + D_2O, 25.05 MHz) δ: 38.0 (EL-3), 49.8 (EL-2), 51.9 (EL-1), 63.6, 64.6, 66.9, 68.4, 71.1, 71.7, 73.0, 73.5, 74.1, 74.3, 76.5, 76.7 (glucose C, EL-5″, 6″), 80.7 (EL-2″), 89.0, 89.7 (EL-4″), 90.7 (α C-1′), 92.1 (C-1), 96.3 (β C-1′, EL-5), 108. 1 (EL-6), 109.2 (EL-3″), 104.3, 108.1, 108.9, 110.5, 114.0, 114.1, 115.4, 115.7, 116.5, 117.1, 118.0, 118.5, 120.3, 120.7, 123.1, 123.4, 126.1, 126.5, 129.1, 129.6, 135.1, 136.2, 136.5, 138.1, 138.3, 138.7, 139.0, 139.2, 139.7, 140.1, 140.3, 141.5, 142.0, 143.6, 144.3, 144.9, 145.2, 145.7, 146.0, 147.6, 148.6, 149.6, 150.1, 151.3 (aromatic C), 163.2, 164.5, 164.7, 165.3, 166.7, 167.1, 167.3, 167.7,

167.8, 168.3 (COO), 170.4, 170.7 (EL-1″), 197.7, 197.9 (EL-4).

Treatment of 16 with Hot Water A solution of **16** (7 mg) in H_2O (1 ml) was heated at 85 °C for 1 h. The reaction mixture was directly subjected to MCI-gel CHP 20P chromatography [H_2O–MeOH (1 : 0—2 : 3)]. The H_2O eluate gave ascorbic acid, which was detected by TLC [silica gel; benzene–ethyl formate–formic acid (1 : 7 : 1.5); *Rf* 0.41], while the 40% MeOH eluate furnished **13** (6 mg).

Preparation of 16 A mixture of **13** (100 mg) and L-ascorbic acid (100 mg) in 0.2 M AcOH in H_2O–MeOH (1 : 1) (6 ml) was kept at 40 °C for 24 h. The solution was concentrated by evaporation under reduced pressure, and the aqueous solution was subjected to MCI-gel CHP 20P chromatography. Elution with 40% MeOH yielded **16** (46 mg).

Acknowledgements The authors are grateful to Mr. Y. Tanaka, Miss Y. Soeda and Mr. R. Isobe for ^1H- and ^{13}C-NMR and MS measurements, and to the staff of the Central Analysis Room of this university for elemental analyses.

References and Notes

1) Part XCVII: G. Nonaka, T. Sakai, T. Tanaka and I. Nishioka, *Chem. Pharm. Bull.*, **38**, 2151 (1990).
2) G. Nonaka, M. Ageta and I. Nishioka, *Chem. Pharm. Bull.*, **33**, 96 (1985).
3) K. Ishimaru, G. Nonaka and I. Nishioka *Phytochemistry*, **26**, 1501 (1987).
4) H. Nishimura, G. Nonaka and I. Nishioka, *Phytochemistry*, **23**, 2621 (1984).
5) T. Tanaka, G. Nonaka and I. Nishioka, *Phytochemistry*, **24**, 2075 (1985).
6) T. Okuda, T. Hatano and K. Yazaki, *Chem. Pharm. Bull.*, **30**, 1113 (1982).
7) T. Tanaka, G. Nonaka, I. Nishioka, K. Miyahara and T. Kawasaki, *J. Chem. Soc., Perkin Trans. 1*, **1986**, 369.
8) O. T. Schmidt, K. Demmler, H. Bittermann and P. Stephan, *Justus Liebigs Ann. Chem.*, **609**, 186 (1957).
9) R. Saijo, G. Nonaka and I. Nishioka, *Chem. Pharm. Bull.*, **37**, 2624 (1989).
10) T. Yoshida, L. Chen, T. Shingu and T. Okuda, *Chem. Pharm. Bull.*, **36**, 2940 (1988).
11) T. Tanaka, G. Nonaka and I. Nishioka, *Chem. Pharm. Bull.*, **34**, 1039 (1986).
12) S.-H. Lee, T. Tanaka, G. Nonaka and I. Nishioka, *Phytochemistry*, in press.
13) T. Okuda, T. Yoshida and T. Hatano, *J. Chem. Soc., Perkin Trans. 1*, **1982**, 9.
14) T. Yoshida, O. Nanba, K. Yokoyama, T. Okuda and L. Chen, Abstracts of Papers, 31th Symposium on the Chemistry of Natural Products, Nagoya, 1989, p. 601.
15) M. A. M. Nawwar, A. M. A. Souleman, J. Buddins, H. Bauer and M. Linscheid, *Tetrahedron Lett.*, **25**, 49 (1984).
16) R. Saijo, G. Nonaka and I. Nishioka, *Chem. Pharm. Bull.*, **37**, 2063 (1989).
17) J.-H. Lin, M. Ishimatsu, T. Tanaka, G. Nonaka and I. Nishioka, *Chem. Pharm. Bull.*, in press.
18) S.-H. Lee, T. Tanaka, G. Nonaka and I. Nishioka, *Phytochemistry*, **28**, 3469 (1989).
19) J.-H. Lin, T. Tanaka, G. Nonaka and I. Nishioka, *Chem. Pharm. Bull.*, in press.