Seven New Phenolic Glucosides from *Viburnum cylindricum*

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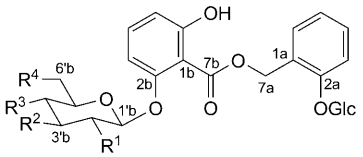
Seven new phenolic glucosides, 2′-*O*-acetylhenryoside (**1**), 2′,3′-di-*O*-acetylhenryoside (**2**), 2′,6′-di-*O*-acetylhenryoside (**3**), 2′,3′,6′-tri-*O*-acetylhenryoside (**4**), 2′,3′,4′,6′-tetra-*O*-acetylhenryoside (**5**), 2-[(2,3-di-*O*-acetyl-β-D-glucopyranosyl)oxy]-6-hydroxybenzoic acid (**6**), and 6-hydroxy-2-[(2,3,4,6-tetra-*O*-acetyl-β-D-glucopyranosyl)oxy]benzoic acid (**7**), were isolated from the leaves and stems of *Viburnum cylindricum*, along with 26 known compounds (henryoside = 2-(β-D-glucopyranosyloxy)-6-hydroxybenzoic acid [2-(β-D-glucopyranosyloxy)phenyl]methyl ester). The structures of the new compounds were established on the basis of chemical and spectroscopic evidences.

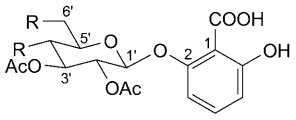
Introduction. – The genus *Viburnum* (Caprifoliaceae), distributed from South America (Peru) to South-East Asia (Philippines, Malaysia), comprises more than 230 species, 80 of which grow in China [1–4]. *Viburnum cylindricum* BUCH., a kind of evergreen shrub, is widely distributed in tropical Asia. Its leaves and stems have been used as folk medicine to treat various diseases such as cough, diarrhea, rheumatoid arthritis, and tumefaction [5].

Our previous studies on *V. cylindricum* collected from the Songming prefecture of Yunnan Province have resulted in the isolation of several triterpenoids and furofuran-type lignans including six new dammarane triterpenoids, cylindrictones A–F [6–7]. Further phytochemical investigation of the same species collected in the Jinping prefecture of Yunnan Province now led to the isolation of 19 phenolic constituents, among them the new phenolic glucosides **1**–**7**, one benzofuran-type lignan, eleven triterpenoids, eight of which were oleanane-type ones, one guaiane-type sesquiterpene [8], and a flavone. The structures of the new phenolic glucosides, 2′-*O*-acetylhenryoside[1]) (**1**), 2′,3′-di-*O*-acetylhenryoside[1]) (**2**), 2′,6′-di-*O*-acetylhenryoside[1]) (**3**), 2′,3′,6′-tri-*O*-acetylhenryoside[1]) (**4**), 2′,3′,4′,6′-tetra-*O*-acetylhenryoside[1]) (**5**), 2-[(2,3-di-*O*-acetyl-β-D-glucopyranosyl)oxy]-6-hydroxybenzoic acid (**6**), and 6-hydroxy-2-[(2,3,4,6-tetra-*O*-acetyl-β-D-glucopyranosyl)oxy]benzoic acid (**7**), were determined by spectroscopic data and by comparison with related known molecules. Herein, we report the isolation and characterization of these metabolites from *Viburnum cylindricum* BUCH.

Results and Discussion. – Compound **1** was obtained as a colorless oil. A molecular formula $C_{28}H_{34}O_{16}$ was assigned on the basis of the HR-ESI-MS ($[M-H]^-$ at *m*/*z*

[1]) Arbitrary atom numbering; for systematic names, see *Exper. Part.*





	R^1	R^2	R^3	R^4
1[1])	AcO	OH	OH	OH
2[1])	AcO	AcO	OH	OH
3[1])	AcO	OH	OH	AcO
4[1])	AcO	AcO	OH	AcO
5[1])	AcO	AcO	AcO	AcO
8[1])	OH	OH	OH	OH

6 R = OH
7 R = AcO

625.1750). The ^{1}H-NMR spectrum of **1** (*Table 1*) showed the signals for a 1,2-disubstituted phenyl group at δ(H) 7.09 (*dd*, $J = 8.0$, 1.5 Hz), 7.17 (*dd*, $J = 8.5$, 8.0 Hz), 6.93 (*dd*, $J = 8.5$, 7.5 Hz), and 7.36 (*dd*, $J = 7.5$, 1.5 Hz) and for a 1,2,6-trisubstituted phenyl group at δ(H) 6.62 (*dd*, $J = 8.5$, 1.5 Hz), 7.12 (*dd*, $J = 8.5$, 8.0 Hz), and 6.46 (*dd*, $J = 8.0$, 1.5 Hz). In addition, the signals of three CH_2O (δ(H) 5.44 and 5.26 (2*d*, $J =$ 13.5 Hz, 2 H), 3.75–3.79 (*m*, 2 H), and 3.97–4.03 (*m*, 2 H)), one Me (δ(H) 1.98 (*s*)) of an Ac group, and ten CH–O groups corresponding to two hexose moieties were also observed. The ^{13}C-NMR spectrum of **1** (*Table 2*) exhibited signals for 12 aromatic C-atoms and two C=O (δ(C) 169.1 and 172.1), three CH_2O (δ(C) 63.5, 62.5, and 62.4), and one Me group (δ(C) 21.2), besides twelve C-atoms for the two hexose units. Analysis of the HSQC and HMBC spectra of **1** and comparison of the ^{1}H- and ^{13}C-NMR chemical shifts with those of henryoside (=2-(β-D-glucopyranosyloxy)-6-hydroxybenzoic acid [2-(β-D-glucopyranosyloxy)phenyl]methyl ester; **8**) disclosed that the two compounds were quite similar [9]. The only difference between them was the presence of an Ac group in **1** compared to henryoside. The sugar moieties with their anomeric H-atom resonating at δ(H) 4.84 (*d*, $J = 7.5$ Hz, H–C(1′a)) and 4.95 (*d*, $J =$ 8.0 Hz, H–C(1′b)) were determined to be β-configured [10]. Acid hydrolysis of **1** did not afford the aglycone which decomposed under acid condition, but gave D-glucose. The monosaccharide was identified by comparison of its R_f value and the specific rotation with those of an authentic sample [11]. The negative-mode FAB-MS of **1** showed a fragment at *m*/*z* 421 due to loss of a mono-*O*-acetylated hexose unit. The HMBC cross-peak H–C(2′b)/C=O (δ(C) 172.1) (*Fig. 1*) further confirmed the location of the Ac group. Thus, the structure of **1** was determined as 2′-*O*-acetylhenryoside.

Compound **2** ($C_{30}H_{36}O_{17}$) displayed a molecular-ion peak $[M-H]^-$ at *m*/*z* 667.1870 in the negative-mode HR-ESI-MS, and the negative-mode FAB-MS experiment gave a fragment at *m*/*z* 421 due to the loss of a di-*O*-acetylated hexose unit. The ^{1}H- and ^{13}C-NMR (*Tables 1* and *2*), HSQC, and HMBC spectra indicated that **2** was similar to **1**, except for the existence of one more Ac group in **2**. The key HMBCs H–C(2′b) (δ(H) 5.03–5.08)/C=O (δ(C) 170.2) and H–C(3′b) (δ(H) 5.15–5.19)/C=O (δ(C) 170.6) indicated that the two AcO groups were located at C(2′b) and C(3′b), respectively. Therefore, **2** was deduced as 2′,3′-di-*O*-acetylhenryoside.

Table 1. *^{1}H-NMR Data* (CD_3OD) *of Compounds* **1**–**5**[1]). δ in ppm, J in Hz.

	1	**2**	**3**	**4**	**5**
H–C(3a)	7.09 (*dd*, *J* = 8.0, 1.5)	7.20 (*dd*, *J* = 8.0, 1.5)	7.07 (*dd*, *J* = 8.0, 1.5)	7.24 (*dd*, *J* = 8.0, 1.5)	7.25 (*dd*, *J* = 8.0, 1.5)
H–C(4a)	7.17 (*dd*, *J* = 8.5, 8.0)	7.27 (*dd*, *J* = 8.5, 8.0)	7.15 (*dd*, *J* = 8.5, 8.0)	7.35 (*dd*, *J* = 8.5, 8.0)	7.32 (*dd*, *J* = 8.5, 8.0)
H–C(5a)	6.93 (*dd*, *J* = 8.5, 7.5)	7.04 (*dd*, *J* = 8.5, 7.5)	6.90 (*dd*, *J* = 8.5, 7.5)	7.06 (*dd*, *J* = 8.5, 7.5)	7.09 (*dd*, *J* = 8.5, 7.5)
H–C(6a)	7.36 (*dd*, *J* = 7.5, 1.5)	7.47 (*dd*, *J* = 7.5, 1.5)	7.36 (*dd*, *J* = 7.5, 1.5)	7.49 (*dd*, *J* = 7.5, 1.5)	7.52 (*dd*, *J* = 7.5, 1.5)
CH_2(7a)	5.44, 5.26 (2*d*, *J* = 13.5)	5.58, 5.36 (2*d*, *J* = 13.0)	5.42, 5.26 (2*d*, *J* = 13.0)	5.60, 5.40 (2*d*, *J* = 12.0)	5.60, 5.41 (2*d*, *J* = 13.0)
H–C(3b)	6.62 (*dd*, *J* = 8.5, 1.5)	6.77 (*dd*, *J* = 8.5, 1.5)	6.54 (*dd*, *J* = 8.5, 1.5)	6.81 (*dd*, *J* = 8.5, 1.5)	6.82 (*dd*, *J* = 8.5, 1.5)
H–C(4b)	7.12 (*dd*, *J* = 8.5, 8.0)	7.30 (*dd*, *J* = 8.5, 8.0)	7.16 (*dd*, *J* = 8.5, 8.0)	7.31 (*dd*, *J* = 8.5, 8.0)	7.36 (*dd*, *J* = 8.5, 8.0)
H–C(5b)	6.46 (*dd*, *J* = 8.0, 1.5)	6.65 (*dd*, *J* = 8.0, 1.5)	6.46 (*dd*, *J* = 8.0, 1.5)	6.71 (*dd*, *J* = 8.0, 1.5)	6.71 (*dd*, *J* = 8.0, 1.5)
H–C(1′a)	4.84 (*d*, *J* = 7.5)	4.98 (*d*, *J* = 7.8)	4.83 (*d*, *J* = 8.0)	5.02 (*d*, *J* = 7.8)	5.02 (*d*, *J* = 7.8)
H–C(2′a)	3.56–3.59 (*m*)	3.56–3.59 (*m*)	3.40–3.47 (*m*)	3.93–4.04 (*m*)	4.23–4.27 (*m*)
H–C(3′a)	3.31–3.39[a])	3.77–3.79 (*m*)	3.55–3.58 (*m*)	3.53–3.61[a])	3.49–3.62[a])
H–C(4′a)	3.31–3.39[a])	3.45–3.49 (*m*)	3.29–3.37[a])	3.48–3.50 (*m*)	3.49–3.62[a])
H–C(5′a)	3.31–3.39[a])	3.50–3.53[a])	3.29–3.37[a])	3.53–3.61[a])	3.49–3.62[a])
CH_2(6′a)	3.75–3.79 (*m*)	3.88–3.93 (*m*)	3.71–3.79 (*m*)	3.74–3.81 (*m*)	3.72–3.78 (*m*)
H–C(1′b)	4.95 (*d*, *J* = 8.0)	5.34 (*d*, *J* = 8.0)	4.93 (*d*, *J* = 8.0)	5.39 (*d*, *J* = 8.0)	5.40 (*d*, *J* = 8.0)
H–C(2′b)	4.83–4.86 (*m*)	5.03–5.08 (*m*)	4.81–4.85 (*m*)	5.07–5.11 (*m*)	5.25 (*d*, *J* = 8.0)
H–C(3′b)	3.31–3.39[a])	5.15–5.19 (*m*)	3.45–3.50 (*m*)	5.20–5.25 (*m*)	5.42 (*d*, *J* = 10.0)
H–C(4′b)	3.31–3.39[a])	3.73–3.75 (*m*)	3.29–3.37[a])	3.69–3.77 (*m*)	5.13–5.16 (*m*)
H–C(5′b)	3.31–3.39[a])	3.50–3.53[a])	3.29–3.37[a])	3.53–3.61[a])	3.49–3.62[a])
CH_2(6′b)	3.97–4.03 (*m*)	3.68–3.72 (*m*)	4.10–4.15 (*m*)	4.41–4.48 (*m*)	4.29–4.34 (*m*)
AcO–C(2′b)	1.98 (*s*)	1.96 (*s*)	1.95 (*s*)	2.02 (*s*)	2.04 (*s*)
AcO–C(3′b)	–	1.99 (*s*)	–	2.00 (*s*)	2.03 (*s*)
AcO–C(4′b)	–	–	–	–	1.99 (*s*)
AcO–C(6′b)	–	–	1.92 (*s*)	2.04 (*s*)	2.02 (*s*)

[a]) Overlapped

Table 2. *^{13}C-NMR Data* (CD_3OD) *of Compounds* **1**–**5**. δ in ppm.

	1	**2**	**3**	**4**	**5**
C(1a)	126.9 (*s*)	126.3 (*s*)	125.7 (*s*)	126.4 (*s*)	126.4 (*s*)
C(2a)	156.6 (*s*)	156.3 (*s*)	155.3 (*s*)	156.1 (*s*)	156.1 (*s*)
C(3a)	116.3 (*d*)	116.0 (*d*)	115.1 (*d*)	116.0 (*d*)	116.0 (*d*)
C(4a)	130.3 (*d*)	130.0 (*d*)	129.0 (*d*)	129.4 (*d*)	129.41 (*d*)
C(5a)	123.5 (*d*)	122.9 (*d*)	122.3 (*d*)	122.9 (*d*)	122.9 (*d*)
C(6a)	130.2 (*d*)	129.9 (*d*)	128.9 (*d*)	129.9 (*d*)	129.9 (*d*)
C(7a)	63.5 (*t*)	62.5 (*t*)	62.4 (*t*)	62.9 (*t*)	62.9 (*t*)
C(1b)	112.4 (*s*)	110.1 (*s*)	111.3 (*s*)	110.5 (*s*)	110.8 (*s*)
C(2b)	157.2 (*s*)	157.4 (*s*)	156.0 (*s*)	157.4 (*s*)	157.1 (*s*)
C(3b)	107.2 (*d*)	107.2 (*d*)	106.2 (*d*)	107.3 (*d*)	107.2 (*d*)
C(4b)	133.2 (*d*)	133.9 (*d*)	132.9 (*d*)	133.9 (*d*)	133.9 (*d*)
C(5b)	111.4 (*d*)	111.7 (*d*)	110.4 (*d*)	111.8 (*d*)	112.0 (*d*)
C(6b)	158.2 (*s*)	159.7 (*s*)	157.1 (*s*)	159.8 (*s*)	159.7 (*s*)
C(7b)	169.1 (*s*)	168.6 (*s*)	167.9 (*s*)	168.6 (*s*)	168.4 (*s*)
Glc-a:					
C(1′a)	102.8 (*d*)	102.4 (*d*)	101.5 (*d*)	102.5 (*d*)	102.4 (*d*)
C(2′a)	74.9 (*d*)	74.6 (*d*)	73.7 (*d*)	74.6 (*d*)	72.3 (*d*)
C(3′a)	78.0 (*d*)	77.7 (*d*)	74.3 (*d*)	74.8 (*d*)	74.6 (*d*)
C(4′a)	71.31 (*d*)	71.1 (*d*)	70.1 (*d*)	71.1 (*d*)	71.1 (*d*)
C(5′a)	78.2 (*d*)	77.8 (*d*)	77.0 (*d*)	77.8 (*d*)	77.8 (*d*)
C(6′a)	62.5 (*t*)	63.0 (*t*)	61.3 (*t*)	62.5 (*t*)	62.5 (*t*)
Glc-b:					
C(1′b)	100.6 (*d*)	99.6 (*d*)	99.4 (*d*)	99.5 (*d*)	99.4 (*d*)
C(2′b)	74.8 (*d*)	72.4 (*d*)	73.5 (*d*)	72.3 (*d*)	71.8 (*d*)
C(3′b)	76.0 (*d*)	76.1 (*d*)	74.6 (*d*)	75.9 (*d*)	73.2 (*d*)
C(4′b)	71.30 (*d*)	68.8 (*d*)	70.3 (*d*)	69.1 (*d*)	69.1 (*d*)
C(5′b)	78.4 (*d*)	77.8 (*d*)	76.8 (*d*)	77.8 (*d*)	77.8 (*d*)
C(6′b)	62.4 (*t*)	61.8 (*t*)	63.4 (*t*)	63.6 (*t*)	62.6 (*t*)
*Ac*O–C(2′b)	172.1 (*s*), 21.2 (*q*)	170.2 (*s*), 20.8 (*q*)	170.9 (*s*), 20.0 (*q*)	170.2 (*s*), 20.8 (*q*)	170.0 (*s*), 20.7 (*q*)
*Ac*O–C(3′b)	–	170.6 (*s*), 20.8 (*q*)	–	170.5 (*s*), 20.8 (*q*)	170.3 (*s*), 20.6 (*q*)
*Ac*O–C(4′b)	–	–	–	–	170.0 (*s*), 20.6 (*q*)
*Ac*O–C(6′b)	–	–	171.5 (*s*), 19.6 (*q*)	170.9 (*s*), 20.6 (*q*)	170.6 (*s*), 20.5 (*q*)

Compound **3** was isolated as a colorless oil and had the same molecular formula $C_{30}H_{36}O_{17}$ as **2**, determined by analysis of the ^{13}C- and DEPT-NMR and HR-ESI-MS data ($[M-H]^-$ at *m/z* 667.1868). The NMR spectra (*Tables 1* and *2*) of **3** suggested that its structure was closely similar to that of **2**. The difference between **2** and **3** was the different positions of the two AcO groups. Correlations from H–C(2′b) to the C=O at δ(C) 170.9 and from CH_2(6′b) to the C=O at δ(C) 171.5 were observed in the HMBC spectrum of **3**, which indicated that the two AcO groups of **3** were attached to C(2′b) and C(6′b). Thus, **3** was elucidated as 2′,6′-di-*O*-acetylhenryoside.

The negative-mode HR-ESI-MS of compound **4** showed a molecular-ion peak $[M-H]^-$ at *m/z* 709.1970, in accordance with the molecular formula $C_{32}H_{38}O_{18}$. The

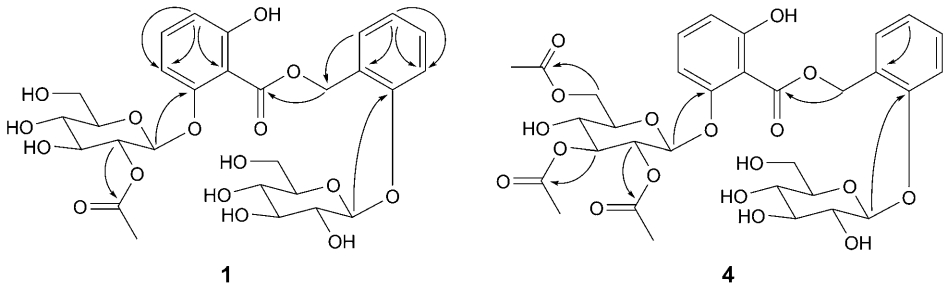


Fig. 1. *Key HMBCs of compounds* **1** *and* **4**

spectroscopic features indicated that **4** was closely related to **3**, except for the presence of one additional Ac group in **4**. The long-range HMBCs H–C(3′b) (δ(H) 5.20–5.25)/C=O (δ(C) 170.5) of the Ac group indicated that the additional AcO group was located at C(3′b) in **4** (*Fig. 1*). Accordingly, **4** was identified as 2′,3′,6′-tri-*O*-acetylhenryoside.

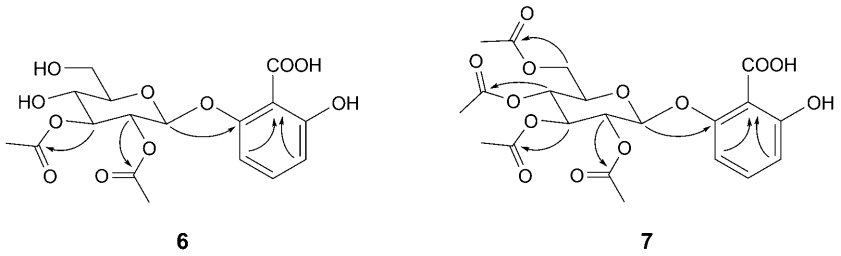
Compound **5** exhibited a quasi-molecular-ion peak $[M-H]^-$ at *m*/*z* 751.2114 in the HR-ESI-MS, corresponding to a molecular formula $C_{34}H_{40}O_{18}$. Examination of the ^{1}H- and ^{13}C-NMR (*Tables 1* and *2*) and DEPT spectra showed the presence of two benzene rings, two hexose units, five C=O, a CH_2O, and four Me groups. These data were similar to those of **4**. The only difference lies in that one more Ac group was observed in **5** compared to **4**. The HMBC H–C(4′b) (δ(H) 5.13–5.16)/C=O (δ(C) 170.0) revealed that the additional AcO group was placed at C(4′b). Thus, compound **5** was established as 2′,3′,4′,6′-tetra-*O*-acetylhenryoside.

Compound **6** was isolated as a colorless oil. The molecular formula was determined to be $C_{17}H_{20}O_{11}$ by HR-ESI-MS (*m*/*z* at 339.1468 ($[M-H]^-$)), and was also verified by the NMR data. The ^{1}H- and ^{13}C-NMR spectra of **6** (*Table 3*) showed the existence of a phenyl and a hexose unit, two Ac and a COOH group. Acid hydrolysis of **6**, by the same method as for **1**, gave D-glucose which was identified by comparison of its R_f and specific rotation with those of an authentic sample [11]. The β-pyranosyl configuration was deduced from the anomeric H-atom at δ(H) 5.50 (*d*, *J* = 7.7 Hz). Complete analysis of the NMR, HSQC, and HMBC spectra of **6** revealed the presence of a 1,2,6-trisubstituted phenyl moiety. The β-D-glucopyranose unit was linked to C(2) of the benzene ring as deduced from the HMBC H–C(1′)/C(2). The location of the two AcO groups at C(2′) and C(3′) of the glucose was deduced by the HMBCs H–C(2′)/C=O (δ(C) 170.5), and H–C(3′)/C=O (δ(C) 170.4), respectively (*Fig. 2*). Therefore, the structure of **6** was elucidated as 2-[(2,3-di-*O*-acetyl-β-D-glucopyranosyl)oxy]-6-hydroxybenzoic acid.

Compound **7** had a molecular formula $C_{21}H_{24}O_{15}$ as elucidated by its HR-ESI-MS ($[M-H]^-$ at *m*/*z* 483.1764). Its NMR spectra displayed the presence of a 1,2,6-trisubstituted phenyl moiety, a β-D-glucopyranose unit, a COOH C-atom, and four Ac groups. In the HMBC spectrum (*Fig. 2*), correlations were observed from H–C(2′), H–C(3′), H–C(4′), and CH_2(6′) to the C=O atoms at δ(C) 169.9, 169.6, 169.9, and 169.2, respectively. Accordingly, **7** was determined to be 6-hydroxy-2-[(2,3,4,6-tetra-*O*-acetyl-β-D-glucopyranosyl)oxy]benzoic acid.

Table 3. *^{1}H- and ^{13}C-NMR Data of Compounds* **6** *and* **7**. δ in ppm, J in Hz.

	6 (CD_3OCD_3)		**7** ($CDCl_3$)	
	δ(H)	δ(C)	δ(H)	δ(C)
C(1)	–	106.9 (*s*)	–	102.7 (*s*)
C(2)	–	158.3 (*s*)	–	155.6 (*s*)
H–C(3)	6.79 (*dd*, *J* = 8.2, 1.5)	106.9 (*d*)	6.78 (*dd*, *J* = 8.5, 1.5)	104.9 (*d*)
H–C(4)	7.38 (*dd*, *J* = 8.3, 8.2)	135.6 (*d*)	7.38 (*dd*, *J* = 8.5, 8.3)	135.3 (*d*)
H–C(5)	6.64 (*dd*, *J* = 8.3, 1.5)	112.6 (*d*)	6.58 (*dd*, *J* = 8.3, 1.5)	114.2 (*d*)
C(6)	–	163.9 (*s*)	–	164.1 (*s*)
COOH	–	170.4 (*s*)	–	170.3 (*s*)
H–C(1′)	5.50 (*d*, *J* = 7.7)	99.8 (*d*)	5.34 (*d*, *J* = 7.8)	99.0 (*d*)
H–C(2′)	5.11–5.17 (*m*)	72.2 (*d*)	5.17–5.23 (*m*)	70.6 (*d*)
H–C(3′)	5.20–5.25 (*m*)	76.0 (*d*)	5.28–5.33 (*m*)	71.9 (*d*)
H–C(4′)	3.72–3.88 (overlapped)	68.7 (*d*)	3.93–3.95 (overlapped)	67.8 (*d*)
H–C(5′)	3.72–3.88 (overlapped)	77.9 (*d*)	3.93–3.95 (overlapped)	72.4 (*d*)
CH_2(6′)	3.94 (*d*, *J* = 13.5), 3.72–3.88 (overlapped)	61.6 (*t*)	4.26 (*d*, *J* = 13.5), 4.18 (*d*, *J* = 13.5)	61.4 (*t*)
*Ac*O–C(2′)	1.99 (*s*)	170.5 (*s*), 20.7 (*q*)	2.08 (*s*)	169.9 (*s*), 20.4 (*q*)
*Ac*O–C(3′)	1.97 (*s*)	170.4 (*s*), 20.6 (*q*)	2.04 (*s*)	169.6 (*s*), 20.5 (*q*)
*Ac*O–C(4′)	–	–	2.08 (*s*)	169.9 (*s*), 20.4 (*q*)
*Ac*O–C(6′)	–	–	2.04 (*s*)	169.2 (*s*), 20.5 (*q*)



6 **7**

Fig. 2. *Key HMBCs of compounds* **6** *and* **7**

Compounds **1**–**7** could be detected in a crude MeOH extract by TLC and HPLC, which demonstrates that they are not artifacts formed by transesterification in the presence of AcOEt during the isolation procedure.

The 26 known compounds (see refs. for corresponding formulas) were identified as henryoside (**8**) [9], *O*-hydroxybenzyl salicylate [12], salicyloylsalicin [12], (+)-licarin A [13], 3,22-dihydroxyolean-12-en-25-al [14], (2α,3β)-olean-12-ene-2,3-diol [15], 6-hydroxy-3-oxoolean-12-en-28-oic acid [16], ovalifoliogenin [17], ursomyricerone [18], olean-12-ene-2,3,22-triol [19], maniladiol [20], crategolic acid [21], camaldulensic acid [22], masticadienic acid [23], betulinic acid [24], alismoxide [8], 3,3′,4′,7-tetrahydroxyflavone [25], apigenin [26], 3,4-dimethylbenzoic acid [27], 4-hydroxybenzoic acid [28], 2*H*-1-benzopyran-2-one [29], umbelliferone [30], aesculetin [31], gallic acid [32], 3,5-dihydroxybenzoic acid methyl ester [33], and 3,5-dihydroxybenzoic acid [32] on the basis of their NMR data and by comparison with the literature data. To the

best of our knowledge, all the known compounds were isolated from this plant for the first time, except for 3,3′,4′,7-tetrahydroxyflavon [34].

In contrast to our previous results [6][7], no dammarane-type triterpenoids and furofuran lignans were identified in the course of this study. This may be due to the different geographical origin of the plant material.

Experimental Part

General. Column chromatography (CC): silica gel (SiO_2; 200–300 mesh; *Qingdao Marine Chemical Inc.*), SiO_2 *H* (10–40 μm; *Qingdao Marine Chemical Inc.*), *Lichroprep RP-18* gel (40–63 μm; *Merck*, Darmstadt, Germany), *MCI* gel (75–150 μm; *Mitsubishi Chemical Corporation*, Japan), and *Sephadex LH-20* (*Pharmacia*). TLC: SiO_2 plates; detection by spraying with 10% H_2SO_4/EtOH followed by heating. Semi-prep. HPLC: *Agilent-1100* liquid chromatograph, equipped with a UV detector (190–400 nm) and a *Zorbax-SB-C*$_{18}$ column (9.4 mm × 25 cm, 5 μm; *Agilent*). Optical rotations: *Horiba-SEPA-300* polarimeter. UV Spectra: *Shimadzu-UV-2401A* spectrometer; MeOH solns.; λ_{max} (log ε) in nm. IR Spectra: *Bio-Rad-FTS-135* spectrometer; KBr pellets; $\tilde{\nu}$ in cm^{-1}. 1D- and 2D-NMR Spectra: *Bruker-AM-400* and *-DRX-500* spectrometers; δ in ppm rel. to Me_4Si as internal standard, *J* in Hz. MS: *VG-Auto-Spec-3000* spectrometer with glycerol as matrix for FAB; *API-QSTAR-Pulsar-1* spectrometer for HR-ESI; in *m*/*z*.

Plant Material. The leaves and stems of *Viburnum cylindricum* were collected in Jinping County, Kunming City of Yunnan Province, P. R. China, in April 2006. The sample was identified by Prof. *Xiao Cheng*, and a voucher specimen (KIB 06051901) has been deposited with the State Key Laboratory of Phytochemistry and Plant Resources in West China, Kunming Institute of Botany, Chinese Academy of Sciences.

Extraction and Isolation. Air-dried and powdered leaves and stems of *V. cylindricum* (4.0 kg) were extracted with MeOH (3 × 8 l, each 24 h) at r.t. After evaporation of the solvent *in vacuo* at 45°, a residue (340 g) was obtained which was dissolved in H_2O (2.5 l) and extracted successively with petroleum ether (3 × 2 l), AcOEt (4 × 2 l), and BuOH (3 × 2 l). The AcOEt extract (178 g) was subjected to CC (*MCI* gel, 95% EtOH, then 100% acetone). The 95% EtOH fraction (129 g) was separated by CC (SiO_2 (1.2 kg), step gradient petroleum ether/acetone 1:0 → 0:1): *Fractions A–E*. *Fr. A* (15 g) was applied to CC (SiO_2, petroleum ether/AcOEt 9:1 → 1:1): *Frs. A1–A3*. *Fr. A1* (4.8 g) was subjected to CC (SiO_2, petroleum ether/acetone 20:1 → 1:1; petroleum ether/i-PrOH 30:1 → 10:1), followed by CC (*Sephadex LH-20*, MeOH/$CHCl_3$ 1:1): 3,22-dihydroxyolean-12-en-25-al (14 mg), (2*α*,3*β*)-olean-12-ene-2,3-diol (31 mg), masticadienic acid (11 mg), 3,5-dihydroxybenzoic acid methyl ester (28 mg), and 3,5-dihydroxybenzoic acid (17 mg). *Fr. A2* (5 g) was subjected to reversed-phase CC (*RP-18*, MeOH/H_2O 1:9 → 1:0) and then purified by semi-prep. HPLC (MeOH/H_2O 63:37, 3 ml/min, det. at 206 nm): **5** (312 mg, t_R 20.6 min). *Fr. A3* (3.7 g) was separated by CC (SiO_2, petroleum ether/$CHCl_3$/acetone 88:7:5) and CC (*Sephadex LH-20*, MeOH): maniladiol (162 mg), masticadienic acid (29 mg), and alismoxide (8 mg). *Fr. B* (23 g) was divided into subfractions by CC (SiO_2, $CHCl_3$/MeOH 97:3 → 7:1): *Frs. B1–B3*. *Fr. B1* (5.1 g) was subjected to CC(SiO_2, $CHCl_3$/acetone 25:1 → 5:1 and petroleum ether/$CHCl_3$/MeOH 97:2:1) and further purified by semi-prep. HPLC (MeOH/H_2O 57:43, 1 ml/min, det. at 207 nm): **4** (22 mg, t_R 14.6 min). *Fr. B2* (4.9 g) was applied to CC (petroleum ether/$CHCl_3$/acetone 18:1:1 and petroleum ether/$CHCl_3$/MeOH 97:2:1), followed by CC (*Sephadex LH-20*, MeOH and MeOH/$CHCl_3$ 1:1): 6-hydroxy-3-oxoolean-12-en-28-oic acid (35 mg), ovalifoliogenin (22 mg), ursomyricerone (101 mg), and betulinic acid (62 mg). *Fr. B3* (7 g) was subjected to CC (SiO_2, petroleum ether/$CHCl_3$/i-PrOH 19:1:1): olean-12-ene-2,3,22-triol (62 mg), crategolic acid (55 mg), and camaldulensic acid (41 mg). *Fr. C* (6 g), separated by CC (petroleum ether/AcOEt 20:1 → 5:1), was then subjected to CC (petroleum ether/acetone 9:1) and finally purified by semi-prep. HPLC (MeOH/H_2O 52.6:47.4, 3 ml/min, det. at 207 nm): **3** (26 mg, t_R 17.1 min) and **6** (28 mg, t_R 23.2 min). *Fr. D* (25 g) was subjected to reversed-phase CC (*RP-18*, MeOH/H_2O 1:19 → 1:1): *Frs. D1–D3* as main fractions. *Fr. D1* (5.9 g) was applied to CC (SiO_2, petroleum ether/$CHCl_3$/i-PrOH 90:9:1 → 90:1:9) and further purified by CC (*Sephadex LH-20*, MeOH): 3,4-dimethylbenzoic acid (16 mg), 4-hydroxybenzoic acid (32 mg),

and 2*H*-1-benzopyran-2-one (9 mg). *Fr. D2* (5.7 g) was subjected to repeated CC (SiO_2, petroleum ether/acetone 15:1 → 5:1): henryoside (9 mg), apigenin (45 mg), and gallic acid (4 mg). *Fr. D3* (6.1 g) was applied to CC (SiO_2, $CHCl_3$/acetone 8:1) and then purified by semi-prep. HPLC (MeOH/MeCN/H_2O 57:5:38, 1 ml/min, det. at 208 nm): **1** (38 mg, t_R 18.8 min) and **2** (31 mg, t_R 22.0 min). *Fr. E* (11 g) was divided into subfractions by reversed-phase CC (*RP-18*, MeOH/H_2O 1:9 → 8:2): *Frs. E1–E3*. *Fr. E1* (3.3 g) was subjected to CC (SiO_2, $CHCl_3$/i-PrOH 15:1) and further purified by CC (*Sephadex LH-20*, MeOH): (+)-licarin A (6 mg), umbelliferone (7 mg), and aesculetin (11 mg). *Fr. E2* was resubjected to CC (SiO_2, $CHCl_3$/MeOH 20:1): *O*-hydroxybenzyl salicylate (12 mg) and 3,3′,4′,7-tetrahydroxyflavone; (5 mg). *Fr. E3* was further purified by CC (*Sephadex LH-20*, MeOH): salicyloylsalicin (62 mg).

Acid Hydrolysis. A soln. of **1** (10 mg) in 2M HCl (3 ml) was heated in a water bath at 72° for 6 h. After cooling, the mixture was neutralized with $NaHCO_3$ and extracted with $CHCl_3$. By TLC comparison ($CHCl_3$/MeOH 7:3) with an authentic sample, D-glucose was detected in the water layer (R_f 0.45). The aq. soln. was further concentrated to dryness and subjected to reversed-phase CC (*RP-18*, 15% MeOH/H_2O): D-glucose (3.4 mg). $[\alpha]_D^{20} = +42.3$ ($c = 0.16$, MeOH). D-Glucose was identified by comparison of its R_f and specific rotation with those of an authentic sample.

Acid hydrolysis of **2**–**7** by the same method as used for **1** afforded D-glucose.

*2′-*O*-Acetylhenryoside* (= *[2-(β-*D*-Glucopyranosyloxy)phenyl]methyl 2-[(2-*O*-Acetyl-β-*D*-glucopyranosyl)oxy]-6-hydroxybenzoate*; **1**): Colorless oil. $[\alpha]_D^{26} = -53.3$ ($c = 0.17$, MeOH). UV: 205 (3.92), 248 (3.13), 273 (3.30). IR: 3293, 1731, 1609, 1461, 1239, 1072. ^{1}H- and ^{13}C-NMR: *Tables 1* and *2*, resp. FAB-MS (neg.): 625 ($[M-H]^-$). HR-ESI-MS: 625.1750 ($[M-H]^-$, $C_{28}H_{33}O_{16}^-$; calc. 625.1768).

*2′,3′-Di-*O*-acetylhenryoside* (= *[2-(β-*D*-Glucopyranosyloxy)phenyl]methyl 2-[(2,3-Di-*O*-acetyl-β-*D*-glucopyranosyl)oxy]-6-hydroxybenzoate*; **2**): Colorless oil. $[\alpha]_D^{26} = -86.5$ ($c = 0.16$, MeOH). UV: 204 (3.98), 249 (3.14), 274 (3.43). IR: 3335, 1746, 1610, 1458, 1239, 1074. ^{1}H- and ^{13}C-NMR: *Tables 1* and *2*, resp. FAB-MS (neg.): 667 ($[M-H]^-$). HR-ESI-MS: 667.1870 ($[M-H]^-$, $C_{30}H_{35}O_{17}^-$; calc. 667.1875).

*2′,6′-Di-*O*-acetylhenryoside* (= *[2-(β-*D*-Glucopyranosyloxy)phenyl]methyl 2-[(2,6-Di-*O*-acetyl-β-*D*-glucopyranosyl)oxy]-6-hydroxybenzoate*; **3**): Colorless oil. $[\alpha]_D^{26} = -47.6$ ($c = 0.21$, MeOH). UV: 204 (4.05), 248 (3.05), 274 (3.55). IR: 3420, 1731, 1610, 1458, 1239, 1074. ^{1}H- and ^{13}C-NMR: *Tables 1* and *2*, resp. FAB-MS (neg.): 667 ($[M-H]^-$). HR-ESI-MS: 667.1868 ($[M-H]^-$, $C_{30}H_{35}O_{17}^-$; calc. 667.1874).

*2′,3′,6′-Tri-*O*-acetylhenryoside* (= *[2-(β-*D*-Glucopyranosyloxy)phenyl]methyl 6-Hydroxy-2-[(2,3,6-tri-*O*-acetyl-β-*D*-glucopyranosyl)oxy]benzoate*; **4**): Colorless oil. $[\alpha]_D^{26} = -66.8$ ($c = 0.22$, MeOH). UV: 205 (4.19), 247 (3.20), 273 (3.50). IR: 3336, 1745, 1610, 1457, 1237, 1074. ^{1}H- and ^{13}C-NMR: *Tables 1* and *2*, resp. FAB-MS (neg.): 709 ($[M-H]^-$). HR-ESI-MS: 709.1970 ($[M-H]^-$, $C_{32}H_{37}O_{18}^-$; calc. 709.1979).

*2′,3′,4′,6′-Tetra-*O*-acetylhenryoside* (= *[2-(β-*D*-Glucopyranosyloxy)phenyl]methyl 6-Hydroxy-2-[(2,3,4,6-tetra-*O*-acetyl-β-*D*-glucopyranosyl)oxy]benzoate*; **5**): Colorless oil. $[\alpha]_D^{26} = -56.5$ ($c = 0.19$, MeOH). UV: 204 (3.94), 248 (3.18), 273 (3.49). IR: 3439, 1756, 1611, 1459, 1228, 1070, 1041. ^{1}H- and ^{13}C-NMR: *Tables 1* and *2*, resp. FAB-MS (neg.): 751 ($[M-H]^-$). HR-ESI-MS: 751.2114 ($[M-H]^-$, $C_{34}H_{39}O_{19}^-$; calc. 751.2108).

*2-[(2,3-Di-*O*-acetyl-β-*D*-glucopyranosyl)oxy]-6-dihydroxybenzoic Acid* (**6**): Colorless oil. $[\alpha]_D^{26} = -43.7$ ($c = 0.18$, MeOH). UV: 207 (4.22), 247 (3.35), 301 (3.47). IR: 3293, 1731, 1608, 1466, 1221, 1078. ^{1}H- and ^{13}C-NMR: *Table 3*. FAB-MS (neg.): 339 ($[M-H]^-$). HR-ESI-MS: 339.1468 ($[M-H]^-$, $C_{17}H_{19}O_{11}^-$; calc. 339.1473).

*6-Hydroxy-2-[(2,3,4,6-tetra-*O*-acetyl-2-β-*D*-glucopyranosyl)oxy]benzoic Acid* (**7**): Colorless oil. $[\alpha]_D^{26} = -58.0$ ($c = 0.15$, MeOH). UV: 207 (4.23), 247 (3.33), 300 (3.60). IR: 3333, 1728, 1615, 1465, 1222, 1074. ^{1}H- and ^{13}C-NMR: *Table 3*. FAB-MS (neg.): 483 ($[M-H]^-$). HR-ESI-MS: 483.1764 ($[M-H]^-$, $C_{21}H_{23}O_{15}^-$; calc. 483.1769).

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Received November 14, 2008