Lignanoids and Diterpenoids from *Callicarpa furfuraceae*

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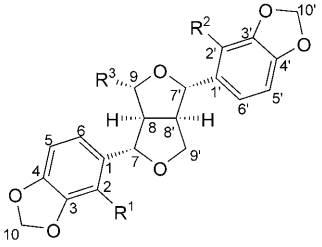
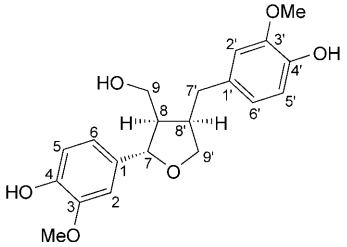
The three new lignanoids **1**–**3** and the five new phyllocladane diterpenoids **7**–**11** were isolated from the leaves of *Callicarpa furfuraceae*, together with two known lignanoids, lariciresinol (**4**) and (+)-sesamin (**5**), and five known diterpenoids, 17-norphyllocladane-3,16-dion (**6**), calliterpenone (**12**), calliterpenone 17-acetate (**13**), (3β,16α)-phyllocladane-3,16,17-triol (**14**), and (3β,16α)-phyllocladane-3,16,17-triol 17-acetate (**15**). Their structures were established by spectral-data interpretation.

Introduction. – Plants of the genus *Callicarpa* are known to have medicinal properties, *e.g.*, for the treatment of rheumatism, stomach disorders, and intestinal troubles [1]. Studies on piscicidal constituents have also been reported [2][3]. The Malaysian species *Callicarpa furfuraceae* (Verbenaceae), as a liquid extract, is drunk against colds in folk medicine [4]. We now report the isolation and structural elucidation of the five lignanoids **1**–**5** and the ten diterpenoids **6**–**15**. The lignanoids **1**–**3** and the diterpenoids **7**–**11** are new[1]).



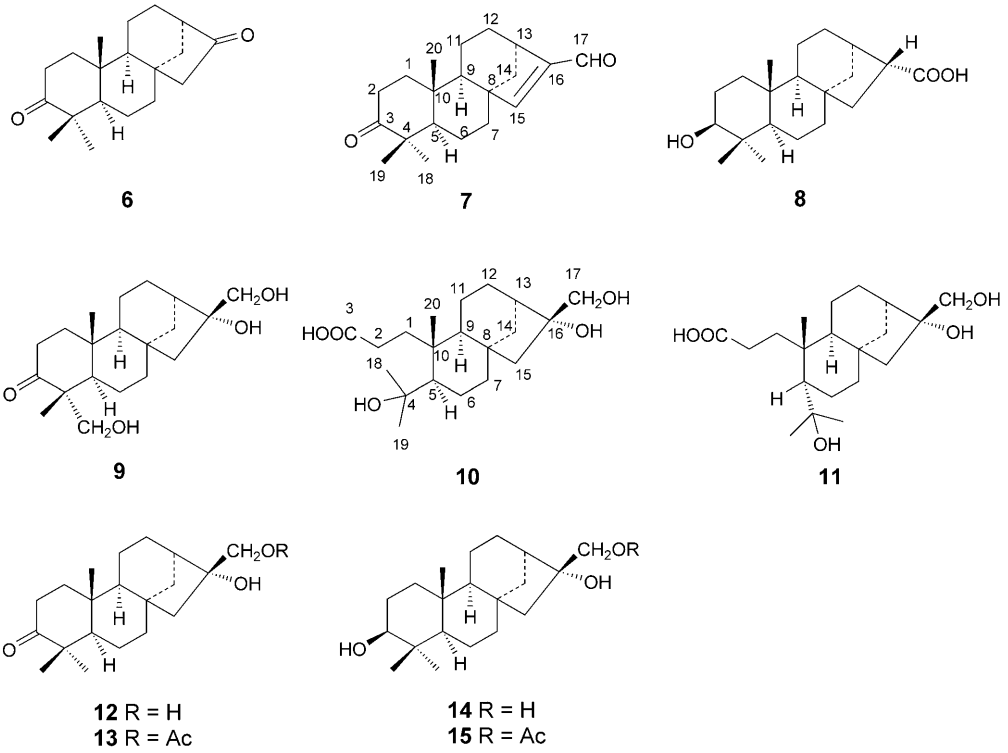
1 [1]) R^1 = OH, R^2 = H, R^3 = H
2 R^1 = OH, R^2 = OH, R^3 = H
3 R^1 = OH, R^2 = OH, R^3 = MeO
5 R^1 = H, R^2 = H, R^3 = H ((+)-sesamin)



Lariciresinol (**4**)

Results and Discussion. – The compounds **4**–**6** and **12**–**15** were identified by detailed NMR and MS analyses as lariciresinol (**4**) [5], (+)-sesamin (**5**) [6], 17-norphyl-

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



locladane-3,16-dion (**6**) [7], calliterpenone (**12**) [8], calliterpenone 17-acetate (**13**) [8], (3β,16α)-phyllocladane-3,16,17-triol (**14**) [8], and (3β,16α)-phyllocladane-3,16,17-triol 17-acetate (**15**) [8].

Compound **1**, an optically active white amorphous powder, was assigned the molecular formula $C_{20}H_{18}O_7$ on the basis of its HR-EI-MS (*m/z* 370.1046, calc. 370.1053). Its IR spectrum showed absorptions at 3018 (OH), 1605, and 1517 cm^{-1} (aromatic). The NMR spectra (*Table 1*) were very similar to those of (+)-sesamin (**5**) [6], which allowed to establish the structure of **1** as sesamin-2-ol.

The NMR data of **1** revealed the signals of twelve olefinic C-atoms (two aromatic rings), two dioxygenated CH_2 groups (δ(H) 5.95 (*s*, 2 H), 5.98 (*d*, 2 H); δ(C) 101.12, 101.62), two oxygenated CH_2 groups (δ(H) 4.15 (*dd*, 1 H), 3.89 (*dd*, 1 H); 4.35 (*dd*, 1 H), 3.87 (*dd*, 1 H); δ(C) 70.67, 72.37), two oxygenated CH groups (δ(H) 4.87 (*d*, 1 H), 4.77 (*d*, 1 H); δ(C) 86.45, 85.39), and two CH groups (δ(H) 3.20 (*m*, 1 H), 3.14 (*m*, 1 H); δ(C) 52.96, 53.43). A *s* at δ 7.75 was assigned to an OH proton. In the HMBC spectrum, the latter showed a cross-peak with C(2) at δ 139.80.

Compound **2** was also obtained as white amorphous powder. The HR-EI-MS (*m/z* 386.1006) established its molecular formula as $C_{20}H_{18}O_8$, containing one O-atom more than **1**. Only ten signals were observed in its ^{13}C-NMR spectrum (*Table 1*) indicating that **2** has a symmetric structure. Comparison of the NMR data with those of compound **1** established the structure of **2** as sesamin-2,2′-diol.

Table 1. *^{1}H- and ^{13}C-NMR Data for Compounds* **1**–**3**[1]). δ in ppm, J in Hz.

	1		**2**		**3**	
	δ(H)[a])	δ(C)[b])	δ(H)[c])	δ(C)[d])	δ(H)[c])	δ(C)[d])
C(1)		119.76		124.56		129.29
C(2)		139.80		139.43		141.59
C(3)		135.12		135.68		137.45
C(4)		148.89		149.01		149.80
H–C(5)	6.40 (*d*, *J*=8.2)	100.63	6.39 (*d*, *J*=8.2)	100.87	6.54 (*d*, *J*=8.1)	102.97
H–C(6)	6.55 (*d*, *J*=8.2)	119.43	6.79 (*d*, *J*=8.2)	119.67	6.89 (*d*, *J*=8.2)	119.10
H_β–C(7)	4.87 (*d*, *J*=6.5)	86.45	4.96 (*d*, *J*=4.4)	83.85	5.05 (*d*, *J*=6.6)	80.51
H_α–C(8)	3.17–3.22 (*m*, 1 H)	52.96	3.06–3.11 (*m*, 1 H)	54.61	2.84 (*t*, *J*=7.2)	63.06
H_α–C(9) or CH_2(9)	4.15 (*dd*, *J*=9.4, 6.6)	70.67	4.29 (*dd*, *J*=9.1, 6.9)	72.83	5.77 (*s*)	103.12
H_β–C(9)	3.89 (*dd*, *J*=9.4, 3.5)		3.98 (*dd*, *J*=9.1, 3.8)			
CH_2(10)	5.98 (*d*, *J*=1.4)	101.62	5.93 (*d*, *J*=1.3)	102.06	5.99 (br. *s*)	102.05
C(1′)		134.59				124.64
H–C(2′)	6.83 (*s*)	106.51				140.03
C(3′)		147.21				136.24
C(4′)		148.15				149.56
H–C(5′)	5.78 (*s*)	108.24			6.37 (*d*, *J*=7.9)	100.64
H–C(6′)	6.78 (*s*)	119.33			6.86 (*d*, *J*=8.2)	122.42
H_β–C(7′)	4.77 (*d*, *J*=4.6)	85.39			5.01 (*d*, *J*=7.5)	87.16
H_α–C(8′)	3.09–3.15 (*m*, 1 H)	53.43			3.20–3.25 (*m*, 1 H)	51.94
H_α–C(9′)	4.35 (*dd*, *J*=9.4, 7.4)	72.37			4.13 (*dd*, *J*=8.9, 4.8)	72.56
H_β–C(9′)	3.87 (*dd*, *J*=9.4, 5.3)				4.06 (*d*, *J*=8.9)	
CH_2(10′)	5.95 (*s*)	101.12			5.93 (br. *s*)	102.05
OH–C(2)	7.75 (*s*)		6.38 (*s*)		8.00 (*s*)	
OH–C(2′)					8.00 (*s*)	
MeO–C(9)					4.02 (*s*)	59.84

[a]) Recorded in $CDCl_3$ at 500 MHz. [b]) Recorded in $CDCl_3$ at 125 MHz. [c]) Recorded in (D_6)acetone at 500 MHz. [d]) Recorded in (D_6)actone at 125 MHz.

Compound **3** was isolated as colorless oil. The HR-EI-MS (*m/z* 416.1079) showed a molecular ion compatible with the formula $C_{21}H_{20}O_9$, *i.e.*, **3** contains one O-atom and one CH_2 group more than **2**. The salient difference between the NMR data (*Table 1*) of **3** and **2** were the signals for the furofurane moiety. The structure of compound **3** was determined as (9α)-**9**-methoxysesamin-2,2′-diol.

In the NMR spectra of **3**, the signals of CH_2(9)[1]) of **2** (δ(H) 4.29 (*dd*, 1 H), 3.98 (*dd*, 1 H); δ(C) 72.83) were replaced by those of a MeO–CH(9) moiety (δ(H) 4.02 (*s*, MeO), 5.77 (*s*, 1 H); δ(C) 59.84, 103.12). The 2D-NOESY experiment, which revealed the correlations H–C(9)/H–C(7) and H–C(7′), established the α-configuration of MeO–C(9).

Compound **7** was isolated as oil. The HR-EI-MS (*m/z* 300.2112) established a molecular formula $C_{20}H_{28}O_2$, which indicated the degree of unsaturation as seven double-bond equivalents. The maximum absorption at 232 nm in the UV spectrum suggested the presence of a conjugated carbonyl group. Detailed analysis of the ^{1}H- and

^{13}C-NMR (*Table 2*), ^{1}H,^{1}H-COSY, HMQC, HMBC, and NOESY data and comparison with those of calliterpenone (**12**) [8][9] allowed to assign to **7** the structure of phyllocladan-15-en-3,17-dione.

Three tertiary Me groups at δ 1.10, 1.07, and 0.93 were observed in the ^{1}H-NMR spectrum of **7**. All 20 C-atoms of the molecular formula, including 3 Me, 7 CH_2, 4 CH, and 5 quaternary C-atoms, appeared in the ^{13}C-NMR spectrum. One carbonyl group (δ(C): 216.62), one aldehyde group (δ(H) 9.76; δ(C) 189.65), and one trisubstituted C=C bond (δ(H) 6.88; δ(C): 155.57 and 147.35) accounted for three degrees of unsaturation in **7**, and the remaining four degrees of unsaturation were assumed to indicate the presence of four rings. Analysis of the ^{1}H,^{1}H-COSY, HMQC (*Fig. 1*), and HMBC data permitted the establishment of three structural fragments *a* (C(1) to C(3) and C(18) to C(19)), *b* (C(6) to C(7) and C(11) to C(12)), and *c* (C(15) to C(17), drawn with bold bonds in *Fig. 1*. In the HMBC spectrum, the correlations Me(18)/C(3), C(4), and C(5), and the correlations CH(5)/C(4), C(7), C(18), and C(19) were observed, indicating that the partial structures *a* and *b* were also connected *via* CH(5) (δ(H) *ca.* 1.40; δ(C) 55.52). The connectivity between CH_2(7) and CH(15) *via* C(8) were established by the correlations CH_2(6)/C(8) and CH_2(7)/C(15); the correlations CH(12)/C(13), CH(17)/C(16), CH(17)/C(13), CH_2(11)/C(9), and CH(9)/C(8) indicated that the partial structures *b* and *c* were connected *via* CH(13) and CH(9). The correlations Me(20)/C(1), C(5), C(9), and C(10), and the correlations CH_2(2)/C(10) indicated that CH_2(1), CH(5), and C(9) were connected *via* the quaternary C(10), which bears the Me(20) group. The correlations Me(18)/C(3) and Me(19)/C(3) were indicative of a linkage between C(3) and C(4); the correlations of CH_2(12)/C(14) and CH(15)/C(14) also implied that C(8) and CH(13) were connected *via* CH_2(14). In the NOESY plot, the correlation Me(20)/Me(19) indicated that Me(20) and Me(19) were on the same side, and the correlations H–C(5)/H_α–C(1), H–C(9), and Me(18) indicated that H–C(5), H_α–C(1), H–C(9), and Me(18) were all on the same side. Hence, H–C(5) and H–C(9) were assumed to be in α-orientation as those of calliterpenone (**12**) [8][9].

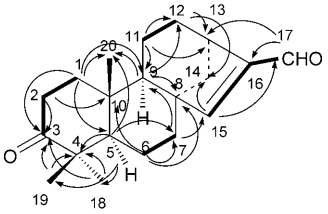


Fig. 1. *Selected HMBC correlations for compound* **7**

Compound **8** was isolated as a white amorphous powder. Its molecular formula was established as $C_{20}H_{32}O_3$ by HR-EI-MS (*m/z* 320.2334, calc. 320.2351). The NMR spectra (*Table 2*) were very similar to those of (3β,16α)-phyllocladane-3,16,17-triol (**14**) [8], with the exception of signals for a COOH and CH group instead of a 16-(hydroxymethyl)group and an oxygenated quaternary C-atom. The structure of **8** was identified as (3β,16α)-3-hydroxyphyllocladane-17-oic acid.

A *dd* at δ 2.59 was assigned to H–C(16), which was correlated with C(12), C(13), and C(14) in the HMBC spectrum. HMBC correlations between H–C(16) and H_b–C(15) (δ *ca.* 1.45), and *C*OOH revealed that the COOH group was located at C(16). The relative configuration at C(16) was established by the 2D-NOESY data. An NOE interaction between H–C(16) and H_β–C(11) allowed to locate the COOH group on the α side.

Compound **9** was isolated as white amorphous powder and exhibited the typical spectral features (see *Table 2*) of a phyllocladane derivative. Its HR-EI-MS established

Table 2. *^{1}H- and ^{13}C-NMR Data for Compounds* **7**–**9**. δ in ppm, J in Hz.

	7		**8**		**9**	
	δ(H)[a])	δ(C)[b])	δ(H)[c])	δ(C)[d])	δ(H)[c])	δ(C)[d])
H_α–C(1)	1.36–1.43 (*m*, 1 H)	37.42	0.91–0.96 (*m*, 1 H)	39.16	1.43–1.50 (*m*, 1 H)	37.74
H_β–C(1)	1.86–1.93 (*m*, 1 H)		1.73 (*dt*, *J* = 10.6, 3.7)		1.86–1.95 (*m*, 1 H)	
H_α–C(2) or CH_2(2)	2.33 (*ddd*, *J* = 18.4, 7.6, 4.3)	34.31	2.26–2.37 (*m*, 1 H)	27.82	2.37–2.45 (*m*, 1 H)	36.47
H_β–C(2)	2.56 (*ddd*, *J* = 18.4, 10.8, 7.3)		2.53–2.59 (*m*, 1 H)			
C(3) or H_α–C(3)		216.62	3.14 (*dd*, *J* = 11.6, 4.8)	79.69		219.81
C(4)		47.61		39.92		53.53
H_α–C(5)	1.36–1.43 (*m*, 1 H)	55.52	0.81 (*dd*, *J* = 11.6, 1.4)	57.07	1.99 (*dd*, *J* = 11.7, 1.4)	48.46
CH_2(6) or H_α–C(6)	1.53–1.64 (*m*, 2 H)	20.85	1.31–1.38 (*m*, 1 H)	21.19	1.59–1.67 (*m*, 1 H)	22.20
H_β–C(6)			1.52–1.58 (*m*, 1 H)		1.36–1.43 (*m*, 1 H)	
H_α–C(7) or CH_2(7)	1.36–1.43 (*m*, 1 H)	35.58	1.50–1.54 (*m*, 1 H)	41.94	1.66–1.71 (*m*, 1 H)	41.59
H_β–C(7)	1.86–1.93 (*m*, 1 H)					
C(8)		49.46		45.71		44.63
H_α–C(9)	1.25–1.33 (*m*, 1 H)	52.98	1.00 (*dd*, *J* = 11.2, 4.3)	58.00	1.27 (*dd*, *J* = 10.8, 6.0)	56.89
C(10)		36.96		38.69		37.81
H_α–C(11)	1.53–1.64 (*m*, 1 H)	19.14	1.52–1.58 (*m*, 1 H)	20.47	1.59–1.67 (*m*, 1 H)	20.91
H_β–C(11)	1.17–1.21 (*m*, 1 H)		1.31–1.38 (*m*, 1 H)		1.36–1.43 (*m*, 1 H)	
H_α–C(12)	1.53–1.64 (*m*, 1 H)	24.43	1.43–1.48 (*m*, 1 H)	33.31	1.43–1.50 (*m*, 1 H)	27.85
H_β–C(12)	1.46–1.52 (*m*, 1 H)		1.59–1.65 (*m*, 1 H)		1.72–1.77 (*m*, 1 H)	
H_β–C(13)	2.90–2.95 (*m*, 1 H)	36.96	2.26–2.37 (*m*, 1 H)	41.04	1.86–1.95 (*m*, 1 H)	45.00
H_α–C(14)	1.86–1.93 (*m*, 1 H)	53.65	1.05 (*dd*, *J* = 12.3, 3.2)	49.83	1.10 (*d*, *J* = 10.9)	49.53
H_β–C(14)	1.25–1.33 (*m*, 1 H)		1.59–1.65 (*m*, 1 H)		2.10–2.15 (*m*, 1 H)	
H–C(15) or CH_2(15)	6.88 (*s*)	155.57	2.33 (*ddd*, *J* = 13.5, 9.4, 2.1), 1.43–1.48 (*m*, 1 H)	37.95	2.08 (*d*, *J* = 14.4), 1.23 (*d*, *J* = 14.4)	45.20
C(16) or H–C(16)		147.35	2.59 (*dd*, *J* = 9.0, 5.6)	49.63		85.59
H–C(17), C(17), or CH_2(17)	9.76 (*s*)	189.65		181.41	3.70 (*d*, *J* = 14.2), 3.59 (*d*, *J* = 14.2)	66.17
Me(18) or CH_2(18)	1.07 (*s*)	21.87	0.78 (*s*)	16.46	3.59 (*d*, *J* = 11.2), 3.33 (*d*, *J* = 11.2)	68.08
Me(19)	1.10 (*s*)	26.14	0.97 (*s*)	28.93	0.90 (*s*)	18.07
Me(20)	0.93 (*s*)	15.07	0.97 (*s*)	15.67	1.09 (*s*)	15.34

[a]) Recorded in $CDCl_3$ at 500 MHz. [b]) Recorded in $CDCl_3$ at 125 MHz. [c]) Recorded in CD_3OD at 500 MHz. [d]) Recorded in CD_3OD at 125 MHz.

a molecular formula $C_{20}H_{32}O_4$ (*m/z* 336.2357, calc. 336.2301). The structure of **9** was established as (16α)-16,17,19-trihydroxyphyllocladan-3-one.

The NMR data of **9** revealed the presence of one carbonyl (δ(C) 219.81) and two CH_2OH groups (δ(H) 3.70 (*d*, 1 H), 3.59 (*d*, 2 H), 3.33 (*d*, 1 H); δ(C) 68.07, 66.17). Comparison of the NMR data with those of calliterpenone (**12**) [8][9] suggested that one of three tertiary Me groups of calliterpenone was replaced by a CH_2OH group in **9**. The HMBC data allowed to place one of the two CH_2OH groups (δ(H) 3.70, 3.59; δ(C) 66.17) at C(16), and the other (δ(H) 3.59, 3.33; δ(C) 68.07) at C(4). The following cross-peaks were observed: CH_2(17)/C(13), C(15), and C(16), and CH_2(18)/C(3), C(4), and C(5). An NOE interaction between Me(19) and Me(20) established that the hydroxymethyl group was assigned to C(18) and was on the α side.

Compound **10** was obtained as white amorphous powder. Its IR spectrum showed the presence of OH groups (3504, 3413 cm^{-1}) and a carboxylic acid (3000–2500 (br.), 1719 cm^{-1}). The molecular formula was determined as $C_{20}H_{34}O_5$ by HR-ESI-MS ($[M+H]^+$ at *m/z* 355.2485, calc. 355.2484). Its spectral data (*Table 3*) and comparison with those of calliterpenone (**12**) [8][9] established the structure of **10** as (16α)-4,16,17-trihydroxy-3,4-secophyllocladan-3-oic acid.

The ^{1}H-NMR of **10** indicated the presence of three tertiary Me groups (δ 1.06, 1.22, and 1.27) and an oxygenated CH_2 group (δ 3.53 and 3.70). The ^{13}C-NMR spectrum revealed 20 C-atoms, which consisted of 3 Me, 9 CH_2, 3 CH, and 5 quaternary C-atoms, two of which were oxygenated quaternary C-atoms at δ 75.51 and 84.34, by DEPT analysis. The NMR data of **10** were very similar to those of calliterpenone (**12**) [8][9], except for the presence of a carboxylic group at δ 175.93 and the oxygenated quaternary C-atom at δ 75.51 for **10** instead of a carbonyl at δ 216.23 and a quaternary C-atom at δ 46.4 for ring A. As no other unsaturated functions except for the COOH group (δ 175.93) appeared in the ^{1}H- and ^{13}C-NMR spectra, **10** should be a tricyclic structure, which means that ring A was cleaved. In the HMBC spectrum, cross-peaks were observed between H_a–C(1), H_b–C(1), and CH_2(2) and *C*OOH at δ 175.93, and between CH(5) and the oxygenated quaternary C-atom at δ 75.51. These indicated that ring A is open between C(3) and C(4), C(3) being oxidized to the COOH group, and C(4) being the oxygenated quaternary C-atom. NOE Correlations Me(20)/H_β–C(11) and H_a–C(15), as well as H–C(5)/H_α–C(9) established the β-configuration of Me(20) and the α-configuration of H–C(5) (see *Fig. 2*).

Compound **11** was also obtained as white amorphous powder that analyzed for $C_{20}H_{34}O_5$ by HR-ESI-MS ($[M+H]^+$ at *m/z* 355.2480, calc. 355.2484). The IR spectrum showed the presence of OH groups (3413 cm^{-1}) and a carboxylic acid (3000–2500 (br.), 1715 cm^{-1}). Comprehensive analysis of the ^{1}H,^{1}H-COSY, HMQC, and HMBC indicated that **11** had the same planar structure as **10**, and further spectral data

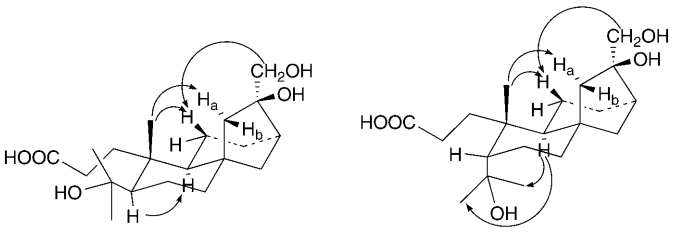


Fig. 2. *Selected NOE correlations for compounds* **10** *and* **11**

Table 3. *^{1}H- and ^{13}C-NMR Data for Compounds* **10**–**11**. δ in ppm, J in Hz.

	10		**11**	
	δ(H)[a])	δ(C)[b])	δ(H)[a])	δ(C)[b])
H_a–C(1)	2.36–2.41 (*m*, 1 H)	34.34	1.68 (*ddd*, *J* = 14.6, 11.8, 2.8)	38.58
H_b–C(1)	1.61–1.67 (*m*, 1 H)		1.49–1.61(*m*, 1 H)	
H_a–C(2)	2.53 (*ddd*, *J* = 15.4, 11.5, 4.3)	29.12	2.64 (*ddd*, *J* = 15.4, 11.8, 3.7)	32.76
H_bC(2)	2.18 (*ddd*, *J* = 15.4, 10.6, 5.0)		2.18 (*ddd*, *J* = 15.4, 7.7, 2.9)	
C(3)		175.93		174.56
C(4)		75.51		85.67
H_α–C(5)	1.42–1.52 (*m*, 1 H)	52.69	1.81 (*dd*, *J* = 11.1, 3.2)	54.79
H_α–C(6) or CH_2(6)	1.38–1.43 (*m*, 1 H)	25.06	1.49–1.61 (*m*, 2 H)	25.45
H_β–C(6)	1.42–1.52 (*m*, 1 H)			
H_α–C(7)	1.55–1.61 (*m*, 1 H)	41.76	1.49–1.61 (*m*, 1 H)	41.21
H_β–C(7)	1.42–1.52 (*m*, 1 H)			
C(8)		44.45		44.45
H_α–C(9)	1.29–1.36 (*m*, 1 H)	49.15	1.21–1.27 (*m*, 1 H)	57.19
C(10)		42.27		40.65
H_α–C(11)	1.29–1.36 (*m*, 1 H)	19.95	1.17–1.23 (*m*, 1 H)	20.74
H_β–C(11)	1.55–1.61 (*m*, 1 H)		1.39–1.44 (*m*, 1 H)	
H_α–C(12)	1.71–1.78 (*m*, 1 H)	27.66	1.71–1.79 (*m*, 1 H)	27.59
H_β–C(12)	1.38–1.43 (*m*, 1 H)		1.43–1.49 (*m*, 1 H)	
H_β–C(13)	1.85–1.90 (*m*, 1 H)	44.62	1.85–1.90 (*m*, 1 H)	44.70
H_α–C(14)	2.06–2.12 (*m*, 1 H)	48.99	2.11 (*ddd*, *J* = 10.9, 6.3, 2.5)	48.87
H_β–C(14)	1.05 (*d*, *J* = 11.2)		1.03 (*d*, *J* = 10.8)	
H_a–C(15)	2.00 (*d*, *J* = 14.2)	45.15	2.03 (*d*, *J* = 14.2)	44.94
H_b–C(15)	1.20 (*d*, *J* = 14.2)		1.22 (*d*, *J* = 14.2)	
C(16)		84.34		84.37
H_a–C(17)	3.70 (*d*, *J* = 10.5)	65.86	3.71 (*dd*, *J* = 10.5, 5.4)	65.79
H_b–C(17)	3.53 (*d*, *J* = 10.5)		3.55 (*dd*, *J* = 10.5, 5.5)	
Me(18)	1.22 (*s*)	28.22	1.36 (*s*)	26.54
Me(19)	1.27 (*s*)	34.10	1.43 (*s*)	32.15
Me(20)	1.06 (*s*)	19.80	1.11 (*s*)	17.40
OH–C(17)			3.60 (*t*, *J* = 5.4)	

[a]) Recorded in $CDCl_3$ at 500 MHz. [b]) Recorded in $CDCl_3$ at 125 MHz.

(*Table 3*) established that **11** is the 5-epimer of **10**, *i.e.*, (5β,15α)-4,16,17-trihydroxy-3,4-secophyllocladan-3-oic acid.

The chemical shift changes of C(2), C(4), and C(9) in going from **10** to **11** were due to the different configuration at C(5). NOE Interactions were observed between H–C(9) at δ *ca.* 1.25 and Me(18) and Me(19) (δ 1.43, 1.36) of **11**, whereas cross-peaks were observed between H–C(9) at δ *ca.* 1.33 and H–C(5) at δ 1.45 in **10** (*Fig. 2*).

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Experimental Part

General. All solvents used were of chemical grade (*Shanghai Chemical Plant*). TLC: precoated silica-gel *GF254* plates (*Qingdao Haiyang Chemical Plant*). Column chromatography (CC): silica gel (200–300 mesh), *MCI Gel CHP20P* (75–150 um; *Mitsubishi Kasei Chemical Industries*), *C18* reversed-phase silica gel (20–45 um; *Fuji Silysia Chemical Ltd.*), *Sephadex LH-20* (*Pharmacia*). Optical rotations: *Perkin-Elmer-341* polarimeter. UV Spectra: *Hewlett-Packard-8452A* diode-array spectrophotometer; λ_{max} (log ε) in nm. IR Spectra: *Bio-Rad-FTIR* spectrophotometer, $\tilde{\nu}$ in cm^{-1}. NMR Spectra: *Bruker-ACF-AMX-500* instrument; at 500 (^{1}H) and 125 MHz (^{13}C), $CDCl_3$, (D_6)acetone, and (D_4)methanol solns. with $SiMe_4$ as an internal standard. EI-MS: *Micromass-VG-7035* mass spectrometer at 70 Ev; in *m/z*.

Plant Material. The leaves of *Callicarpa furfuraceae* were collected from Mt. Tawai, Kinabatangan, Sabah, Malaysia, in 1998 and identified by *J. T. Pereira* and *L. Madani*. A voucher specimen SAN135178 was deposited at the herbarium of the *Forest Research Centre*, Sepilok, Sandakan, Sabah, Malaysia.

Extraction and Isolation. The leaves (900 g) of *C. furfuraceae* were extracted with hexane in a *Soxhlet* apparatus for three days. The extract was evaporated, the residue dissolved in acetone (50 ml), and the soln. filtered. The acetone-soluble portion (22 g) was then separated by CC (silica gel, hexane/AcOEt 1:0, 40:1, 20:1, 10:1, 5:1, 1:1, 1:2). *Fractions 1.1–1.7. Fr. 1.7* (4 g) was subjected to CC (*Sephadex LH-20*, EtOH): *Fr. 1.7.1–1.7.4. Fr. 1.7.3* was purified by CC (ODS, acetone/H_2O 9:1): **6** (16.0 mg) and **7** (4.0 mg).

The plant residue was reextracted with $CHCl_3$ in a *Soxhlet* apparatus for three days. The extract was evaporated and the residue dissolved in acetone (100 ml) and filtered. The acetone-soluble portion (40 g) was then separated by CC (silica gel, $CHCl_3$/MeOH 1:0, 50:1, 20:1, 10:1, and 5:1). *Fr. 2.1–2.5*. *Fr. 2.2* was subjected to CC (polyamide, acetone/H_2O 8:2; ODS, acetone/H_2O 7:3: *Fr. 2.2.1.–2.2.4. Fr. 2.2.2* was purified by CC (*Diol*, hexane/AcOEt 4:1): **1** (9.0 mg), **2** (12.3 mg), **3** (7.8 mg), and **5** (8.2 mg). *Fr. 2.2.3* was also purified by CC (*Diol*, hexane/AcOEt 8:1): **12** (2.5 g) and **13** (253.2 mg). *Fr. 2.3* was subjected to CC (polyamide, acetone/H_2O 8:2; ODS, acetone/H_2O 65:35): *Fr. 2.3.1–2.3.4. Fr. 2.3.2* was finally purified by CC (*Diol*, hexane/AcOEt 2:1): **4** (9.1 mg). *Fr. 2.3.3* was separated by CC (*Diol*, hexane/AcOEt 4:1): **8** (4.2 mg), **10** (28.2 mg), **11** (21.1 mg), and **14** (693 mg). *Fr. 2.4* was resubjected to CC (polyamide, acetone/H_2O 8:2; ODS, acetone/H_2O 6:4): *Fr. 2.4.1–2.4.4*. Purification by CC of *Fr. 2.4.3* (*Diol*, hexane/AcOEt 4:1) gave **9** (2.3 mg) and **14** (10.4 mg).

Sesamin-2-ol (=*5-[(1*S*,3*aR*,4*S*,6*aR*)-4-(1,3-Benzodioxol-5-yl)-tetrahydro-1*H*,3*H*-furo[3,4-*c*]furan-1-yl]-1,3-benzodioxol-4-ol*; **1**): White amorphous powder. $[\alpha]_D^{26.7} = -4.00$ ($c = 0.090$,$CHCl_3$). IR (KBr): 3018, 2937, 2850, 1605, 1517, 1442, 1365, 1251. ^{1}H- and ^{13}C-NMR: *Table 1*. EI-MS: 370 (M^+), 352, 197, 125, 71, 43.

Sesamin-2,2′-diol (*5,5′-[(1*S*,3*aR*,4*S*,6*aR*)-Tetrahydro-1*H*,3*H*-furo[3,4-*c*]furan-1,4-diyl]bis[1,3-benzodioxol-4-ol]*; **2**): White amorphous powder. $[\alpha]_D^{26.7} = +39.06$ ($c = 0.064$, $CHCl_3$). IR (KBr): 3018, 2966, 2856, 1612, 1515, 1465, 1363, 1269. ^{1}H- and ^{13}C-NMR: *Table 1*. EI-MS: 386 (M^+), 368, 350, 337, 151, 53.

(9α)-9-Methoxysesamin-2,2′-diol (*5,5′-[(1*S*,3*R*,3*aS*,4*S*,6*aR*)-Tetrahydro-3-methoxy-1*H*,3*H*-furo[3,4-*c*]furan-1,4-diyl]bis[1,3-benzodioxol-4-ol];* **3**). Oil. $[\alpha]_D^{26.7} = -38.97$ ($c = 0.078$, MeOH). IR (film): 3020, 2931, 1606, 1514, 1465, 1429, 1267, 1215. ^{1}H- and ^{13}C-NMR: *Table 1*. EI-MS: 416 (M^+), 398, 329, 189, 162, 77, 53.

Phylloclad-15-ene-3,17-dione (=*(5α,9α,10β)-Kaur-15-ene-3,17-dione*; **7**): Oil. $[\alpha]_D^{27.1} = +1.55$ ($c = 0.040$, $CHCl_3$). IR (film): 1698, 1655, 1457, 1262, 1100, 1024. UV (MeOH): 214 (3.20), 232 (3.32). ^{1}H- and ^{13}C-NMR: *Table 2*. EI-MS: 300 (M^+), 268, 215, 123, 69, 43.

(3β,16α)-3-Hydroxyphyllocladan-17-oic Acid (=*(3β,5α,9α,10β,16α)-3-Hydroxykauran-17-oic Acid*; **8**): White amorphous powder. $[\alpha]_D^{26.7} = -5.95$ ($c = 0.042$, MeOH). IR (KBr): 3426, 3000–2500 (br.), 1690, 1459, 1414, 1207, 1177, 1034, 1013. ^{1}H- and ^{13}C-NMR: *Table 2*. EI-MS: 320 (M^+), 302, 287, 233, 136, 121, 41.

(16α)-16,17,18-Trihydroxyphyllocladan-3-one (=*(4α,5α,9α,10β,16α)-16,17,18-Trihydroxykauran-3-one*; **9**): White amorphous powder. $[\alpha]_D^{26.7} = +29.13$ ($c = 0.023$, MeOH). IR (KBr): 3509, 3434, 3288, 1703, 1459, 1051. ^{1}H- and ^{13}C-NMR: *Table 2*. EI-MS: 336 (M^+), 318, 305, 275, 231, 151, 107, 55, 44.

(16α)-4,16,17-Trihydroxy-3,4-secophyllocladan-3-oic Acid (=*(1*R*,2*R*,4*aS*,6*R*,7*S*,9*aS*)-Decahydro-6-hydroxy-6-(hydroxymethyl)-2-(1-hydroxy-1-methylethyl)-1-methyl-4a,7-methano-4a*H*-benzocyclohep-*

tene-1-propanoic Acid; **10**): White amorphous powder. $[\alpha]_D^{26.7} = +14.15$ ($c = 0.282$, MeOH). IR (KBr): 3504, 3413, 3000–2500 (br.), 1719, 1644, 1462, 1410, 1385, 1311, 1213, 1038. ^{1}H- and ^{13}C-NMR: *Table 3*.

(5β,16α)-4,16,17-Trihydroxy-3,4-seco-phyllocladan-3-oic Acid (= *(1*R*,2*S*,4a*S*,6*R*,7*S*,9a*S*)-Decahydro-6-hydroxy-6-(hydroxymethyl)-2-(1-hydroxy-1-methylethyl)-1-methyl-4a,7-methano-4a*H*-benzocycloheptene-1-propanoic Acid*; **11**): White amorphous powder. $[\alpha]_D^{26.7} = +49.62$ ($c = 0.211$, MeOH). IR (KBr): 3413, 3000–2500 (br.), 1715, 1686, 1657, 1455, 1371, 1113, 1038. ^{1}H- and ^{13}C-NMR: *Table 3*.

REFERENCES

[1] R. S. Chen, J. S. Lai, T. S. Wu, *J. Chin. Chem. Soc.* **1986**, *33*, 329.
[2] C. Nishino, K. Kawazu, T. Mitsui, *Tetrahedron Lett*. **1971**, 1541.
[3] K. Kawazu, M. Inaba, T. Mitsui, *Agric. Biol. Chem.* **1967**, *31*, 494.
[4] L. M. Perry, J. Metzger, 'Medicinal Plants of East and Southeast Asia', MIT Press, Cambridge, 1980.
[5] S. F. Fonseca, J. D. P. Kampello, L. E. S. Barata, E. A. Reveda, *Phytochemistry* **1978**, *17*, 499.
[6] P. Andrew, S. W. Robert, *Tetrahedron* **1976**, *32*, 2783; S. C. Roy, K. K. Rana, C. Guin, *J. Org. Chem.* **2002**, *67*, 3242.
[7] A. B. Anderson, R. McCrindle, J. K. Tumbull, *Can. J. Chem*. **1975**, *53*, 1181.
[8] P. K. Agrawal, A. K. Singh, R. S. Bhakuni, *Indian J. Chem., Sect. B* **1996**, *35*, 803.
[9] P. K. Agrawal, V. Bishnoi, A. K. Singh, *Phytochemistry* **1995**, *39*, 929.

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