Nortriterpenoids and Lignans from the Fruit of *Schisandra chinensis*

Yong-Bo XUE,[a,b] Yan-Long ZHANG,[c] Jian-Hong YANG,[a] Xue DU,[a] Jian-Xin PU,*[,a] Wei ZHAO,[a,b] Xiao-Nian LI,[a] Wei-Lie XIAO,[a] and Han-Dong SUN*[,a]

[a] *State Key Laboratory of Phytochemistry and Plant Resources in West China, Kunming Institute of Botany, Chinese Academy of Sciences; Kunming 650204, P.R. China:* [b] *Graduate School of the Chinese Academy of Sciences; Beijing 100039, P.R. China: and* [c] *College of Life Sciences, Heilongjiang University; Harbin 150080, P.R. China.*
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Phytochemical investigation of the fruit of *Schisandra chinensis* led to the isolation of a schisanartane nortriterpenoid, schindilactone H (1); an 18-norschiartane bisnortriterpenoid, wuweizidilactone I (2); two tetrahydrofuran-type lignans, schinlignins A and B (18 and 19); and three dibenzyl butane-type lignans, schineolignins A—C (20—22), together with 16 known compounds. The structures of these new compounds were elucidated on the basis of extensive analysis of spectroscopic data.

Key words *Schisandra chinensis*; nortriterpenoid; lignan

Plants of the genus *Schisandra* (Schisandraceae) have attracted much attention due to a variety of pharmacologic effects such as antihepatitis, antitumor, and anti-human immunodeficiency virus-1 (HIV-1) bioactivities, and many species of this genus have been used as traditional Chinese medicine.[1—7] Previous phytochemical studies showed that this family is a rich sources of lignans[8—12] and lanostane- and cycloartane-type triterpenoids.[6,13—15] During the present decade, considerable efforts of our group have been devoted to discovering structurally interesting and bioactive natural products from the *Schisandra* species. These resulted in the discovery of highly oxygenated, polycyclic, fused heterocyclic triterpenoid and nortriterpenoid derivatives endowed with a different carbon skeleton, most of which can be related biogenetically to cycloartane precursors.[16]

Schisandra chinensis (TURCZ.) BAILL., a climbing plant widely distributed in the region of the Russian Far East, Korea, Japan, and northeastern China, is often considered to be an example of a medicinal plant used as sedative and tonic agents in traditional Chinese medicine.[17] As part of our continuing investigation of the natural products from *Schisandra* species, we phytochemically studied the fruit of *S. chinensis*. This work resulted in the isolation of seven new compounds, including a schisanartane nortriterpenoid, schindilactone H (**1**); an 18-norschiartane bisnortriterpenoid, wuweizidilactone I (**2**); two tetrahydrofuran-type lignans, schinlignins A and B (**18** and **19**); and three dibenzyl butane-type lignans, schineolignins A—C (**20**—**22**), together with 16 known compounds. To our knowledge, this is the first report on highly oxygenated *Schisandra* nortriterpenoids[16] featuring schisanartane, 18-norschiartane, 18(13→14)-abeo-schiartane, and pre-schisanartane skeletons from the fruit of *S. chinensis*. This paper deals with the isolation and structural elucidation of these new compounds on the basis of their spectroscopic data.

Results and Discussion

Phytochemical studies on the 70% aqueous acetone extract of the fruit of *S. chinensis* led to the isolation of seven new compounds, including schindilactone H (**1**), wuweizidilactone I (**2**), schinlignins A and B (**18** and **19**), and schineolignins A—C (**20**—**22**), together with 16 known compounds, called lancifodilactone N (**3**),[18] schindilactone B (**4**),[19] lancifodilactone C (**5**),[20] lancifodilactone L (**6**),[18] henridilactone D (**7**),[21] lancifodilactone I (**8**),[18] wuweizidilactone A (**9**),[22] wuweizidilactone B (**10**),[22] wuweizidilactone

Table 1. ^{1}H- and ^{13}C-NMR Data of Compounds **1**—**2** (500, 125 MHz, in C_5D_5N, δ in ppm, J in Hz)

Position	**1**		**2**	
	δ_H	δ_C	δ_H	δ_C
1		108.3 s	4.32 (br s)	81.8 d
2α	3.18 (s)	44.0 t	2.78 (d, 18.2)	35.3 t
2β	3.20 (s)		3.05 (dd, 5.3, 18.2)	
3		173.2 s		174.7 s
4		83.8 s		84.0 s
5	2.31[a)]	58.6 d	2.57 (dd, 3.5, 13.0)	54.5 d
6α	2.30[a)]	23.6 t	1.94[a)]	30.5 t
6β	2.16[a)]		1.64 (m)	
7	7.11 (t like, 4.3)	135.2 d	5.64 (d, 8.1)	70.3 d
8		138.1 s	2.91 (s)	46.6 d
9		82.1 s		78.3 d
10		96.4 s		98.0 s
11α	1.65 (m)	39.7 t	2.24 (d, 8.3)	42.9 t
11β	2.16[a)]		2.24 (d, 8.3)	
12α	1.45 (m)	31.5 t	4.22 (d, 8.3)	70.4 d
12β	1.85 (m)			
13		50.6 s		92.3 s
14		198.8 s		70.0 s
15		99.3 s	3.74 (s)	55.2 d
16α		45.7 d	2.14 (m)	27.1 t
16β	2.79 (d, 7.9)		1.94[a)]	
17		220.3 s	2.91[a)]	43.0 d
18	0.97 (s)	26.4 q		
19α	2.60 (d, 16.5)	40.9 t	2.29[a)]	45.8 t
19β	2.80 (d, 16.5)		2.29[a)]	
20	2.59 (m)	44.8 d	2.63[a)]	36.5 d
21	1.22 (d, 6.9)	14.8 q	0.85 (d, 6.8)	11.7 q
22	2.90 (m)	40.3 d	3.92 (d, 8.6)	84.4 d
23	5.23 (br s)	74.9 d	4.99 (br s)	81.2 d
24	4.76 (s)	72.6 d	7.18 (br s)	147.1 d
25		77.0 s		130.6 s
26		177.7 s		174.3 s
27	2.11 (s)	18.1 q	1.76 (br s)	10.7 q
29	1.34 (s)	24.4 q	0.98 (s)	21.7 q
30	1.27 (s)	29.0 q	1.18 (s)	28.0 q
1′				166.1 s
2′				127.5 s
3′			5.87 (m)	140.1 d
4′			2.09 (s)	20.9 q
5′			2.02 (d, 7.2)	15.9 q

a) Signals were overlapped.

* To whom correspondence should be addressed. e-mail: pujianxin@mail.kib.ac.cn; hdsun@mail.kib.ac.cn

C (**11**),[22] wuweizidilactone H (**12**),[23] pre-schisanartanin A (**13**),[19] pre-schisanartanin B (**14**),[23] kadcoccilactone Q (**15**),[24] kadsuphilactone B (**16**),[25] pre-gomisin (**23**),[26] and *meso*-dihydroguaiaretic acid (**24**).[27] This paper deals with the isolation and structural elucidation of these new compounds. The known compounds, especially these highly oxygenated nortriterpenoids that our group previously isolated from the stems and leaves of *S. chinensis*, were determined by comparing their TLC behaviors and NMR data with those reported in the literature. The new compounds were characterized on the basis of comprehensive spectroscopic analysis.[19,22,23]

Schindilactone H (**1**) was obtained as amorphous powder. Its empirical formula $C_{29}H_{34}O_{11}$ was characterized based on the high-resolution electrospray ionization (ESI)-MS pseudo-molecular ion peak at *m*/*z* 581.2011 ($[M+Na]^+$, $C_{29}H_{34}O_{11}Na$, Calcd 581.1198) and the ^{13}C-NMR spectroscopic data (Table 1), requiring 13 degrees of unsaturation. The IR spectrum of **1** indicated strong absorption bands for OH (3441 cm^{-1}) and carbonyl (1738, 1779 cm^{-1}) functional groups. The ^{1}H- and ^{13}C-NMR spectra revealed that **1** contained 29 carbons, including five methyls (one secondary and four tertiary), five methylenes, seven methines (two oxygenated and one olefinic), and 12 quaternary carbons (two esters, two carbonyls, six oxygenated, and one olefinic). These suggest that compound **1** requires the presence of eight rings to satisfy the observed degrees of unsaturation and has a highly oxygenated nortriterpenoid with a schisanartane skeleton.[19] The structural determination of **1** was conducted by careful analyses of the 1D- and 2D-NMR spectroscopic data and comparison with those of schindilactone A (**17**).[19] Comprehensive analysis of the ^{1}H- and ^{13}C-NMR data of **1** revealed that it had many structural similarities (rings A—G) to the NMR data reported for **17**. The obvious difference between **1** and **17** was the presence of an oxygenated quaternary carbon at C-25 in **1** rather than an aliphatic methine in **17**. In the heteronuclear multiple bond correlation (HMBC) spectra of **1**, the strong correlations from H_3-27 (δ_H 2.11) to C-24 (δ_C 72.6), C-25 (δ_C 77.0), and C-26 (δ_C 177.7), and from H-24 (δ_H 4.76) to C-25, C-26, and C-27 (δ_C 18.1) indicated the presence of a five-membered α-hydroxy-α-methyl-γ-lactone ring.[19] Moreover, the ^{1}H–^{1}H correlation spectroscopy (COSY) correlations of H_3-21/H-20/H-22/H-23/H-24 observed in compound **1** (Fig. 1) also

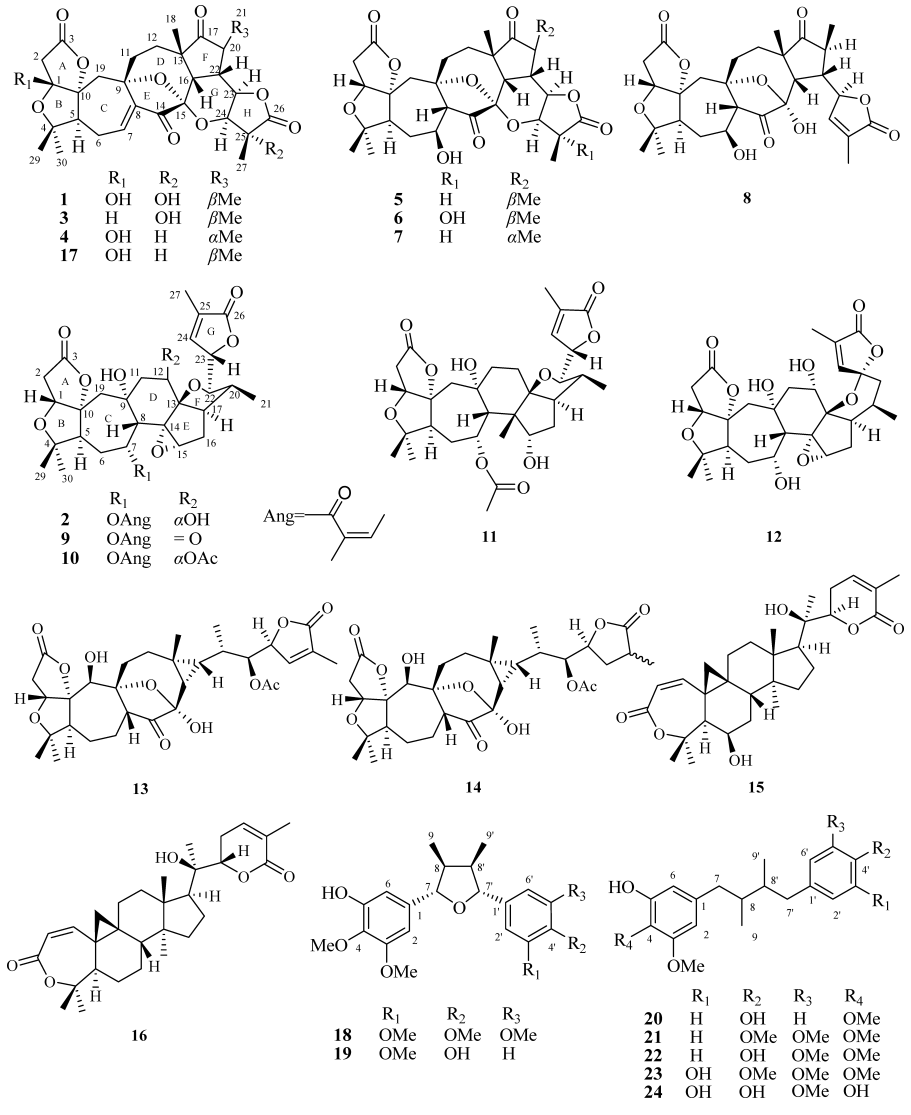


Chart 1

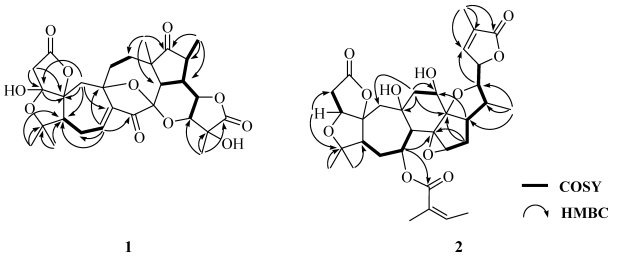
supported the above conclusion. Thus the planar structure of **1** was established as shown.

Its relative configuration was determined by a rotating frame Overhauser enhancement spectroscopy (ROESY) experiment and by comparing the NMR data with those of schindilactone A.[19] In the ROESY spectra, the strong correlations of H_3-18/H-16, H-16/H-22, H-23/H-20, and H-24/H-23 indicated that H-16 and H-22 were β-oriented and H-23 and H-24 were α-oriented. The relative stereochemistry of H_3-27 was determined to be β-oriented and OH-25 was α-oriented, on the basis of the ROESY correlation observed between H_3-27 (δ_H 2.11) and H-16 (δ_H 2.79). Hence all of the other chiral centers of **1** were identical to those of **17**. In addition, a computer-generated 3D structure was obtained using Chem 3D Ultra V 8.0, with MM2 force-field calculations for energy minimization (Fig. 2), and further supported the well-defined ROESY correlations observed for each of these proton pairs.

Wuweizidilactone I (**2**), obtained as amorphous white powder, had the molecular formula $C_{33}H_{42}O_{11}$, as derived from the high-resolution ESI-MS pseudo-molecular ion peak at *m/z* 637.2734 ($[M+Na]^+$, $C_{33}H_{42}O_{11}Na$, Calcd 637.2624) and 1D-NMR data. The ^{1}H- and ^{13}C-NMR spectra of **2** (Table 1) showed the coexistences of four tertiary and two secondary methyls, five methylenes, four aliphatic methines, six oxygenated methines, five oxygen-bearing quaternary carbons, three ester groups, and two trisubstituted double bonds. This observation suggested that **2** was likely to be an 18-norschiartane-type bisnortriterpenoid that was substituted by an angeloyl group.[22] This assumption was subsequently confirmed by conducting a set of 2D-NMR spectroscopic experiments (including ^{1}H–^{1}H COSY, heteronuclear single quantum coherence (HSQC), HMBC, and ROESY spectra) that provided data for the unequivocal assignment of all proton and carbon signals (Table 1). The planar structure of **2** was constructed by analyzing the 2D-NMR data obtained and by comparing these results with the NMR data obtained for wuweizidilactone B (**10**).[22] The close similarities of the NMR spectroscopic data for rings A—C and E—H with those of **10** suggested that **2** has similar substructures, except for the differences in the chemical shifts at C-11, C-12, and C-13 of ring D. The substructure of ring D was revealed by the ^{1}H–^{1}H COSY spin system of H_2-11/H-12 and HMBC correlations (Fig. 1) to be H_2-11 (δ_H 2.24) with C-9 (δ_C 78.3), C-12 (δ_C 70.4), C-13 (δ_C 92.3), and C-19 (δ_C 45.8), and of H-17 (δ_H 2.91) with C-12, coupled with the upfield shifts of H-12 from δ_H 5.44 ppm in **10** to δ_H 4.22 ppm in **2**. The presence of an angeloyl group at C-7 was evident from the HMBC correlation of H-7 (δ_H 5.64) with carbonyl carbon C-1′ (δ_C 166.1). Furthermore, the ^{1}H–^{1}H COSY correlations (Fig. 1) of H-15/H-16/H-17 and HMBC correlations of H-15 (δ_H 3.74) with C-13, C-14, C-16, and C-17 indicated that there was also an epoxy ring between C-14 and C-15, which was very close to that of **10**. Thus the gross structure of **2** was established to be as shown.

The relative stereochemistry of **2** was mainly established by means of ROESY experiments and by comparison of its spectroscopic data with those of **10**. Biogenetically, this type of nortriterpenoid is derived from cycloartane triterpenes.[28] Therefore H-5 was tentatively assigned to be α-oriented. The same relative stereochemistry of rings A—G in **2** as in **10** was deduced from the similar carbon and proton chemical shifts and ROESY correlations found in **2** (Table 1, Fig. 3). The strong ROESY correlations of H-15 with H-7 showed the α-orientation of the epoxy ring between C-14 and C-15. The α-orientation of OH-12 was deduced from the key correlation between H-12 (δ_H 4.22) and H-20 (δ_H 2.63), as shown in the computer-generated 3D drawing (Fig. 3), which was minimized using the MM2 force field. Therefore compound **2** was determined to be wuweizidilactone I.

Schinlignin A (**18**), obtained as yellow oil, had the molecular formula $C_{23}H_{30}O_7$, as derived from the high-resolution ESI-MS pseudo-molecular ion peak at *m/z* 419.2082 ($[M+H]^+$, $C_{23}H_{31}O_7$, Calcd 419.2069), acquiring nine degrees of unsaturation. The IR spectrum showed the presence of an OH group (3425 cm^{-1}), aromatic moieties (1593, 1509, 1461 cm^{-1}), and C–O–C functionality (1127 cm^{-1}). The ^{1}H- and ^{13}C-NMR (Tables 2, 3) and distortionless enhancement by polarization transfer (DEPT) spectra of **18** showed signals of showed four aromatic protons at (δ_H 6.57, d, J=1.8 Hz, 1H), (δ_H 6.72, d, J=1.8 Hz, 1H), and (δ_H 6.66, s, 2H), two methyls (δ_H 1.02, d, J=6.5 Hz, H_3-9, 9′), two oxygenated



1 **2**

Fig. 1. ^{1}H–^{1}H COSY and Selected HMBC Correlations of **1**—**2**

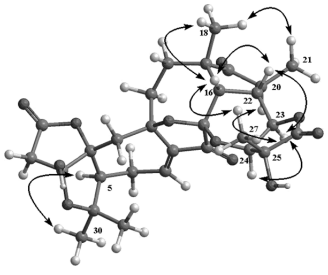


Fig. 2. Computer-Generated Molecular Model Showing Key ROESY Correlations of **1**

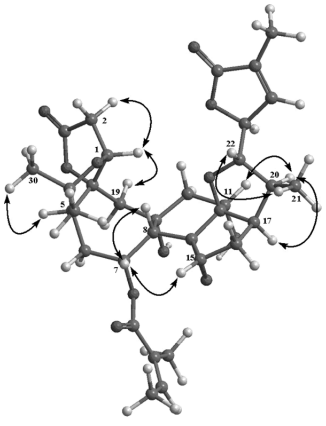


Fig. 3. Computer-Generated Molecular Model Showing Key ROESY Correlations of **2**

Table 2. ^{1}H-NMR [500 MHz, δ_H, (J, Hz)] of Schinlignins A and B (**18** and **19**) and ^{1}H-NMR [400 MHz, δ_H, (J, Hz)] of Schineolignins A—C (**20**—**22**) in $CDCl_3$

Position	**18**	**19**	**20**	**21**	**22**
2	6.57 (d, 1.8)	6.59 (d, 1.5)	6.22 (br s)	6.23 (d, 1.7)	6.23 (d, 1.7)
6	6.72 (d, 1.8)	6.72 (d, 1.5)	6.40 (d, 1.5)	6.43 (d, 1.7)	6.43 (d, 1.7)
7	4.40[a] (d, 6.3)	4.51[a] (d, 6.8)	2.19—2.23 (m, H_a), 2.68—2.73[b] (m, H_b)	2.24—2.31[b] (m, H_a), 2.68—2.76[b] (m, H_b)	2.22—2.31[b] (m, H_a), 2.68—2.75[b] (m, H_b)
8	2.31—2.35 (m)	2.30—2.37 (m)	1.73—1.75 (m)	1.76 (m)	1.72—1.77 (m)
9	1.02 (d, 6.5)	1.08[a] (d, 6.6)	0.83[a] (d, 6.5)	0.84 (d, 6.8)	0.84[a] (d, 6.3)
2′	6.66[b] (s)	7.00 (s)	7.02[b] (d, 8.3)	6.69 (dd, 1.8, 8.0)	6.67 (dd, 7.8, 1.5)
3′			6.75[b] (d, 8.3)	6.78 (d, 8.0)	6.82 (d, 7.8)
5′		6.94[b] (s)	6.75[b] (d, 8.3)		
6′	6.66[b] (s)	6.94[b] (s)	7.02[b] (d, 8.3)	6.66 (d, 1.8)	6.64 (br s)
7′	4.48[a] (d, 6.3)	4.49[a] (d, 6.8)	2.28—2.32 (m, H_a), 22.68—2.73[b] (m, H_b)	2.24—2.31[b] (m, H_a), 2.68—2.76[b] (m, H_b)	2.22—2.31[b] (m, H_a), 2.68—2.75[b] (m, H_b)
8′	2.31—2.35 (m)	2.30—2.37 (m)	1.73—1.75 (m)	1.76 (m)	1.72—1.77 (m)
9′	1.02 (d, 6.5)	1.03[a] (d, 6.6)	0.82[a] (d, 6.5)	0.84 (d, 6.8)	0.85[a] (d, 5.8)
MeO-3	3.85 (s)	3.88 (s)	3.83 (s)	3.83 (s)	3.81 (s)
MeO-4	3.88 (s)	3.91[a] (s)	3.89 (s)	3.86[a,b] (s)	3.86[a] (s)
OH-5					5.76 (s)
MeO-3′	3.86[b] (s)	3.92[a] (s)			
MeO-4′	3.83 (s)			3.86[a,b] (s)	5.52 (s)
MeO-5′	3.86[b] (s)			3.87[a] (s)	3.87[a] (s)

a) Assignments may be interchanged. *b*) Overlapped.

Table 3. ^{13}C-NMR [125 MHz, δ_C] of Schinlignins A and B (**18** and **19**) and ^{13}C-NMR [100 MHz, δ_C] of Schineolignins A—C (**20**—**22**) in $CDCl_3$

Position	**18**	**19**	**20**	**21**	**22**
1	138.4 s	138.7 s	138.4 s	138.2 s	138.2 s
2	102.4 d	102.4 d	104.9 d	104.7 d	104.7 d
3	152.2 s	152.2 s	152.0 s	152.0 s	152.0 s
4	134.7 s	134.7 s	133.8 s	133.4 s	133.4 s
5	149.2 s	149.1 s	148.8 s	148.8 s	148.8 s
6	105.8 d	105.8 d	108.6 d	108.5 d	108.5 d
7	87.2[a] d	87.3[a] d	39.2[a] d	39.4 t	39.3 t
8	44.0[a] d	44.4[a] d	39.4[a] d	39.0[a] d	39.2[a] d
9	13.0[a] q	13.2[a] q	16.3[a] q	16.2[a] q	16.2[a] q
1′	137.9 s	133.9 s	133.8 s	133.8 s	133.7 s
2′	103.2 d	109.2 d	130.1 d	120.9 d	121.6 d
3′	153.1 s	145.1 s	115.1 d	110.9 d	113.9 d
4′	137.1 s	146.5 s	153.6 s	147.0 s	143.5 s
5′	153.1 s	114.1 s	115.1 s	148.6 s	146.3 s
6′	103.2 d	119.4 d	130.1 d	112.1 d	111.4 d
7′	87.4[a] d	87.2[a] d	38.5[a] t	38.7 t	38.8 t
8′	44.4[a] d	44.1[a] d	38.9[a] d	39.0[a] d	38.9[a] d
9′	13.0[a] q	12.6[a] q	16.0[a] q	16.2[a] q	16.2[a] q
MeO-3	55.7 q	55.8[a] q	55.8 q	55.7[a] q	55.7[a] q
MeO-4	60.9 q	60.9 q	61.0 q	60.9 q	60.9 q
MeO-3′	56.0 q	55.7[a] q			
MeO-4′	60.8 q			55.8[a] q	
MeO-5′	56.0 q			55.8[a] q	55.8[a] q

a) Assignments may be interchanged.

methines (δ_H 4.40, 4.48, d, J=6.3 Hz, each, H-7, 7′), and two aliphatic methines (δ_H 2.33, m, each, H-8, 8′), which pointed to a tetrahydrofuran moiety.[29] Combination analysis of 1D- and 2D-NMR spectra revealed that **18** had a close resemblance to *rel*-(7*S*,8*S*,7′*R*,8′*R*)-3,3′,4,4′,5,5′-hexamethoxylignan,[30] known as a natural product from *Aristolochia birostris*. The main difference was the appearance of an OH substitute at C-5 in **18** (Fig. 4). The HMBC correlations of H-2 (δ_H 6.57) and H-6 (δ_H 6.72) to C-3 (δ_C 152.2) and C-7 (δ_C 87.2), and of H-2′ (δ_H 6.66) and H-6′ (δ_H 6.66) to C-3′ (δ_C 153.1) and C-7′ (δ_C 87.4) implied that the two aromatic

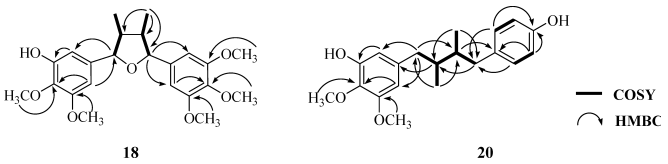


Fig. 4. ^{1}H–^{1}H COSY and Selected HMBC Correlations of **18** and **20**

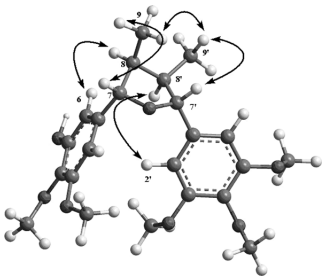


Fig. 5. Computer-Generated Molecular Model Showing Selected Key ROESY Correlations of **18**

rings are attached to the C-7 and C-7′ of a tetrahydrofuran moiety (Fig. 4). The HMBC correlation from methoxy functionalities (δ_H 3.83, 3H; δ_H 3.85, 3H; δ_H 3.86, 6H; δ_H 3.88, 3H) to C-3′, C-4′, C-5′, C-3, and C-4 suggested that the coexistence of five methoxy groups should be attached to C-3′, C-4′, C-5′, C-3, and C-4 of the aromatic rings (Fig. 4), respectively. Moreover, the key HMBC correlations from H-6 (δ_H 6.72) to C-2, C-4, and C-5 (δ_C 149.2) and H-2 (δ_H 6.57) to C-6, C-3, and C-4 implied that the OH group was attached to C-5.

The relative configuration of the tetrahydrofuran ring was determined to be 7,8-*trans*-8,8′-*cis*-7′,8′-*trans* according to the chemical shifts of H_3-9 (δ_H 1.02, d, J=6.5 Hz) and H-7 (δ_H 4.40, d, J=6.3 Hz) in **18**, which are consistent with those reported in the literature.[31—34] The strong ROESY correlations (Fig. 5) between H_3-(9/9′) and H-(7/7′) further com-

firmed the above conclusion. Thus the structure of **18** was determined to be as shown.

Schinlignin B (**19**) was obtained as yellow oil, and the molecular formula $C_{21}H_{26}O_6$ was derived by the high-resolution ESI-MS pseudo-molecular ion peak at *m/z* 397.1629 ($[M+Na]^+$, $C_{21}H_{26}O_6Na$, Calcd 397.1627) and the ^{13}C-NMR spectroscopic data (Table 3). Careful comparison of the NMR spectroscopic data of **19** and **18** (Tables 2, 3) indicated that **19** was also a metabolite with a tetrahydrofuran ring. The main difference between them was the presence of an OH group at C-4′ and an aromatic proton at C-5′ in **19**, instead of MeO-4′ and MeO-5′ in **18**, and the presence of an OH group at C-4′ and an aromatic proton at C-5′ in **19**. The HMBC correlations from H-2′ and H-6′ to C-1′ (δ_C 133.9), C-4′ (δ_C 146.5), and C-7′ (δ_C 87.2), and from H-2′ and H-5′ to C-3′ (δ_C 145.1) and C-4′, as well as the ^1H–^1H COSY spin system H-5′/H-6′ and ROESY correlation between H-2′ and MeO-3′, further confirmed the above conclusion. The relative stereochemistry of **19** was deduced as described in compound **18**. Thus the structure of **19** was determined to be as shown.

Schineolignin A (**20**) was obtained as a white, amorphous solid. Its molecular formula was determined to be as $C_{20}H_{26}O_4$ based on the high-resolution ESI-MS pseudo-molecular ion peak at *m/z* 353.1721 ($[M+Na]^+$, $C_{20}H_{26}O_4Na$, Calcd 353.1728). The strong IR absorption bands showed the presence of an OH group (3423 cm^{-1}) and aromatic rings (1594, 1513, 1459 cm^{-1}). The ^1H- and ^{13}C-NMR spectra (Tables 2, 3) displayed the appearance of four methyl groups (including two methoxy moieties), two methylene groups, eight methine groups (including six olefinic), and six olefinic quaternary carbons. This suggested that **20** is a derivative of 1,4-biphenyl-2,3-dimethylbutane-type lignan.[35] Detailed analysis of the NMR data of **20** indicated that it is an analogue of pregomisin (**23**).[26] In the ^1H-NMR spectra (Table 2), four aromatic proton signals (δ_H 7.02, 2H, d, J=8.3 Hz, H-2′, H-6′; δ_H 6.75, 2H, J=8.3 Hz, d, H-3′, H-5′), together with the correlations of H-2′/H-3′ and of H-4′/H-5′ in the ^1H–^1H COSY spectrum indicated the presence of a 1,4-bisubstituted aromatic moiety in **20**. The remaining aromatic proton signals at δ_H 6.22 (1H, br s, H-2) and δ_H 6.40 (1H, d, J=1.5 Hz, H-6) suggested the existence of a 1,3,4,5-tetrasubstituted aromatic moiety. The strong HMBC correlations of two methoxy groups to C-3 and C-4 indicated that the methoxys should be substituted at C-3 and C-4, respectively.

Schineolignins B and C (**21** and **22**) were obtained as white, amorphous solids. Their molecular formulae were $C_{22}H_{30}O_5$ and $C_{21}H_{28}O_5$, deduced based on the high-resolution ESI-MS pseudo-molecular ion peak at *m/z* 375.2177 ($[M+H]^+$, $C_{22}H_{31}O_5$, Calcd 375.2171) and *m/z* 361.2018 ($[M+H]^+$, $C_{21}H_{29}O_5$, Calcd 361.2014), respectively. The IR spectra of **21** and **22** displayed absorption bands similar to that of schineolignin A (**20**). The structures of schineolignins B and C (**21** and **22**) were determined on the basis of their spectral data (Tables 2, 3) and comparison with those of **20**. Careful analysis of the NMR spectroscopic data of **21** and **22** and comparison with those of **20** showed many similarities, except for the substitutes at C-3′, C-4′, and C-5′. In the HMBC spectrum, the strong correlations from MeO (δ_H 3.83, 3H; δ_H 3.86, 6H; δ_H 3.87, 3H, each s) of **21** to C-3, C-4, C-4′, and C-5′, and from MeO (δ_H 3.81, 3H; δ_H 3.86, 3H; δ_H 3.87, 3H, each s) of **22** to C-3, C-4, and C-5′, determined the positions of these methoxy groups in the structures of **21** and **22**, respectively.

The relative stereochemistry of compounds **20**—**22** could not be determined on the basis of ROESY spectrum because the C–C bonds can rotate randomly. Thus the structures of **20**—**22** were assigned to be schineolignins A—C.

Experimental

General Procedure Petroleum ether (PE, 60—90 °C), EtOAc, $CHCl_3$, Me_2CO, MeOH, and *i*-PrOH were of analytical grade and produced by Sinopharm Chemical Reagent Co., Ltd., China. Column chromatography (CC) was performed on silica gel (200—300 mesh; Qingdao Marine Chemical Inc., Qingdao, P. R. China), Lichroprep RP-18 gel (40—63 μm, Merck, Darmstadt, Germany), and Sephadex LH-20 (GE Healthcare, Sweden). Fractions were monitored with TLC, and spots were visualized by spraying with 8% H_2SO_4 in EtOH, followed by heating. Semipreparative HPLC was performed on an Agilent 1100 liquid chromatograph with a Zorbax SB-C_{18}, 9.4 mm×25 cm column. UV data were obtained using a UV-210A spectrometer. IR spectra were obtained on a Bio-Rad FtS-135 spectrophotometer with KBr pellets. MS were recorded on a VG Auto Spec-3000 spectrometer. NMR spectra were obtained on Bruker DRX-400 and Bruker DRX-500 instruments with tetramethylsilane (TMS) as an internal standard.

Plant Material The fruit of *S. chinensis* was collected in Dongning county, Heilongjiang province, P. R. China, in September 2008 and identified by Prof. Xi-Wen Li, Kunming Institute of Botany. A voucher specimen (No. 20081015) has been deposited in the Herbarium of the Kunming Institute of Botany, Chinese Academy of Sciences.

Extraction and Isolation The fruit of *S. chinensis* (3.9 kg) was air-dried at room temperature and pulverized, then extracted with 70% aqueous acetone (4×10 l) at room temperature to yield an extract. The extract was concentrated *in vacuo* to yield a residue (690 g), 650 g of which was suspended in water and successively partitioned with EtOAc and *n*-butanol. The solvent was evaporated under a vacuum to afford an EtOAc extract (233.5 g) and *n*-butanol extract (380 g). The EtOAc extract (220 g) was chromatographed on silica gel (1.8 kg, 100—200 mesh), eluted with a gradient system of $CHCl_3$/Me_2CO (1 : 0, 9 : 1, 8 : 2, 2 : 1, 1 : 1, 0 : 1) and yielded fractions 1—8. Fraction 2 (20.6 g) was further purified with repeated CC (silica gel, 200—300 mesh) eluted with petroleum ether/EtOAc and Sephadex LH-20 ($CHCl_3$/MeOH, 1 : 1) to give compounds wuweizidilactone A (**9**, 11 mg), wuweizidilactone B (**10**, 75 mg), wuweizidilactone C (**11**, 8 mg), and schinlignin A (**18**, 6 mg). Fraction 3 (12 g) was subjected to RP-18 and repeated CC (silica gel, 200—300 mesh) eluted with $CHCl_3$/EtOAc to give schineolignin A (**20**, 12 mg), schineolignin B (**21**, 9 mg), and pre-gomisin (**23**, 683 mg). Fraction 4 (33 g) was subjected to CC (silica gel, 200—300 mesh) eluted with petroleum ether/Me_2CO, followed by RP-18, and further purified with semipreparative HPLC (MeCN/H_2O, 42 : 58) to afford compounds schindilactone H (**1**, 130 mg), wuweizidilactone I (**2**, 13 mg), lancifodilactone N (**3**, 5 mg), schindilactone B (**4**, 6 mg), lancifodilactone C (**5**, 8 mg), and lancifodilactone L (**6**, 151 mg). Fraction 5 (6.5 g) was subjected to CC (silica gel, 200—300 mesh) eluted with $CHCl_3$/Me_2CO, followed by Sephadex LH-20, and further purified with semipreparative HPLC (MeOH/H_2O, 55 : 45) to yield henridilactone D (**7**, 20 mg), kadcoccilactone Q (**15**, 14 mg), and kadsuphilactone B (**16**, 54 mg). Fraction 6 (45.7 g) was subjected to CC (silica gel, 200—300 mesh) eluted with a system of $CHCl_3$/Me_2CO (20 : 1, 9 : 1, 6 : 1, 3 : 1, 1 : 1) to give fractions 6A—6E. Subsequently, fraction 6B (13.2 g) was purified by recrystallization and repeated CC (silica gel, 200—300 mesh) eluted with $CHCl_3$/Me_2CO to give compounds lancifodilactone I (**8**, 208 mg), wuweizidilactone H (**12**, 156 mg), and schinlignin B (**19**, 18 mg). Fraction 6D (8.0 g) was subjected to Sephadex LH-20 and CC (silica gel, 200—300 mesh) eluted with a system of petroleum ether/*i*-PrOH (15 : 1, 9 : 1, 4 : 1, 2 : 1, 1 : 1) and purified with semipreparative HPLC (MeOH/H_2O, 47 : 53) to yield compounds pre-schisanartanin A (**13**, 48 mg), pre-schisanartanin B (**14**, 53 mg), schineolignin C (**22**, 4 mg), and *meso*-dihydroguaiaretic acid (**24**, 5 mg).

Schindilactone H (**1**): Amorphous white powder; $[\alpha]_D^{19}$ +80.8 (c=0.20, CH_3OH); UV λ_{max} (MeOH) nm (log ε): 242 (3.32); IR (KBr) ν_{max} cm^{-1}: 3441, 2962, 2929, 1779, 1738, 1663, 1458, 1381, 1330, 1110, 1011; ^1H- and ^{13}C-NMR spectra: see Table 1; high-resolution ESI-MS *m/z* 581.2011 [$(M+Na)^+$; Calcd $C_{29}H_{34}O_{11}Na$, 581.1198, Δ +1.2 mmu].

Wuweizidilactone I (**2**): Amorphous white powder; $[\alpha]_D^{19}$ −23.8 (c=0.12, CH_3OH); UV λ_{max} (MeOH) nm (log ε): 213 (3.83); IR (KBr) ν_{max} cm^{-1}:

3456, 2969, 2926, 1761, 1719, 1644, 1629, 1455, 1439, 1385, 1333, 1229, 1150, 1129, 1064, 1040; ^{1}H- and ^{13}C-NMR spectra: see Table 1; high-resolution ESI-MS *m/z* 637.2734 [(M+Na)$^+$; Calcd $C_{33}H_{42}O_{11}Na$, 637.2624, Δ +0.9 mmu].

Schinlignin A (**18**): Yellow oil; $[\alpha]_D^{26.5}$ −6.9 (*c*=0.18, CH_3OH); UV λ_{max} (MeOH) nm (log ε): 192 (4.05), 207 (4.62), 270 (3.31); IR (KBr) ν_{max} cm^{-1}: 3425, 2961, 2935, 1593, 1509, 1462, 1384, 1234, 1127, 1108, 1005; ^{1}H- and ^{13}C-NMR spectra: see Tables 2 and 3; high-resolution ESI-MS *m/z* 419.2082 [(M+H)$^+$; Calcd $C_{23}H_{31}O_7$, 419.2069, Δ +1.2 mmu].

Schinlignin B (**19**): Yellow oil; $[\alpha]_D^{26.7}$ −4.2 (*c*=0.24, CH_3OH); UV λ_{max} (MeOH) nm (log ε): 205 (4.56), 280 (3.52), 375 (3.14); IR (KBr) ν_{max} cm^{-1}: 3424, 2962, 2935, 1596, 1515, 1463, 1432, 1383, 1352, 1271, 1234, 1201, 1106, 1002; ^{1}H- and ^{13}C-NMR spectra: see Tables 2 and 3; high-resolution ESI-MS *m/z* 397.1629 [(M+Na)$^+$; Calcd $C_{21}H_{26}O_6Na$, 397.1627, Δ +0.2 mmu].

Schineolignin A (**20**): White amorphous solid; $[\alpha]_D^{19}$ −18.2 (*c*=0.26, CH_3OH); UV λ_{max} (MeOH) nm (log ε): 205 (4.34), 278 (3.28); IR (KBr) ν_{max} cm^{-1}: 3423, 2957, 2923, 1613, 1594, 1513, 1459, 1349, 1237, 1168, 1098, 1001; ^{1}H- and ^{13}C-NMR spectra: see Tables 2 and 3; high-resolution ESI-MS *m/z* 353.1721 [(M+Na)$^+$; Calcd $C_{20}H_{26}O_4Na$, 353.1728, Δ −0.8 mmu].

Schineolignin B (**21**): White amorphous solid; $[\alpha]_D^{23.4}$ +14.9 (*c*=0.34, CH_3OH); UV λ_{max} (MeOH) nm (log ε): 193 (3.83), 205 (4.36), 279 (3.20); IR (KBr) ν_{max} cm^{-1}: 3433, 2956, 2931, 1592, 1514, 1463, 1349, 1261, 1237, 1199, 1155, 1141, 1106, 1029, 1005; ^{1}H- and ^{13}C-NMR spectra: see Tables 2 and 3; high-resolution ESI-MS *m/z* 375.2177 [(M+H)]$^+$; Calcd $C_{22}H_{31}O_5$, 375.2171, Δ +0.6 mmu].

Schineolignin C (**22**): White amorphous solid; $[\alpha]_D^{23.4}$ −2.86 (*c*=0.31, CH_3OH); UV λ_{max} (MeOH) nm (log ε): 205 (4.44), 281 (3.26); IR (KBr) ν_{max} cm^{-1}: 3425, 2957, 2933, 1593, 1514, 1462, 1351, 1269, 1236, 1202, 1152, 1103, 1034, 1001; ^{1}H- and ^{13}C-NMR spectra: see Tables 2 and 3; high-resolution ESI-MS *m/z* 361.2018 [(M+H])$^+$; Calcd $C_{21}H_{29}O_5$, 361.2014, Δ +0.3 mmu].

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