Five New β-Carboline-Type Alkaloids from *Stellaria dichotoma* var. *lanceolata*

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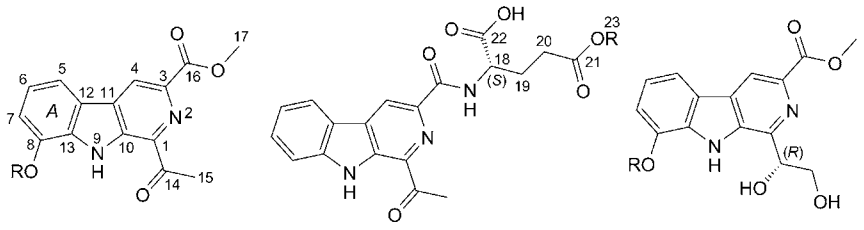
Five new β-carboline-type alkaloids, dichotomines F–J (**1**–**5**, resp.), along with nine known compounds, dichotomides I, III, V, and VII (**6**–**9**, resp.), stellarines A and C (**10**–**11**, resp.), dichotomine B (**12**), glucodichotomine B (**13**), and 1-acetyl-3-carboxy-β-carboline (**14**), were isolated from the roots of Chinese medicinal plant *Stellaria dichotoma* L. var. *lanceolata*. Their structures were determined by chemical and spectroscopic means. Compounds **12** and **13** exhibited moderate cytotoxicity.

Introduction. – The *Stellaria dichotoma* L. var. *lanceolata* BUNGE (Caryophyllaceae) is distributed in Ningxia and neighboring provinces of China. Its roots are being used as a traditional Chinese medicine (*Yin-Chai-Hu*) to treat fever, consumptive disease, and the infantile malnutrition syndrome [1]. Previous investigations of this species have led to isolation of a series of compounds including flavonoids, sterols, cyclic peptides, neolignans, phenylpropanoids, and β-carboline alkaloids [1–9], some of which displayed various biological properties, such as antifebrile [1–3], antiallergic [3], vasorelaxant [4], cytotoxic [5][6], antibacterial, antifungal, and anti-inflammatory activities [7][10]. As part of our ongoing studies on the chemical constituents of medicinal plants in the Caryophyllaceae [11–13], five new β-carboline alkaloids, dichotomines F–J[1]) (**1**–**5**, resp.), along with nine known compounds, **6**–**14**, were isolated from the roots of *S. dichotoma* var. *lanceolata* (*Fig. 1*). The cytotoxicities of **1**–**14** against human cancer cell lines Bel7402, SMMC-7721, HCT116, and H460 were evaluated. Here, the isolation, structure elucidation, and cytotoxic activities of these isolates are reported.

Results and Discussion. – *Structure Elucidation*. Compound **1** was isolated as yellow powder, presumably being endowed with a N function on the basis of TLC examinations by using *Dragendorff*'s reagent. The molecular formula $C_{15}H_{12}N_2O_4$ was deduced from the *quasi*-molecular-ion peak at *m*/*z* 307.0686 ($[M+Na]^+$; calc. 307.0689) in the HR-ESI-MS. The IR spectrum evidenced the presence of OH (3373 cm^{-1}), CO (1702 cm^{-1}), and aromatic groups (1437 cm^{-1}). Absorption maxima in the UV spectrum of **1** were observed at 385, 286, and 236 nm, suggesting the presence of a β-carboline chromophore [14][15].

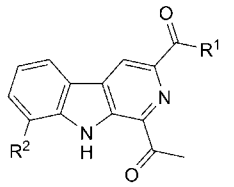
[1]) For systematic names, see *Exper. Part.*



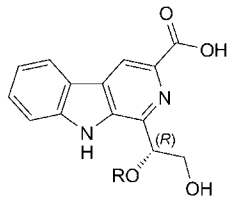
1 R = H
4 R = β-D-Glc

2 R = Me
3 R = H

5 R = β-D-Glc
5a R = H



	R^1	R^2
6	$MeOOC(CH_2)_2NH$	H
7	(*E*)-MeOOCCH=CHNH	H
8	(*Z*)-MeOOCCH=CHNH	OH
9	NH_2	β-D-Glc–O
10	NH_2	H
11	MeO	H
14	OH	H



12 R = H
13 R = β-D-Glc

Fig. 1. *Structures of* **1**–**14**

The ^{1}H-NMR ((D$_6$)DMSO) spectrum of **1** (*Table 1*) exhibited signals of a Me group at δ(H) 2.83 (*s*), of a MeO group at δ(H) 3.97 (*s*), a *singlet*, characteristic for a β-carboline skeleton at δ(H) 9.11 (*s*, H–C(4)), and two broad *singlet*s at δ(H) 10.13 and 11.75 (D$_2$O-exchangeable). Moreover, three vicinally coupled aromatic H-atom signals (δ(H) 7.93 (*d*, J = 8.0), 7.23 (*t*, J = 8.0), and 7.05 (*d*, J = 7.8)) were indicative of a trisubstituted aromatic ring *A* within the β-carboline unit. The ^{13}C-NMR spectrum of **1** (*Table 2*), along with the information obtained from the HSQC experiment, showed 15 C-atom signals. Besides the signals of a β-carboline alkaloid skeleton, there were those of one Me C-atom at δ(C) 25.5, of one MeO C-atom at δ(C) 52.2, and of two CO C-atoms at δ(C) 201.2 and 165.2, suggesting the presence of ketone and ester CO group. In the HMBC spectrum, a correlation was observed between the signals at δ(H) 10.13 (br. *s*) and δ(C) 143.4 (C(8)), indicating the presence of a phenolic OH group at C(8) (*Fig. 2*). Furthermore, the correlations between the signals at δ(H) 2.83 (Me(15)), and those at δ(C) 135.3 (C(1)) and 201.2 (C(14)), as well as between the signals at δ(H) 3.97 (Me(17)), and those at δ(C) 135.7 (C(3)) and 165.2 (C(16)) suggested that the Ac and COOMe groups were at C(1) and C(3), respectively (*Fig. 2*). Thus, the chemical structure of **1** was deduced as shown in *Fig. 1* and named dichotomine F.

Compounds **2**–**5** were also identified as β-carboline derivatives, since they all were found to display the same characteristic UV- and IR-spectroscopic data as compound **1**, and they also showed positive responses toward *Dragendorff*'s reagent. Compound **2**

Table 1. *^{1}H-NMR Spectroscopic Data for the Isolated β-Carboline Derivatives* **1**–**5** (500 MHz, (D_6)DMSO, δ in ppm, J in Hz). Atom numbering as indicated in *Fig. 1*.

	1	**2**	**3**	**4**	**5**
H–C(4)	9.11 (*s*)	9.11 (*s*)	9.08 (*s*)	9.19 (*s*)	8.83 (*s*)
H–C(5)	7.93 (*d*, *J* = 8.0)	8.46 (*d*, *J* = 8.0)	8.44 (*d*, *J* = 7.5)	8.17 (*d*, *J* = 8.0)	8.06 (*d*, *J* = 7.8)
H–C(6)	7.23 (*t*, *J* = 8.0)	7.35 (*t*, *J* = 7.8)	7.33 (*t*, *J* = 7.5)	7.32 (*t*, *J* = 8.0)	7.24 (*t*, *J* = 7.5)
H–C(7)	7.05 (*d*, *J* = 7.8)	7.63 (*t*, *J* = 7.8)	7.62 (*t*, *J* = 7.8)	7.43 (*d*, *J* = 7.8)	7.39 (*d*, *J* = 7.5)
H–C(8)		7.84 (*d*, *J* = 8.0)	7.83 (*d*, *J* = 7.8)		
HO–C(8)	10.13 (br. *s*)				
H–N(9)	11.75 (br. *s*)	12.22 (br. *s*)	12.18 (br. *s*)	11.48 (br. *s*)	10.99 (br. *s*)
H–C(14)					5.15–5.19 (*m*)
HO–C(14)					5.95 (*d*, *J* = 4.5)
Me(15) or CH_2(15)	2.83 (*s*)	2.94 (*s*)	2.89 (*s*)	2.84 (*s*)	3.89–3.94, 3.82–3.87 (2*m*)
HO–C(15)					4.86 (*t*, *J* = 5.5)
Me(17) or H–N(17)	3.97 (*s*)	8.83 (*d*, *J* = 8.0)	8.99 (*d*, *J* = 8.0)	3.97 (*s*)	3.91 (*s*)
H–C(18)		4.57–4.61 (*m*)	4.32–4.33 (*m*)		
CH_2(19)		2.25–2.31, 2.10–2.18 (2*m*)	2.13–2.15, 1.93–1.97 (2*m*)		
CH_2(20)		2.42–2.50 (*m*)	2.33–2.39, 2.26–2.29 (2*m*)		
HO–C(22)		12.99 (br. *s*)			
Me(23)		3.54 (*s*)			
H–C(1′)				4.94 (*d*, *J* = 7.5)	4.96 (*d*, *J* = 7.5)
H–C(2′)				3.40–3.47 (*m*)	3.40–3.47 (*m*)
H–C(3′)				3.40–3.47 (*m*)	3.40–3.47 (*m*)
H–C(4′)				3.24–3.27 (*m*)	3.22–3.27 (*m*)
H–C(5′)				3.33–3.36 (*m*)	3.34–3.37 (*m*)
CH_2(6′)				3.77–3.80, 3.51–3.56 (2*m*)	3.76–3.80, 3.51–3.55 (2*m*)

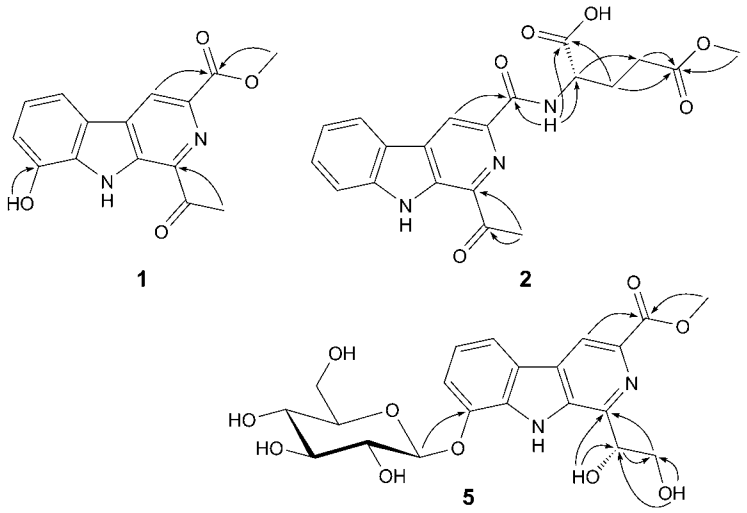


Fig. 2. *Key HMBCs* (H → C) *of compounds* **1**, **2**, *and* **5**

Table 2. *^{13}C-NMR Spectroscopic Data for the Isolated β-Carboline Derivatives* **1**–**5** (125 MHz, (D_6)DMSO, δ in ppm). Atom numbering as indicated in *Fig. 1*.

	1	**2**	**3**	**4**	**5**
C(1)	135.3 (*s*)	133.9 (*s*)	133.8 (*s*)	135.7 (*s*)	146.4 (*s*)
C(3)	135.7 (*s*)	138.0 (*s*)	138.6 (*s*)	135.9 (*s*)	135.7 (*s*)
C(4)	121.3 (*d*)	118.1 (*d*)	117.7 (*d*)	121.5 (*d*)	116.8 (*d*)
C(5)	112.9 (*d*)	122.3 (*d*)	122.2 (*d*)	116.2 (*d*)	115.8 (*d*)
C(6)	122.3 (*d*)	120.9 (*d*)	120.7 (*d*)	122.1 (*d*)	120.9 (*d*)
C(7)	114.8 (*d*)	129.4 (*d*)	129.2 (*d*)	115.4 (*d*)	114.0 (*d*)
C(8)	143.4 (*s*)	113.3 (*d*)	113.3 (*d*)	144.1 (*s*)	144.2 (*s*)
C(10)	134.8 (*s*)	134.9 (*s*)	134.8 (*s*)	134.9 (*s*)	135.0 (*s*)
C(11)	131.7 (*s*)	131.9 (*s*)	131.9 (*s*)	132.4 (*s*)	131.6 (*s*)
C(12)	122.2 (*s*)	120.3 (*s*)	120.3 (*s*)	121.9 (*s*)	122.4 (*s*)
C(13)	130.8 (*s*)	142.4 (*s*)	142.3 (*s*)	131.6 (*s*)	128.5 (*s*)
C(14)	201.2 (*s*)	200.9 (*s*)	200.6 (*s*)	200.9 (*s*)	74.4 (*d*)
C(15)	25.5 (*q*)	25.9 (*q*)	25.6 (*q*)	25.6 (*q*)	65.2 (*t*)
C(16)	165.2 (*s*)	164.2 (*s*)	162.9 (*s*)	165.1 (*s*)	165.9 (*s*)
C(17)	52.2 (*q*)			52.3 (*q*)	52.0 (*q*)
C(18)		51.7 (*d*)	53.3 (*d*)		
C(19)		26.4 (*t*)	28.7 (*t*)		
C(20)		29.9 (*t*)	32.5 (*t*)		
C(21)		173.0 (*s*)			
C(22)		173.0 (*s*)			
C(23)		51.4 (*q*)			
C(1′)				102.6 (*d*)	102.6 (*d*)
C(2′)				73.2 (*d*)	73.4 (*d*)
C(3′)				77.3 (*d*)	77.4 (*d*)
C(4′)				69.7 (*d*)	69.8 (*d*)
C(5′)				75.7 (*d*)	75.9 (*d*)
C(6′)				60.7 (*t*)	60.8 (*t*)

was obtained as a yellowish amorphous solid. The HR-ESI-MS, and the ^{1}H- and ^{13}C-NMR data provided the molecular formula $C_{20}H_{19}N_3O_6$. In the ^{1}H-NMR spectrum, resonances for four mutually coupled, vicinal aromatic H-atoms at (δ(H) 7.35, 7.63 (2*t*, $J = 7.8$), and 8.46, 7.84 (2*d*, $J = 8.0$)) were indicative of the presence of an unsubstituted aromatic ring *A*. A broad *singlet* NH H-atom signal at δ(H) 12.22 (br. *s*, D_2O-exchangeable) and an aromatic H-atom *singlet* at δ(H) 9.11 (*s*) were also displayed. These signals were indicative of a β-carboline skeleton. As in compound **1**, a MeO signal at δ(H) 3.54 (*s*), a Me signal at δ(H) 2.94 (*s*), together with the C-atom signals at δ(C) 173.0 and 51.4, and 200.9 and 25.9, also indicated the presence of a COOMe group and an Ac group, respectively. In addition, five mutually coupled H-atom signals at δ(H) 4.57–4.61 (*m*, 1 H) and 2.50–2.10 (*m*, 4 H), a COOH signal at δ(H) 12.99 (br. *s*), along with three saturated C-atom signals at δ(C) 51.7–26.4, and a *C*OOH signal at δ(C) 173.0, suggested the presence of a $CHCH_2CH_2$ moiety and of a carboxylic acid unit with the aid of HSQC.

The HMBCs between the signals at δ(H) 2.25–2.31 and 2.10–2.18 (CH_2(19)), and δ(C) 173.0 (C(22)), between the signals at δ(H) 3.54 (Me(23)) and δ(C) 173.0 (C(21)), and between those δ(H) 8.83 (H–N(17)) and δ(C) 164.2 (C(16)) and 51.7 (C(18)) led

to the construction of the fragment $CONHCH(COOH)CH_2CH_2CO_2Me$ [7]. Moreover, the ^3J correlations from δ(H) 2.94 (H–C(15)) to δ(C) 133.9 (C(1)), and from δ(H) 9.11 (H–C(4)) to δ(C) 164.2 (C(16)), evidenced that the side chains Ac and $CONHCH(CO_2H)CH_2CH_2CO_2Me$ were at C(1) and C(3), respectively (*Fig. 2*). Compound **2** exhibited a positive optical rotation, similar to dichotomide XII [7]. Thus, the absolute configuration at C(18) was determined as (*S*). On the basis of the above results, the structure of **2** was deduced as shown in *Fig. 1*, and named dichotomine G.

Compound **3**, a yellowish amorphous solid, had the molecular formula $C_{19}H_{17}N_3O_6$ deduced from HR-ESI-MS (*m/z* 406.1016 ($[M+Na]^+$)). The ^{1}H- and ^{13}C-NMR spectra displayed very similar signals to those of **2**, except for the absence of a MeO signal in **3**. This is in agreement with a comparison of the molecular formulae of **3** ($C_{19}H_{17}N_3O_6$) and **2** ($C_{20}H_{19}N_3O_6$). The absolute configuration at C(18) was also determined to be (*S*), as in compound **2** [7], and the structure of compound **3**, named dichotomine H, was thus established as shown in *Fig. 1*.

Compound **4**, purified as a pale yellow amorphous solid, was determined to have the molecular formula $C_{21}H_{22}N_2O_9$ by HR-ESI-MS (*m/z* 445.1251 ($[M-H]^-$)). The ^{1}H- and ^{13}C-NMR data of **4** were similar to those of **1**, the major difference being the presence of an additional glucosyl unit (δ(H) 4.94 (*d*, *J* = 7.5, H–C(1′)), 3.24–3.80 (*m*, 6 H); δ(C) 102.6, 77.3, 75.7, 73.2, 69.7, 60.7). Acid hydrolysis of **4** with 1M H_2SO_4 furnished a sugar, which was identified as D-glucose by its optical rotation and TLC comparison with an authentic sample. The ^3J(1,2) coupling constant (7.5 Hz) indicated a β-D-glucoside. The sugar unit was connected to C(8) through a C–O linkage as indicated by the HMBC between the signal at δ(H) 4.94 (H–C(1′)) and that at δ(C) 144.1 (C(8)). Thus, structure **4** was assigned to dichotomine I.

Compound **5** was obtained as a yellowish amorphous solid. On the basis of its HR-ESI-MS (*m/z* 463.1355, $[M-H]^-$), along with the ^{1}H- and ^{13}C-NMR data (*Tables 1* and *2*), its molecular formula was established as $C_{21}H_{24}N_2O_{10}$. The ^{1}H-NMR spectrum of **5** was found to be very similar to that of **4**, except that the Ac group of **4** was replaced by a 1,2-dihydroxyethyl group (δ(H) 5.15–5.19 (*m*), 3.89–3.94 (*m*), 3.82–3.87 (*m*), δ(C) 74.4, 65.2). The HMBCs between the signals at δ(H) 5.95 (HO–C(14)) and δ(C) 65.2 (C(15)); the signals at δ(H) 4.86 (HO–C(15)) and δ(C) 74.4 (C(14)), and those at δ(H) 3.89–3.94, 3.82–3.87 (CH_2(15)) and δ(C) 146.4 (C(1)) confirmed the above conclusion (*Fig. 2*).

Acid hydrolysis of **5** with 1M H_2SO_4 liberated compound **5a** as the aglycon and D-glucose. The absolute configuration at C(14) in **5** is proposed as (*R*) by comparison of the sign of the specific rotation of **5a** with that of dichotomine C [15]. Thus, structure **5** was assigned to dichotomine J.

Besides compounds **1**–**5**, the nine known β-carboline alkaloids dichotomides I, III, V, and VII (**6**–**9**, resp.) [7][15], stellarines A and C (**10**–**11**, resp.) [16][17], dichotomine B (**12**) [15], glucodichotomine B (**13**) [18], and 1-acetyl-3-carboxy-β-carboline (**14**) [19], were also isolated and identified by comparison with spectroscopic data recorded in the literatures.

Biological Studies. The cytotoxicities of compounds **1**–**14** against four human cancer cell lines Bel7402 (human liver cancer), SMMC-7721 (human liver cancer), HCT 116 (human colon cancer), and H460 (human lung cancer) were tested by the MTT (= 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyl-2*H*-tetrazolium bromide) method

[20]. Compound **12** showed cytotoxicity only towards SMMC-7721 cells with an IC_{50} value of 85.36 μM. Compound **13** exhibited cytotoxicity towards HCT116 and SMMC-7721 cells with IC_{50} values 50.29 and 74.52 μM, respectively. The other isolated compounds showed no or low cytotoxic activities (IC_{50} values > 100 μM) against the tested tumor cells.

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Experimental Part

General. All the reagents and solvents were of the anal. grade (*Jiangsu Hanbang Sci. & Tech. Co. Ltd.*, Huaian, P. R. China). Column chromatography (CC): commercial silica gel (SiO_2; 100–200 and 200–300 mesh; *Qingdao Marine Chemical Factory*, Qingdao, P. R. China), *RP-18* SiO_2 (40–63 μm; *Fuji Silysia Chemical Ltd.*), *D101* macroporous resin (*The Chemical Plant of Nankai University*, Tianjin, P. R. China), and *Sephadex LH-20* (*Pharmacia*, *Amersham Biosciences*, Uppsala, Sweden). TLC: SiO_2 plates; detection by spraying with vanillin/H_2SO_4 in EtOH, followed by heating. Optical rotations: *JASCO P-1020* polarimeter. UV Spectra: *Shimadzu UV-2450* spectropolarimeter; λ_{max} (log ε) in nm. IR Spectra: *Bruker Tensor-27* spectrometer; KBr pellets; in cm^{-1}. 1D- and 2D-NMR spectra: *Bruker AV-500* spectrometer; at 500 (^1H) and 125 MHz (^{13}C); in (D_6)DMSO; δ in ppm rel. to TMS as an internal standard, *J* in Hz. ESI-MS: *Agilent 1100* Series LC/MSD Trap mass spectrometer; in *m*/*z*; HR-ESI-MS: *Micro Q-TOF MS* instrument; in *m*/*z*.

Plant Material. The roots of *S. dichotoma* L. var. *lanceolata* BUNGE were purchased from Nanjing Medicine Company, and identified by Prof. *Mian Zhang*, the Research Department of Pharmacognosy, China Pharmaceutical University. A voucher specimen (No. 20100801) was deposited with the Department of Natural Medicinal Chemistry, China Pharmaceutical University.

Extraction and Isolation. The powdered dry roots of *S. dichotoma* var. *lanceolata* (8.0 kg) were extracted four times with 95% aq. EtOH under reflux, each for 2 h. The extract was concentrated *in vacuo*. Then, the residue (500.0 g) was suspended in H_2O and partitioned by precipitation. The supernatant was subjected to CC (*D101*; EtOH/H_2O 0:100, 30:70, 50:50, 70:30, 100:0 (*v*/*v*)) to yield five fractions, *Frs. 1–5*. *Fr. 2* (30:70, 50.0 g) was subjected to CC (*MCI*; MeOH/H_2O 4:6) and further purified by CC (*RP-18* gel; MeOH/H_2O 3:7) to affording **12** (50.6 mg). *Fr. 3* (50:50, 20.0 g) was also subjected to CC (*MCI*; MeOH/H_2O 30:70 → 100:0) to furnish four subfractions; *Subfrs. 3.1–3.4*. *Subfr. 3.2* (50:50) was separated by CC (SiO_2; CH_2Cl_2/MeOH 10:1 → 1:1) to afford seven pooled subfractions, *Subfrs. 3.2.1–3.2.7*. *Subfrs. 3.2.4* (10:3) and *3.2.7* (1:1) were both subjected to CC (*RP-18* gel), followed by CC (*Sephadex LH-20*; MeOH) to afford **5** (11.5 mg), **9** (3.2 mg), and **13** (7.4 mg), resp. *Subfr. 3.3* (70:30) was submitted to CC (SiO_2; CH_2Cl_2/MeOH 4:1 → 1:1), followed by CC (*RP-18* gel; MeOH/H_2O 30:70 → 70:30), to furnish three subfractions *Subfrs. 3.3.1–3.3.3*. *Subfrs. 3.3.1* (30:70) and *3.3.3* (70:30) were further purified by CC (*Sephadex LH-20*; MeOH) to give **2** (8.1 mg) and **4** (6.7 mg), resp. Prep. TLC of *Subfr. 3.3.2* (50:50) with AcOEt/MeOH 8:2 yielded **3** (14.3 mg; R_f 0.2) and **14** (4.6 mg; R_f 0.5). *Fr. 4* (70:30; 5.0 g) was chromatographed continuously into five subfractions, *Subfrs. 4.1–4.5* using a SiO_2 CC (gradient of CH_2Cl_2/MeOH). *Subfr. 4.3* was successively subjected to CC (*RP-18* gel; MeOH/H_2O 40:60 → 100:0) and CC (*Sephadex LH-20*; MeOH) to give **10** (60.4 mg).

The precipitate (90.0 g) was subjected to CC (SiO_2; PE/AcOEt 100:1, 100:3, 20:1, 10:1, 10:3, 2:1, 1:1, 0:1) to give eight fractions, *Frs. A–H*. *Fr. E* (10:3) was applied to CC (silica gel; petroleum ether (PE)/acetone) to furnish five subfractions, *Subfrs. E.1–E.5*. *Subfr. E.2* was further separated by CC (SiO_2; PE/AcOEt 10:4) to give compound **7** (15.4 mg). *Subfr. E.3* was further purified by CC (*Sephadex LH-20*) to give compounds **1** (7.8 mg) and **8** (4.6 mg). *Fr. F* (2:1) was subjected to CC (*RP-18* gel; MeOH/H_2O 50:50 → 100:0) to give four subfractions, *Subfrs. F.1–F.4*. *Subfr. F.1* was further separated by CC (*Sephadex LH-20*; MeOH) to yield compounds **6** (2.5 mg) and **11** (5.6 mg).

Dichotomine F (= *Methyl 1-Acetyl-8-hydroxy-9*H-*β-carboline-3-carboxylate*; **1**). Yellow powder. UV (MeOH): 236 (4.19), 286 (4.20), 385 (3.56). IR: 3373, 2963, 2941, 1702, 1671, 1587, 1437, 1415, 1352, 1259,

1232, 1217. ^{1}H- and ^{13}C-NMR: see *Tables 1* and *2*, resp. HR-ESI-MS: 307.0686 ($[M+Na]^+$, $C_{15}H_{12}N_2NaO_4^+$; calc. 307.0689).

Dichotomine G (= *(2S)-2-{[(1-Acetyl-9*H*-β-carbolin-3-yl)carbonyl]amino}-5-methoxy-5-oxopentanoic Acid* = N-*[(1-Acetyl-9*H*-pyrido[3,4-*b*]indol-3-yl)carbonyl]-*L*-glutamic Acid 5-Methyl Ester*; **2**). Yellowish powder. $[\alpha]_D^{23} = +28.4$ ($c = 0.05$, MeOH). UV (MeOH): 220 (4.25), 286 (4.34), 376 (3.51). IR: 3385, 2952, 1738, 1661, 1537, 1494, 1450, 1335, 1254, 1182. ^{1}H- and ^{13}C-NMR: see *Tables 1* and *2*, resp. HR-ESI-MS: 396.1199 ($[M-H]^-$, $C_{20}H_{18}N_3O_6^-$; calc. 396.1201).

Dichotomine H (= N-*[(1-Acetyl-9*H*-β-carbolin-3-yl)carbonyl]-*L*-glutamic Acid*; **3**). Yellowish powder. $[\alpha]_D^{23} = +12.0$ ($c = 0.02$, MeOH). UV (MeOH): 219 (3.85), 286 (3.87), 377 (3.04). IR: 3389, 1592, 1495, 1410, 1185. ^{1}H- and ^{13}C-NMR: see *Tables 1* and *2*, resp. HR-ESI-MS: 406.1016 ($[M+Na]^+$, $C_{19}H_{17}N_3NaO_6^+$; calc. 406.1010).

Dichotomine I (= *Methyl 1-Acetyl-8-(β-*D*-glucopyranosyloxy)-9*H*-β-carboline-3-carboxylate*; **4**). Pale yellow powder. $[\alpha]_D^{23} = -6.6$ ($c = 0.07$, MeOH). UV (MeOH): 208 (4.42), 284 (4.08), 376 (3.29). IR: 3772, 3428, 2922, 1717, 1662, 1510, 1433, 1369, 1258, 1101. ^{1}H- and ^{13}C-NMR: see *Tables 1* and *2*, resp. HR-ESI-MS: 445.1251 ($[M-H]^-$, $C_{21}H_{21}N_2O_9^-$; calc. 445.1253).

Dichotomine J (= *Methyl 1-[(1*R*)-1,2-Dihydroxyethyl]-8-(β-*D*-glucopyranosyloxy)-9*H*-β-carboline-3-carboxylate*; **5**). Yellowish powder. $[\alpha]_D^{20} = -17.8$ ($c = 0.06$, MeOH). UV (MeOH): 229 (4.14), 268 (4.23), 306 (3.62). IR: 3412, 2963, 2941, 1702, 1671, 1587, 1437, 1415, 1352, 1259, 1232, 1217. ^{1}H- and ^{13}C-NMR: see *Tables 1* and *2*, resp. HR-ESI-MS: 463.1355 ($[M-H]^-$, $C_{21}H_{23}N_2O_{10}^-$; calc. 463.1358).

Acid Hydrolysis of Compounds **4** *and* **5**. A soln. of **4** or **5** (each 3.0 mg) in 1M H_2SO_4 (4.0 ml) was heated under reflux for 3 h. After cooling, the mixture was extracted with BuOH three times. The acid aq. layer was neutralized with $BaCl_2$ to give a $BaSO_4$ precipitate. After filtering, the aq. layer was concentrated to dryness under reduced pressure. TLC Analysis with authentic glucose as reference (BuOH/AcOH/H_2O 4:1:5 (*v*/*v*/*v*), upper layer), together with its optical rotation ($[\alpha]_D^{23} = +52.6$, $c = 0.03$, H_2O), indicated the presence of D-glucose. The BuOH layer was washed with brine then dried ($MgSO_4$). After removal of the solvent under reduced pressure, the residue was purified CC (*Sephadex LH-20*; MeOH) to yield compounds **1** (1 mg) and **5a** (1.5 mg), resp.

*Methyl 1-[(1*R*)-1,2-Dihydroxyethyl]-8-hydroxy-9*H*-β-carboline-3-carboxylate* (**5a**). Yellow powder. $[\alpha]_D^{23} = -20.9$ ($c = 0.15$, MeOH). ^{1}H-NMR (500 MHz, CD_3OD): 4.09 (*s*, MeO–C(16)), 4.01–4.07 (*m*, CH_2(15)), 5.51–5.54 (*m*, H–C(14)), 7.05 (*d*, $J = 7.5$, H–C(6)), 7.21 (*t*, $J = 7.5$, H–C(7)), 7.76 (*d*, $J = 7.5$, H–C(5)), 8.85 (*s*, H–C(4)).

Cytotoxicity Assay. Cells were seeded in 96-well plates 12 h before treatment and continuously exposed to different concentrations of compounds (120, 60, 30, 15, 7.5, 3.25 μM). After 48 h, 20 μl of MTT (= 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyl-2*H*-tetrazolium bromide; 5 mg/ml) soln. were added to each well. The old medium was removed after 4 h, and then 100 μl of DMSO was added to each well. The optical density was measured at 570 nm with a *Spectra Shell Microplate Reader* (*Tecan*, Research Triangle Park, NC, USA). The cells were obtained from the Cell Bank of the Shanghai Institute of Cell Biology. All assays were carried out in triplicate.

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