Polyoxygenated Bipyridine, Pyrrolylpyridine, and Bipyrrole Alkaloids from *Speranskia tuberculata*

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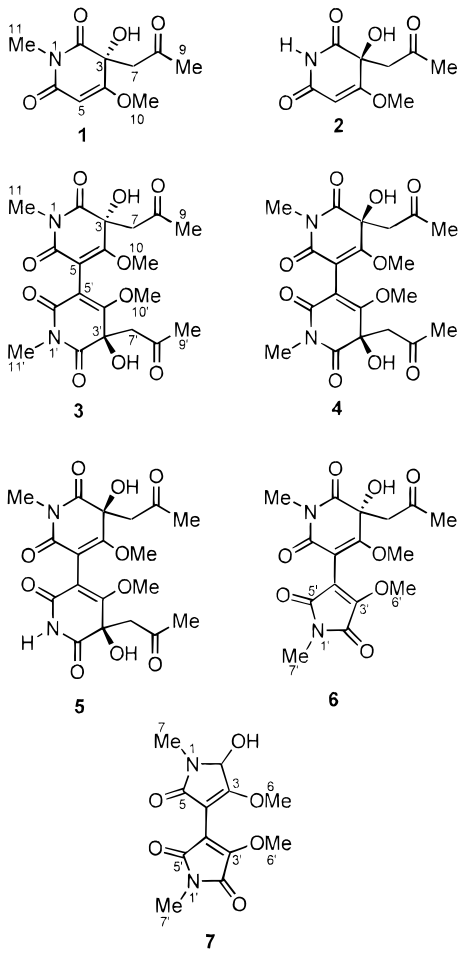
Five novel polyoxygenated alkaloids, speranculatines A−C (**3**−**5**), speranskilatine A (**6**), and speranberculatine A (**7**), have been isolated from *Speranskia tuberculata*. Compounds **3**−**5**, **6**, and **7**, have bipyridine, pyrrolylpyridine, and bipyrrole skeletons, respectively. This is the first time that these three alkaloid structural types have been reported. The structures of **3**−**7** were elucidated by spectroscopic methods, including 2D NMR techniques and X-ray crystallographic analysis.

Hermidin is a natural pyridine-2,6-(1*H*,3*H*)-dione alkaloid, determined by synthesis to be 5-hydroxy-4-methoxy-1-methylpyridine-2,6-(1*H*,3*H*)-dione, which was reported from *Mercurialis perennis* L. (Euphorbiaceae). The colorless stems of this plant, when bruised or cut, develop transient blue or yellow colors, with hermidin, a powerful reducing agent, considered to be the chromogen.[1,2] In a continuation of our survey of natural products of plants in the Euphorbiaceae,[3−8] we have investigated the constituents of *Speranskia tuberculata* (Bge.) Ball (Euphorbiaceae) used as a folk medicine "Tou Gu Cao" in the People's Republic of China for the treatment of rheumatic arthritis, sores, swellings, pain, and inflammatory diseases.[9] This plant did not change color when bruised or cut. No chemical constituent had been described for this genus before we reported two optically active pyridine-2,6-(1*H*,3*H*)-dione alkaloids, speranskatines A (**1**) and B (**2**), in a previous paper.[10] We report here the isolation and structure elucidation of five novel polyoxygenated alkaloids based on three different skeletons, named speranculatines A−C (**3**−**5**), speranskilatine A (**6**), and speranberculatine A (**7**).

Results and Discussion

The acetone extract of the air-dried and ground whole plants of *S. tuberculata* was subjected to column chromatography on Si gel to afford a fraction that demonstrated a positive reaction to the Dragendorff's test. This fraction was further purified to give speranskatines A (**1**) and B (**2**), speranculatines A−C (**3**−**5**), speranskilatine A (**6**), and speranberculatine A (**7**). These seven compounds were also obtained when the plant material was extracted with methanol in place of acetone.

Speranculatine A (**3**), $[\alpha]^{18}_{D}$ + 21.9°, was obtained as colorless prisms from EtOAc. The IR spectrum of **3** showed absorption bands for hydroxyl (3370, 3211 cm^{-1}), carbonyl (1716 cm^{-1}), and lactam carbonyl (1671, 1655 cm^{-1}) groups. The EIMS and positive-ion FABMS data exhibited a molecular ion at *m*/*z* 452 $[M]^+$ and a quasimolecular ion at *m*/*z* 453 $[M + H]^+$, respectively. The HRFABMS gave a molecular formula equivalent to $C_{20}H_{24}N_2O_{10}$. Both the ^1H and ^{13}C NMR spectra contained only half the number of signals expected from the molecular formula, suggesting that **3** was a symmetrical dimer. The ^{13}C and DEPT spectra of **3** (Table 2) resembled those of **1**,[10] for except that the olefinic methine carbon at δ 94.5 of **1** was replaced by the quaternary carbon at δ 105.1 in the case of **3**, indicating **3** was a dimer of **1** linked at C-5 and C-5′.



To confirm the complete structure and relative stereochemistry, **3** was subjected to a single-crystal X-ray diffraction analysis. The ORTEP drawing, with the atom-numbering scheme indicated, is shown in Figure 1. The two rings possessed the envelope conformation. In each ring, the total of three bond angles from the nitrogen center was 360°, indicating that the nitrogen was in the sp^2 hybrid

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Table 1. ^{1}H NMR Data for Speranculatines A−C (**3**−**5**), Speranskilatine A (**6**), and Speranberculatine A (**7**)[a]

proton	3	4	5	6	7
2					5.22 s
6					3.99 s
7a	3.51 d (17.9)	3.57 d (17.8)	3.56 d (18.0)	3.56 d (17.8)	2.94 s
7b	3.45 d (17.9)	3.37 d (17.8)	3.40 d (18.0)	3.35 d (17.8)	
9	2.16 s	2.13 s	2.12 s	2.12 s	
10	3.78 s	3.87 s	3.89 s	3.89 s	
11	3.13 s	3.24 s	3.24 s	3.24 s	
6′				3.96 s	4.08 s
7′a	3.51 d (17.9)	3.25 s	3.60 d (17.5)	3.03 s	3.00 s
7′b	3.45 d (17.9)	3.25 s	3.41 d (17.5)		
9′	2.16 s	2.25 s	2.12 s		
10′	3.78 s	3.87 s	3.91 s		
11′	3.13 s	3.22 s			
N−H			9.39 s		

[a] Measured in $CDCl_3$ at 400.13 MHz, δ in ppm, J (in parentheses) in Hz.

Table 2. ^{13}C NMR Data for Speranculatines A−C (**3**−**5**), Speranskilatine A (**6**), and Speranberculatine A (**7**)[a]

carbon	3	4	5	6	7
2	172.4 s	171.6 s	171.5 s	171.8 s	81.3 d
3	71.9 s	71.2 s	71.2 s	71.3 s	170.2 s
4	167.5 s	165.8 s	167.6 s	167.1 s	96.0 s
5	105.1 s	104.0 s[b]	102.0 s[b]	102.9s[b]	169.3 s
6	166.8 s	166.0 s	166.8 s	164.6 s	58.6 q
7	50.4 t	49.8 t	49.8 t	50.3 t	26.0 q
8	207.2 s	206.3 s	206.6 s	205.7 s	
9	29.7 q	29.8 q	29.7 q	29.8 q	
10	60.7 q	60.2 q	60.5 q	60.6 q	
11	27.2 q	27.4 q	27.7 q	27.4 q	
2′	172.4 s	171.9 s	171.2 s	171.4 s	171.2 s
3′	71.9 s	73.1 s	71.5 s	156.1 s	156.2 s
4′	167.5 s	164.9 s	169.1 s	101.4 s[b]	101.1 s
5′	105.1 s	102.5 s[b]	101.8 s[b]	165.4 s	165.5 s
6′	166.8 s	165.9 s	167.0 s	59.5 q	59.2 q
7′	50.4 t	48.4 t	49.3 t	24.0 q	24.0 q
8′	207.2 s	206.8 s	206.7 s		
9′	29.7 q	31.1 q	29.7 q		
10′	60.7 q	60.1 q	60.6 q		
11′	27.2 q	27.6 q			

[a] Measured in $CDCl_3$ at 100.62 MHz, δ in ppm. [b] Values in same column may be interchanged.

mode and that the *N*-methyl group was on one plane together with two lactam carbonyl groups and two olefinic carbons. The dihedral angle between the two ring planes was 88.20° in the solidstate. Consequently, the structure of speranculatine A (**3**) was assigned as *rel*-(3*R**,3′*R**)-(+)-3,3′-dihydroxy-4,4′-dimethoxy-3,3′-bis(2-oxopropyl)-1,1′-dimethyl-5,5′-bipyridine-2,2′,6,6′-(1*H*,1′*H*,3*H*,3′*H*)-tetrone.

Speranculatine B (**4**), $[\alpha]^{18}_D$ +6.0°, colorless prisms (EtOAc), showed almost identical UV, IR, EIMS, and FABMS data with those of **3**. The HRFABMS gave a molecular formula of $C_{20}H_{24}N_2O_{10}$, which was identical to that of **3**. The ^{1}H and ^{13}C NMR and DEPT spectra of **4** (Tables 1 and 2), the signals of which were assigned by HMQC and HMBC experiments, revealed that **4** was also a dimer of 3-hydroxy-4-methoxy-3-(2-oxopropyl)-1-methylpyridine-2,6-(1*H*,3*H*)-dione (**1**) linked at C-5 and C-5′. The presence of 20 carbon signals in the ^{13}C NMR spectrum indicated the asymmetry of **4**, and the only difference between the two monomers of **4** was the configuration of the chiral centers at C-3 and C-3′. An X-ray crystallographic analysis of **4** confirmed the structure and relative stereochemistry assigned from all of the evidence obtained. The ORTEP drawing is shown in Figure 2. The two rings had conformations similar to those observed in **3**, but the C-3 and C-3′ chiral centers showed different configurations. Accordingly, speranculatine B (**4**) was assigned as *rel*-(3*S**,3′*R**)-(+)-3,3′-dihydroxy-4,4′-dimethoxy-3,3′-bis(2-oxopropyl)-1,1′-dimethyl-5,5′-bipyridine-2,2′,6,6′-(1*H*,1′*H*,3*H*,3′*H*)-tetrone. The optical activity of **4** indicated that the rotation about the central bond connecting the two rings was restricted.

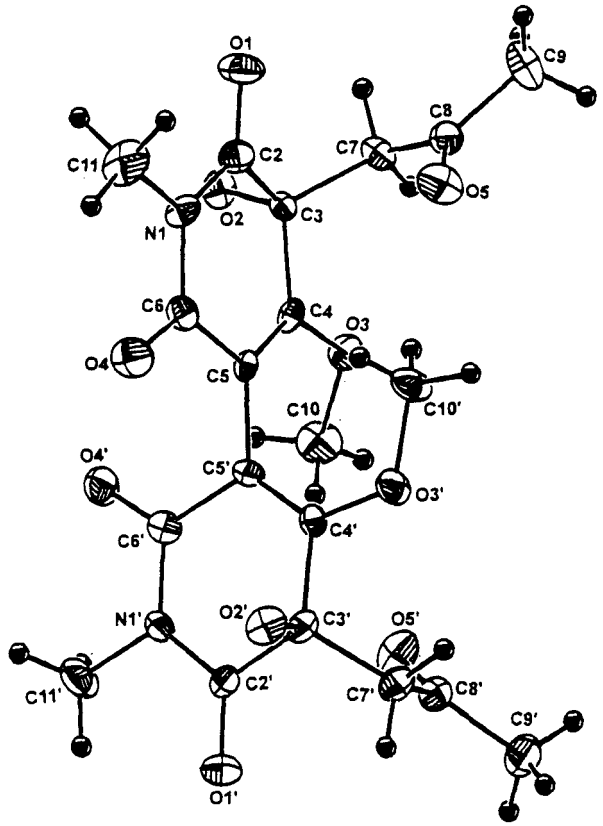

Figure 1. ORTEP diagram of speranculatine A (**3**).

Speranculatine C (**5**), $[\alpha]^{18}_D$ +9.6°, white crystals (EtOAc), showed UV and IR absorption bands similar to those of **3** and **4**. Its molecular formula was determined as $C_{19}H_{22}N_2O_{10}$ by HRFABMS, which was one CH_2 less than that of **3** or **4**. The most prominent differences in the ^{1}H NMR spectrum of **5**, compared with that of **4**, were that a *N*-H at δ 9.39 (1H, s) and an AB system at δ 3.60, 3.41 (each 1H, d, J = 17.5 Hz) of **5** replaced the *N*-methyl group at δ 3.22 (3H, s) and the singlet at δ 3.25 (2H, s) of **4**, respectively. Thus, the structure of **5** was established as *rel*-(3*S**,3′*R**)-(+)-3,3′-dihydroxy-4,4′-dimethoxy-3,3′-bis(2-oxopropyl)-1-methyl-5,5′-bipyridine-2,2′,6,6′-(1*H*,1′*H*,3*H*,3′*H*)-tetrone, which was supported by the ^{13}C NMR data (Table 2) of **5**. The NMR signals of **5** were assigned by HMQC and HMBC experi-

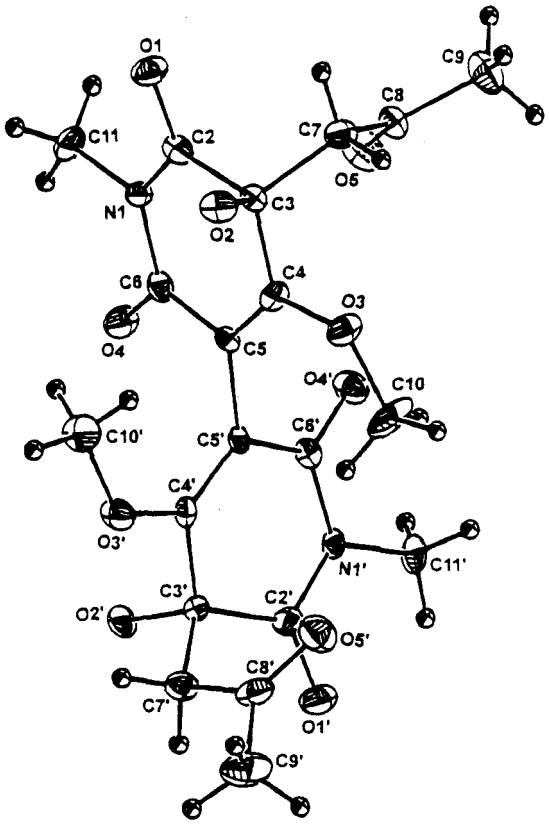

Figure 2. ORTEP diagram of speranculatine B (**4**).

ments. No available crystal of **5** was obtained for X-ray diffraction analysis.

Speranskilatine A (**6**), $[\alpha]^{18}_D$ +3.8°, was obtained as colorless prisms from $CHCl_3$. The IR spectrum of **6** showed the presence of hydroxyl (3381 cm^{-1}), carbonyl (1715 cm^{-1}), and lactam carbonyl (1780, 1680, 1657 cm^{-1}) groups. The EIMS and positive-ion FABMS data exhibited a molecular ion at *m/z* 366 $[M]^+$ and a quasimolecular ion at *m/z* 367 $[M + H]^+$, respectively. HRFABMS gave a molecular formula equivalent to $C_{16}H_{18}N_2O_8$ for **6**. The ^1H and ^{13}C NMR data of **6** (Tables 1 and 2) indicated that there was a 3-hydroxy-4-methoxy-3-(2-oxopropyl)-1-methyl-pyridine-2,6-(1*H*,3*H*)-dione-5-yl moiety in **6**. The remaining NMR signals were attributed unambiguously to a 3′-methoxy-2′,5′-dioxo-1′-methylpyrrol-4′-yl moiety based on the HMBC cross-peaks from H_3-7′ to C-2′, C-5′ and from H_3-6′ to C-3′.

A single crystal of **6** suitable for X-ray crystallographic analysis was obtained from a careful reisolation of this compound from the methanolic extract of the plant without exposing this extract and subsequent fractions to acetone. The ORTEP drawing, with the atom numbering scheme indicated, is shown in Figure 3. The pyridine-2,6-(1*H*,3*H*)-dione ring possessed the same envelope conformation as that observed for compounds **1**−**4**. All atoms of the 2′,5′-dioxo-1′-methylpyrrolyl ring were on one plane, indicating that the nitrogen was in the sp^2 hybrid mode. The dihedral angle between the two ring planes was 77.80° in the solid state. Therefore, the structure of speranskilatine A (**6**) was established as *rel*-(3*R**)-(+)-3-hydroxy-4-methoxy-3-(2-oxopropyl)-5-(3′-methoxy-2′,5′-dioxo-1-methylpyrrol-4′-yl)-1-methyl-pyridine-2,6-(1*H*,3*H*)-dione.

Speranberculatine A (**7**), $[\alpha]^{18}_D$ −14.8°, a pale yellow gum, displayed IR absorption bands for hydroxyl (3283 cm^{-1}) and lactam carbonyl (1778, 1714, 1700 cm^{-1}) groups. The EIMS and positive-ion FABMS data exhibited a molecular ion at *m/z* 282 $[M]^+$ and a quasimolecular ion at

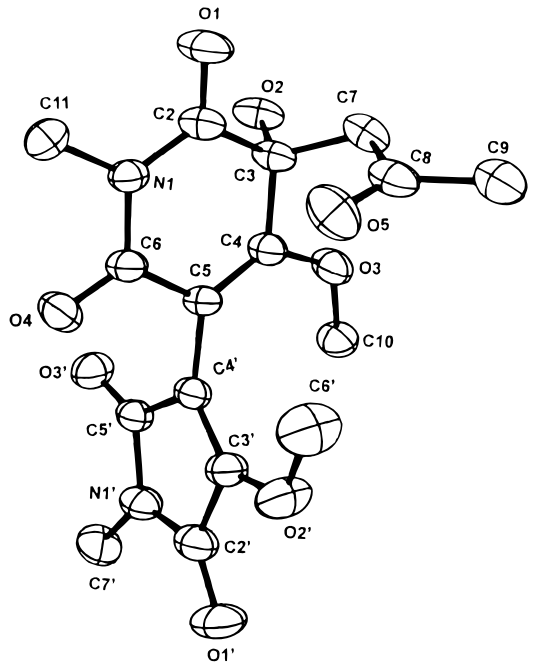

Figure 3. ORTEP diagram of speranskilatine A (**6**).

m/z 283 $[M + H]^+$, respectively. The molecular formula was determined as $C_{12}H_{14}N_2O_6$ on the basis of HRFABMS. The ^1H and ^{13}C NMR data of **7** (Tables 1 and 2) revealed that there was a 3′-methoxy-2′,5′-dioxo-1′-methylpyrrol-4′-yl moiety in **7**. Therefore, the elemental composition of the remaining moiety of **7** was determined as $C_6H_8NO_3$. Comparison of the NMR spectral data of **7** with those of **6** indicated that an oxymethine of **7** (δ_H 5.22, 1H, s; δ_C 81.3 d) replaced the 2-oxopropyl group and C-3 of **6**. Moreover, the ^{13}C NMR spectrum of **7** showed three lactam carbonyl signals, instead of four lactam carbonyl signals as in **6**. The HMBC spectrum of **7** exhibited cross-peaks from the oxymethine proton to C-4, C-5; from H_3-7 to C-2, C-5; and from H_3-6 to C-3, but no cross-peak from the oxymethine proton to C-4′ was observed. This evidence proved that the upper moiety of **7** was a 2-hydroxy-3-methoxy-1-methylpyrrol-5(2*H*)-one-4-yl unit. Accordingly, the structure of speranberculatine A (**7**) was elucidated as (−)-2-hydroxy-3,3′-dimethoxy-1,1′-dimethyl-4,4′-bipyrrole-5,2′,5′-(2*H*)-trione.

Compounds **1**−**7** were first isolated from the acetone extract of this plant collected in 1993, and acetone was used in the isolation procedure, so that there was the possibility that all of the compounds might be artifacts resulting from addition of acetone to the keto groups of the natural products. To eliminate this possibility, extraction and isolation of the plants recollected in the same area in 1998 was carried out free from acetone. Compounds **1**−**7** were obtained again, and their structures were confirmed as actual natural products rather than extraction artifacts.

Speranculatines A−C (**3**−**5**), speranskilatine A (**6**), and speranberculatine A (**7**) are the first known examples of polyoxygenated bipyridine, pyrrolylpyridine, and bipyrrole alkaloids from plants. The absolute stereostructures of **3**−**7** have not yet been determined.

Experimental Section

General Experimental Procedures. Melting points were determined on an X-4 micromelting point apparatus and are uncorrected. Optical rotations were measured with Rudolph Research Autopol III automatic polarimeter. UV spectra were acquired on a Perkin-Elmer Lambda 4B UV/vis spectrometer. IR spectra were recorded as KBr disks on a Nicolet 170 SX

FT-IR instrument. EIMS were run at 70 eV on a VG ZAB-HS mass spectrometer, and the positive-ion FABMS were obtained using a glycerol matrix on a Micromass Autospec-Ultima ETOF spectrometer. All NMR spectra were recorded on a Bruker AM-400 spectrometer in $CDCl_3$ with TMS as internal standard, operating at 400.13 MHz for ^1H and 100.62 MHz for ^{13}C.

X-ray diffraction intensity data of speransculatines A (**3**) and B (**4**) were collected on a Rigaku AFC 5R diffractometer with graphite-monochromated Mo Kα radiation ($\lambda = 0.71069$ Å) by the $\omega-2\theta$ scan technique [scan width $(1.313 + 0.35 \tan\theta)°$ for **3**, and $(0.94 + 0.35 \tan\theta)°$ for **4**, $2\theta \leq 50°$], and were corrected by Lorentz, polarization, and ψ-scan and DIFABS program[11] based absorption factors. Altogether 4103 and 3950 reflections were collected, of which 1327 and 1344 with $I \geq 3\sigma(I)$ were observed for **3** and **4**, respectively. Their structures were solved by direct methods and refined by full-matrix least-squares procedure to $R = 0.060$ and $R_w = 0.066$ [$w = 1/\sigma(I)^2$] of **3**, and $R = 0.058$ and $R_w = 0.068$ [$w = 1/\sigma(I)^2$] of **4**, with hydrogens found from difference Fourier maps, and refined. All calculations were carried out on a Microvax II computer using the TEXSAN program system. Diffraction intensity data of speranskilatine A (**6**) were collected on the MAC DIP-2030K diffractometer with graphite-monochromated Mo Kα radiation ($\lambda = 0.71073$ Å) by the ω scan technique [scan width 0−180°, 2θ 0−50°] and were corrected by Lorentz and polarization. Altogether 2678 reflections were collected, of which 2531 with $|F|^2 \geq 8\sigma|F|^2$ were observed. The structure was solved by direct methods and refined by block-matrix least-squares procedure to $R = 0.052$ and $R_w = 0.050$ [$w = 1/\sigma(F)^2$]. Hydrogen positions were found from difference Fourier maps and geometric calculations. All calculations were carried out on a PC computer by using the NOMCSDP program system.[12]

Adsorption column chromatography was performed with Si gel (200−300 mesh). TLC was carried out with glass precoated Si gel GF_{254} plates. Spots were visualized under UV and by spraying with 10% H_2SO_4 in 95% EtOH followed by heating. All solvents used were either spectral grade or were distilled from glass prior to use.

Plant Material. *S. tuberculata* was collected in Beizai, Gansu Province, People's Republic of China, in September 1993, and a recollection was carried out in the same area in September 1998. The plant identification was verified by Professor Guo-Liang Zhang (Department of Biology, Lanzhou University, Lanzhou 73000, People's Republic of China). Voucher specimens (no. 930911, no. 980923) were deposited at the Herbarium of the Department of Biology, Lanzhou University.

Extraction and Isolation. Air-dried and ground whole plants (10 kg) collected in 1993 were extracted with Me_2CO at 30 °C for 4 × 24 h, and the solvent was removed under reduced pressure at <40 °C to give a residue (235 g). The residue was chromatographed on a Si gel (1200 g) column, eluting with a petroleum ether (boiling point range 60−90°)−Me_2CO (20:1−0:1) gradient (1500 mL each step). The fraction (2.7 g) eluted with petroleum ether−Me_2CO (1:1) gave a positive Dragendorff's test and was repeatedly chromatographed on Si gel using petroleum ether−EtOAc (1:3) as eluent to yield pure speranskatines A (**1**) (54 mg) and B (**2**) (18 mg), and a mixture of additional compounds (2.1 g). The mixture was further purified by HPLC on a Whatman Partisil column eluting with CH_2Cl_2−Me_2CO (5:1) to give speranculatines A (**3**) (68 mg), B (**4**) (82 mg), and C (**5**) (25 mg); speranskilatine A (**6**) (45 mg); and speranberculatine A (**7**) (54 mg).

Air-dried and ground whole plants (6.7 kg) recollected in 1998 were extracted with methanol by percolation at room temperature. The methanolic extract was concentrated under vacuum to give a residue (181 g). This residue was repeatedly chromatographed on Si gel using the above solvent systems with EtOAc instead of Me_2CO to afford speranskatines A (**1**) (22 mg) and B (**2**) (9 mg); speranculatines A (**3**) (40 mg), B (**4**) (57 mg), and C (**5**) (13 mg); speranskilatine A (**6**) (38 mg); and speranberculatine E (**7**) (18 mg).

Speranculatine A (3): colorless prisms(EtOAc); mp 192−194 °C; $[\alpha]^{18}_D + 21.9°$ (*c* 0.54, MeOH); UV (MeOH) λ_{max} (log ϵ) 225 (4.87), 267 (1.62) nm; IR (KBr) ν_{max} 3370, 3211, 3023, 2966, 1716, 1671, 1655, 1628, 1431, 1382, 1314, 1281, 1230, 1208, 1165, 1108, 1035, 979, 935, 842, 782, 741 cm^{-1}; ^1H NMR ($CDCl_3$, 400.13 MHz), see Table 1; ^{13}C NMR ($CDCl_3$, 100.62 MHz), see Table 2; EIMS *m/z* 452 $[M]^+$ (5), 395 (3), 394 (3), 367 (35), 349 (4), 338 (5), 336 (5), 321 (10), 309 (52), 307 (34), 293 (16), 277 (20), 251 (15), 236 (15), 208 (13), 196 (12), 182 (13), 180 (15), 152 (7), 138 (5), 123 (11), 95 (20), 80 (15), 69 (13), 58 (44), 43 (100); FABMS *m/z* 453 $[M + H]^+$ (100), 437 (74), 421 (16), 393 (25), 377 (11), 351 (8), 333 (15); HRFABMS *m/z* 453.14849 (calcd for $C_{20}H_{25}N_2O_{10}$ 453.1509), 437.1535 (calcd for $C_{20}H_{25}N_2O_9$ 437.1560), 421.1598 (calcd for $C_{20}H_{25}N_2O_8$ 421.1611), 393.1322 (calcd for $C_{18}H_{21}N_2O_8$ 393.1298), 377.1383 (calcd for $C_{18}H_{21}N_2O_7$ 377.1349), 333.1085 (calcd for $C_{16}H_{17}N_2O_6$ 333.1087).

Crystal data: $C_{20}H_{24}N_2O_{10}$, $M_r = 452.42$, monoclinic, space group $P21/n$, $a = 11.958(2)$, $b = 14.589(2)$, $c = 13.142(4)$ Å, $\beta = 112.47(1)°$, $V = 2118.6(9)$ Å^3, $Z = 4$, $D_c = 1.41$ g cm^{-3}, $F(000) = 944$, μ(Mo Kα) = 1.07 cm^{-1}; crystal dimensions 0.3 × 0.4 × 0.7 mm.

Speranculatine B (4): colorless prisms (EtOAc); mp 147−149 °C; $[\alpha]^{18}_D + 6.0°$ (*c* 0.30, MeOH); UV (MeOH) λ_{max} (log ϵ) 224 (4.96), 267 (1.66) nm; IR (KBr) ν_{max} 3378, 3049, 2964, 1714, 1660, 1630, 1622, 1457, 1426, 1389, 1369, 1343, 1318, 1234, 1211, 1160, 1110, 1037, 927, 836, 781, 738, 704, 690, 679 cm^{-1}; ^1H NMR ($CDCl_3$, 400.13 MHz), see Table 1; ^{13}C NMR ($CDCl_3$, 100.62 MHz), see Table 2; EIMS *m/z* 452 $[M]^+$ (4), 394 (3), 367 (68), 349 (5), 338 (5), 336 (5), 321 (12), 309 (100), 293 (23), 277 (33), 251 (24), 236 (21), 208 (16), 196 (18), 180 (19), 152 (9), 138 (6), 123 (19), 95 (27), 80 (19), 69 (16), 58 (71), 43 (100); FABMS *m/z* 453 $[M + H]^+$ (63), 437 (100), 421 (46), 393 (59), 377 (69), 351 (38), 336 (37), 335 (36), 333 (81), 307 (35), 292 (46); HRFABMS *m/z* 453.1536 (calcd for $C_{20}H_{25}N_2O_{10}$ 453.1509), 437.1578 (calcd for $C_{20}H_{25}N_2O_9$ 437.1560), 421.1593 (calcd for $C_{20}H_{25}N_2O_8$ 421.1611), 393.1322 (calcd for $C_{18}H_{21}N_2O_8$ 393.1298), 377.1376 (calcd for $C_{18}H_{21}N_2O_7$ 377.1349), 351.1210 (calcd for $C_{16}H_{19}N_2O_7$ 351.1192), 336.1008 (calcd for $C_{15}H_{16}N_2O_7$ 336.0957), 335.0907 (calcd for $C_{15}H_{15}N_2O_7$ 335.0879), 333.1111 (calcd for $C_{16}H_{17}N_2O_6$ 333.1087), 307.0943 (calcd for $C_{14}H_{15}N_2O_6$ 307.0930), 292.0839 (calcd for $C_{14}H_{14}NO_6$ 292.0821).

Crystal data: $C_{20}H_{24}N_2O_{10}$, $M_r = 452.42$, triclinic, space group $P\bar{1}$, $a = 9.451(4)$, $b = 15.195(4)$, $c = 7.608(4)$ Å, $\alpha = 93.99(4)°$, $\beta = 98.83(4)°$, $\gamma = 101.20(3)°$, $V = 1043.4(8)$ Å^3, $Z = 2$, $D_c = 1.42$ g cm^{-3}, $F(000) = 472$, μ(Mo Kα) = 1.08 cm^{-1}; crystal dimensions 0.3 × 0.3 × 1.0 mm.

Speranculatine C (5): white crystals (EtOAc); mp 183−185 °C; $[\alpha]^{18}_D + 9.6°$ (*c* 0.43, MeOH); UV (MeOH) λ_{max} (log ϵ) 221 (4.57), 262 (1.38) nm; IR (KBr) ν_{max} 3364, 3341, 3034, 2967, 1718, 1699, 1663, 1658, 1620, 1435, 1386, 1310, 1244, 1212, 1168, 1108, 1047, 931, 840, 799 cm^{-1}; ^1H NMR ($CDCl_3$, 400.13 MHz), see Table 1; ^{13}C NMR ($CDCl_3$, 100.62 MHz), see Table 2; EIMS *m/z* 438 $[M]^+$ (4), 380 (4), 379 (6), 353 (13), 335 (3), 324 (5), 307 (5), 295 (20), 279 (7), 261 (6), 251 (8), 237 (8), 220 (5), 208 (9), 195 (6), 180 (7), 167 (6), 152 (5), 138 (7), 123 (9), 95 (12), 80 (8), 69 (29), 58 (34), 43 (100); FABMS *m/z* 439 $[M + H]^+$ (82), 423 (100), 407 (46), 379 (28), 363 (34), 337 (8), 319 (24); HRFABMS *m/z* 439.1342 (calcd for $C_{19}H_{23}N_2O_{10}$ 439.1353), 423.1401 (calcd for $C_{19}H_{23}N_2O_9$ 423.1404), 407.1448 (calcd for $C_{19}H_{23}N_2O_8$ 407.1454), 379.1142 (calcd for $C_{17}H_{19}N_2O_8$ 379.1141), 363.1192 (calcd for $C_{17}H_{19}N_2O_7$ 363.1192), 319.0923 (calcd for $C_{15}H_{15}N_2O_6$ 319.0930).

Speranskilatine A (6): colorless prisms ($CHCl_3$); mp 166−167 °C; $[\alpha]^{18}_D + 3.8°$ (*c* 1.30, MeOH); UV (MeOH) λ_{max} (log ϵ) 229 (4.34), 268 (1.89) nm; IR (KBr) ν_{max} 3381, 3021, 2955, 1780, 1715, 1680, 1657, 1632, 1449, 1387, 1354, 1316, 1260, 1234, 1208, 1160, 1110, 1078, 1046, 994, 942, 804, 754, 666, 600, 528 cm^{-1}; ^1H NMR ($CDCl_3$, 400.13 MHz), see Table 1; ^{13}C NMR ($CDCl_3$, 100.62 MHz), see Table 2; EIMS *m/z* 366 $[M]^+$ (5), 338 (7), 334 (12), 324 (9), 319 (20), 308 (40), 295 (4), 281 (100), 277 (15), 266 (13), 251 (21), 234 (18), 208 (47), 196 (34), 180 (45), 166 (10), 152 (17), 138 (12), 123 (40), 95 (54), 80 (26), 69 (19), 61 (32), 58 (32), 43 (88); FABMS *m/z* 367 $[M + H]^+$ (100), 351 (31), 307 (93), 293 (24), 281 (16), 266 (16); HRFABMS *m/z*

367.1154 (calcd for $C_{16}H_{19}N_2O_8$ 367.1141), 351.1235 (calcd for $C_{16}H_{19}N_2O_7$ 351.1192), 307.0975 (calcd for $C_{14}H_{15}N_2O_6$ 307.0930).

Crystal data: $C_{16}H_{18}N_2O_8$, M_r = 366.32, triclinic, space group $P\bar{1}$, a = 8.871(1), b = 10.330(1), c = 10.387(1) Å, α = 90.765(4)°, β = 114.277(4)°, γ = 99.908(3)°, V = 850.97(15) Å^3, Z = 2, D_c = 1.43 g cm^{-3}, $F(000)$ = 384, μ(Mo Kα) = 0.90 cm^{-1}, crystal dimensions 0.2 × 0.4 × 0.5 mm.

Speranberculatine A (7): gum: $[\alpha]^{18}_D$ −14.8° (*c* 0.50, MeOH); UV (MeOH) λ_{max} (log ϵ) 204 (3.79), 230 (2.44), 271 (sh) (2.04) nm; IR (KBr) ν_{max} 3283, 3012, 2954, 2925, 2855, 1778, 1714, 1700, 1628, 1516, 1449, 1371, 1312, 1262, 1233, 1105, 1075, 1036, 993, 933, 838, 798, 752, 667, 607, 542 cm^{-1}; ^{1}H NMR ($CDCl_3$, 400.13 MHz), see Table 1; ^{13}C NMR ($CDCl_3$, 100.62 MHz), see Table 2; EIMS *m*/*z* 282 $[M]^+$ (100), 267 (22), 265 (16), 250 (92), 235 (3), 221 (19), 208 (23), 193 (14), 181 (54), 165 (26), 154 (18), 136 (18), 123 (16), 108 (9), 95 (20), 80 (8), 42 (11); FABMS *m*/*z* 283 $[M + H]^+$ (100), 265 (65); HRFABMS *m*/*z* 283.0918 (calcd for $C_{12}H_{15}N_2O_6$ 283.0930), 265.0825 (calcd for $C_{12}H_{13}N_2O_5$ 265.0824).

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Supporting Information Available: Table showing atomic coordination and equivalent isotropic displacement parameters for speranculatines A (**3**) and B (**4**) and speranskilatine A (**6**). This material is available free of charge via the Internet at http://pubs.acs.org.

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(12) Crystallographic data for the structures reported in this paper have been deposited with the Cambridge Crystallographic Data Centre. Copies of the data can be obtained, free of charge, on application to the Director, CCDC, 12 Union Road, Cambridge CB2 1EZ, U.K. (Fax: +44-(0) 1223-336033 or e-mail: deposit@ccdc.cam.ac.uk).

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