Meehanines A−K, Spermidine Alkaloidal Glycosides from *Meehania urticifolia*

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From the whole plant of *Meehania urticifolia*, 11 new spermidine alkaloidal glycosides, meehanines A−K (**1**−**11**), were isolated. The structures of these new compounds were elucidated on the basis of the results of spectroscopic data analysis.

Polyamine alkaloids are found as basic components or secondary metabolites in certain plants and show various types of biological activities.[1–5] Cyclic spermidine alkaloids are a category of polyamine alkaloids[6] and include celacinnine and celabenzine from *Maytenus serrata* (Hochst. ex A. Rich.) R. Wilczek (Celastraceae),[7] mayfoline from *Maytenus buxifolia* (A. Rich.) Griseb,[8] dovyalicins from *Dovyalis macrocalyx* (Oliv.) Warb. (Flacourtiaceae),[9,10] and capparispine from *Capparis spinosa* L. (Capparidaceae).[11] In the present work, 11 new cyclic spermidine alkaloidal glycosides, meehanines A−K (**1**−**11**), were isolated from the whole plants of *Meehania urticifolia* (Miq.) Makino (Labiatae), and their structure elucidation is described herein. *M. urticifolia* is a herbaceous perennial and grows in the mountainous areas of East Asia. Its boiled shoots are consumed as a vegetable.[12] To the best of our knowledge, this is the first report on the glycosides of polyamine alkaloids from a plant belonging to the Labiatae.

Results and Discussion

An acetone extract of whole plant of *M. urticifolia* was dissolved in water and extracted with ether. The water layer was passed through a porous polymer gel Diaion HP-20 column. The methanol eluate was separated by preparative LPLC and HPLC to afford meehanines A−K (**1**−**11**). Each of them was isolated as an amorphous powder, and on the basis of HRFABMS, their molecular formulas were determined. Their ^{1}H and ^{13}C NMR spectra, measured in methanol-d_4 at 30 °C, showed the presence of two sets of closely spaced resonances at a ratio of 1:1 or more (Tables 1 and 2), due to the slow to intermediate exchange on the NMR time scale at 30 °C. To obtain its ^{1}H NMR spectrum under conditions of fast exchange, **1** was dissolved in DMSO-d_6 and recorded at temperatures from 30 to 120 °C in steps of 15 °C (Figure 2). The spectrum acquired at 30 °C showed separate sets of signals for each conformation (Table 3), and the distances between them decreased as the temperature rose. The spectrum acquired at 120 °C showed only one set of resonances (Table 3). The observations of these complicated signals were attributed to the hindered rotation of the amide bonds.[10,13–15]

Meehanine A (**1**) had the molecular formula $C_{42}H_{59}N_3O_{15}$ (see Experimental Section). The anomeric carbons at δ 98.8 and 106.7 (Table 2) suggested the presence of two monosaccharide moieties. The anomeric proton at δ 5.75 (d, J = 2 Hz) (Table 1), which was also observed in the ^{1}H−^{1}H COSY and differential HOHAHA spectra, showed the presence of a rhamnopyranose unit. The anomeric configuration of the rhamnosyl residue was determined to be α from the ^{13}C NMR chemical shifts at C-3 and C-5.[16] Sugar analysis showed the presence of L-rhamnose.[17] The anomeric proton at δ 4.57 (d, J = 7.5 Hz) along with the ^{1}H−^{1}H COSY and differential HOHAHA spectra demonstrated the presence of a β-glucopyranose unit. After appropriate sugar analysis D-glucose was evident.[17] The ^{1}H NMR [δ 7.85 (dd, J = 8, 2 Hz), 7.48 (tt, J = 8, 2 Hz), 7.27 (dd, J = 8, 8 Hz), 7.10 (d, J = 8.5 Hz), and δ 6.95 (d, J = 8.5 Hz)] and ^{13}C NMR (δ 156.5, 156.5, 137.7, 137.7, 134.1, 134.1, 131.1, 131.1, 130.5, 130.5, 129.5, 129.5, 128.5, and 117.5) data also suggested the presence of a monosubstituted and a 1,4-disubstituted benzene ring. In the ^{1}H−^{1}H COSY spectrum of **1**, the methyl protons at δ 0.89 (t, J = 7 Hz) and 0.85 (t, J = 7 Hz) were correlated with methylene protons H-3″ at δ 1.64 (m) and 1.40 (m). These methylene protons correlated with methine protons at δ 2.81 (m) and 2.65 (m), and the latter correlated with methyl protons at δ 1.06 (d, J = 7 Hz) and 1.04 (d, J = 7 Hz). The H-2″, -3″, and -5″ signals were long-range coupled with the amide carbon at δ 179.1 (C-1″) in the HMBC spectrum. These data suggested the presence of a CH_3-CH_2-CH(-CH_3)-C(=O)-N moiety. The protons at δ 4.98 (brt, J = 9 Hz) and 5.08 (brt, J = 9 Hz) and the ^{1}H−^{1}H COSY data were consistent with a N-$(CH_2)_2$-CH(-O)-CH_2-N moiety. The acetylic methyl protons at δ 1.92 (s) and 2.00 (s) and the protons at δ 5.08 (brt, J = 9 Hz, H-8) and 5.10 (brt, J = 9 Hz, H-8) were long-range coupled with the carbons at δ 172.6 and 172.3. Analysis of the ^{1}H NMR, ^{1}H−^{1}H COSY, and differential HOHAHA spectra showed the presence of a N-C(=O)-CH_2-CH-N and N-$(CH_2)_3$-N spin system. In the HMBC spectrum, the anomeric proton of Glc-1 [δ 4.57 (d, J = 7.5 Hz)] was long-range coupled with the carbon of Rha-2 (δ 81.8), and the Rha-2 proton [δ 4.04 (dd, J = 4, 2 Hz)] was long-range coupled with the anomeric carbon (Glc-1, δ 106.7). These data suggested that **1** has a β-D-glucopyranosyl-(1→2)-α-L-rhamnopyranosyl moiety. The aromatic protons H-3‴ and H-7‴ [δ 7.85 (dd, J = 8, 2 Hz)] and the protons of Glc-6 [δ 4.72 (dd, J = 12, 2 Hz), 4.37 (dd, J = 12, 6.5 Hz)] were long-range coupled with the ester carbon (C-1‴, δ 167.7), consistent with a benzoate at C-6 of the glucopyranose unit. The anomeric proton of the rhamnopyranose moiety was long-range coupled with the aromatic carbon at δ 156.5 (C-4′). The protons at δ 3.96 (dd, J = 9, 2 Hz, H-4) and 3.98 (dd, J = 9, 4 Hz, H-4) were long-range coupled with aromatic carbons at δ 137.7 (C-1′) and 128.5 (C-2′, C-6′). Other long-range couplings included the methylene protons at δ 2.24 (m, H-6) and 2.54 (overlapped, H-6) with the carbon at δ 61.6 (C-4), the methylene protons H_2-9 (δ 3.14, 3.60, 3.79, and 4.22) with the amide carbon the C-1″ (δ 179.1), the methylene protons at δ 3.60 and 3.66 (H_2-11) with the carbons at δ 50.7 and 52.9 (C-9), and the methylene protons at δ 3.40 and 3.50 (H_2-13) with the amide carbon C-2 (δ 174.7). These data suggested the planar configuration shown for **1**.

Meehanine B (**2**) had the molecular formula $C_{40}H_{57}N_3O_{14}$ (see Experimental Section). The ^{1}H and ^{13} C NMR spectra of **2** were

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Table 1. ^{1}H NMR Spectroscopic Data (δ_H (J in Hz), 400 MHz, CD_3OD) for Compounds **1**−**11**

position	1	2	3	4	5	6	7	8	9	10	11
2											
3	2.36, m	2.33, m	2.41, m	2.34, m	2.35, m	2.35, m	2.36, m	2.41[a]	2.38, m	2.41[a]	2.39[a]
4	3.96, dd (9, 2)	3.90[a]	4.02[a]	3.92, m	3.96, m	3.96, m	3.98, m	4.04, dd (12.5, 4)	3.90[a]	4.03, m	4.04, m
	3.98, dd (9, 4)		4.05[a]	3.96, m			3.95, m		3.95[a]		
6	2.24, m	2.21[a]	2.33[a]	2.22, m	2.35[a]	2.30[a]	2.29[a]	2.31[a]	2.28[a]	2.30−2.42[a]	2.30−2.65[a]
	2.54[a]	2.59[a]	2.38[a]	2.47, m	2.55[a]	2.35[a]	2.56, m	2.37[a]	2.69[a]	2.64−2.70[a]	
	2.58[a]		2.64[a]			2.55, m		2.68[a]			
			2.66[a]			2.66[a]					
7	1.56, m	1.41[a]	1.55, m	1.22, m	1.50[a]	1.52[a]	1.53[a]	1.50[a]	1.58−1.62[a]	1.53[a]	1.55[a]
		1.50[a]	1.59, m	1.64, m	1.55[a]	1.56[a]		1.62[a]		1.61[a]	1.62[a]
		1.59[a]									
8	4.98, brt (9)	3.25[a]	4.99, brt (8.5)	5.02, m	4.96, m	4.96, brt (9)	4.98, brt (9)	5.00, brt (9)	3.19[a]	4.99, m	4.99, brt (9)
	5.08, brt (9)	3.75[a]	5.10, brt (9)	5.22, m	5.05, m	5.07, brt (9)	5.04, brt (9)	5.10, brt (9)	3.80[a]	5.10, m	5.10, brt (9)
9	3.14, dd (14, 1.5)	3.48[a]	3.15, dd (14, 1)	3.39[a]	3.13[a]	3.13[a]	3.06[a]	3.15, dd (14, 1)	3.67[a]	3.14, m	3.14, dd (14, 1.5)
	3.60[a]	3.73[a]	3.55[a]	3.66, m	3.60[a]	3.60[a]	3.14[a]	3.59[a]	3.74[a]	3.58, m	3.59[a]
	3.79, brdd (16, 9)		3.80[a]	3.84, m	3.78[a]	3.77, dd (15.5, 10)	3.75[a]	3.80, dd (15, 9.5)		3.80, dd (14.5, 9.5)	3.80, dd (14, 9.5)
	4.22, dd (14, 9)		4.23, dd (14, 9)	4.31, m	4.20, dd (14, 9.5)	4.20, dd (14, 9.5)	4.19, dd (13.5, 9)	4.23, dd (14, 9)		4.23, dd (14.5, 9.5)	4.23, dd (14, 9.5)
11	3.11[a]	3.15[a]	3.08[a]	3.39[a]	3.00−3.15[a]	2.98−3.11[a]	2.98−3.12[a]	3.09[a]	3.00[a]	3.10[a]	3.00−3.11[a]
	3.32[a]	3.62[a]	3.32[a]	3.87[a]	3.60[a]	3.55−3.73[a]	3.61[a]	3.36[a]	3.15[a]	3.60[a]	3.38[a]
	3.60[a]		3.59[a]		3.68[a]		3.66[a]	3.60[a]	3.47[a]	3.67[a]	3.60−3.70[a]
	3.66[a]		3.68[a]					3.62[a]	3.65[a]		
12	1.60[a]	1.61[a]	1.53, m	1.46[a]	1.52[a]	1.50[a]	1.55[a]	1.60[a]	1.57[a]	1.53[a]	1.55[a]
	2.05[a]	2.07[a]	2.08, m	1.69[a]	1.98−2.15[a]	2.04[a]	2.05, brt (7)	2.05, m	1.62[a]	2.03−2.20[a]	1.95−2.15[a]
				1.83[a]					2.08[a]		
				2.11[a]							
13	3.05[a]	2.98, m	3.04, m	2.88[a]	3.03[a]	3.04[a]	3.04[a]	3.05[a]	3.01[a]	3.02[a]	3.05[a]
	3.09[a]	3.44[a]	3.08, m	3.25[a]	3.10[a]	3.11[a]	3.11[a]	3.09[a]	3.47[a]	3.04[a]	3.09[a]
	3.40[a]	3.51[a]	3.33[a]		3.39[a]	3.34[a]	3.36[a]	3.34[a]		3.40[a]	3.40[a]
	3.50[a]		3.52[a]		3.50[a]	3.45[a]	3.50[a]	3.49[a]		3.52[a]	3.51[a]
Ac C=O											
Ac CH_3	1.92, s		1.91, s	1.97, s	1.93, s	1.92, s	1.93, s	1.92, s		1.92, s	1.91, s
	2.00, s		2.00, s	2.00, s	2.00, s	2.00, s	2.00, s	2.00, s		2.00, s	2.00, s
1′											
2′	7.10, d (8.5)	7.10, d (8.5)	7.23, d (8)	7.09, d (8.5), 7.11, d (8.5)	7.10, d (8.5)	7.10, d (8.5)	7.10, d (8)	7.23, d (8)	7.21, d (8)	7.21, d (8)	7.25, d (7.5)
3′	6.95, d (8.5)	6.95, d (8.5)	7.07, d (8)	6.74, d (8.5), 6.75, d (8.5)	6.95, d (8.5)	6.95, d (8.5)	6.95, d (8)	7.05, d (8)	7.04, d (8)	7.00, d (8)	7.05, d (7.5)
4′											
5′	6.95, d (8.5)	6.95, d (8.5)	7.07, d (8)	6.74, d (8.5), 6.75, d (8.5)	6.95, d (8.5)	6.95, d (8.5)	6.95, d (8)	7.05, d (8)	7.04, d (8)	7.00, d (8)	7.05, d (7.5)
6′	7.10, d (8.5)	7.10, d (8.5)	7.23, d (8)	7.09, d (8.5), 7.11, d (8.5)	7.10, d (8.5)	7.10, d (8.5)	7.10, d (8)	7.23, d (8)	7.21, d (8)	7.21, d (8)	7.25, d (7.5)
Rha-1	5.75, d (2)	5.76, d (2)	5.81, d (1.5)	5.75, d (2)	5.76, d (1.5)	5.76, d (1.5)	5.75, d (2)	5.69, d (2)	5.70, d (1.5)	5.71, d (2)	5.73, d (2)
-2	4.04, dd (4, 2)	4.04, dd (4, 2)	4.09, dd (3.5, 1.5)	4.03[a]	4.04, dd (3.5, 1.5)	4.04, dd (3.5, 1.5)	4.03, dd (3.5, 2)	3.99, dd (3.5, 2)	3.98, dd (3.5, 1.5)	4.00, dd (3.5, 2)	3.99, dd (3.5, 2)
-3	3.90, dd (10, 4)	3.89, dd (10, 4)	3.91, dd (9.5, 3.5)	3.88[a]	3.90, dd (9.5, 3.5)	3.89, dd (9.5, 3.5)	3.89, dd (9.5, 3.5)	3.91, dd (9.5, 3.5)	3.89, dd (9.5, 3.5)	3.90, dd (9.5, 3.5)	3.90, dd (9.5, 3.5)
-4	3.44, dd (10, 10)	3.44[a]	3.46, dd (9.5, 9.5)	3.44[a]	3.43[a]	3.44, dd (9.5, 9.5)	3.44, dd (9.5, 9.5)	3.44, dd (10, 9.5)	3.41[a]	3.43, m	3.45[a]
-5	3.60[a]	3.57[a]	3.67[a]	3.60[a]	3.59[a]	3.60[a]	3.60[a]	3.60[a]	3.58[a]	3.59, m	3.60[a]
-6	1.19, d (6)	1.18, d (6)	1.22, d (6)	1.18, d (6)	1.18, d (6.5)	1.19, d (6.5)	1.19, d (6)	1.21, d (6)	1.20, d (6.5)	1.20, d (6.5)	1.21, d (6)
Glc-1	4.57, d (7.5)	4.56, d (7.5)	4.52, d (7.5)	4.56, d (7.5)	4.56, d (7.5)	4.56, d (7.5)	4.56, d (7.5)	4.49, d (7.5)	4.48, d (7.5)	4.51, d (7.5)	4.48, d (7.5)
-2	3.37, dd (7.5, 8)	3.33, dd (7.5, 8)	3.30[a]	3.36[a]	3.38[a]	3.36, dd (7.5, 8)	3.33[a]	3.29[a]	3.30[a]	3.33[a]	3.33[a]
-3	3.42, dd (8, 8)	3.41[a]	3.30−3.40[a]	3.40[a]	3.44[a]	3.38[a]	3.30−3.45[a]	3.38[a]	3.42[a]	3.39[a]	3.35[a]
-4	3.42, dd (8, 8)	3.39[a]	3.30−3.40[a]	3.40[a]	3.40[a]	3.41, dd (8, 8)	3.41[a]	3.30[a]	3.38[a]	3.30[a]	3.30[a]
-5	3.64, m	3.62[a]	3.30[a]	3.61[a]	3.62[a]	3.59[a]	3.63[a]	3.49[a]	3.64[a]	3.51[a]	3.49[a]
-6	4.37, dd (12, 6.5)	4.35, dd (12.5, 6.5)	3.65[a]	4.34, dd (12, 6)	4.35, dd (11.5, 6.5)	4.35, dd (11.5, 6.5)	4.36, dd (12, 6.5)	4.12, dd (12, 6.5)	4.11, dd (11.5, 6.5)	4.19, dd (11.5, 6.5)	4.13, dd (11.5, 6.5)
	4.72, dd (12, 2)	4.73, dd (12.5, 1.5)	3.84, dd (11, 1.5)	4.72, dd (12, 2)	4.72, dd (11.5, 2)	4.72, dd (11.5, 2)	4.72, dd (12, 1.5)	4.50, dd (12, 2)	4.50, dd (11.5, 2)	4.49, dd (11.5, 2)	4.45, dd (11.5, 2)
1″											
2″	2.65, m	2.72, m	2.66, m		2.20−2.60[a]	2.87, sep (6.5)	2.47, q (7.5)	2.65, m	2.71[a]	2.65[a]	2.63, m
	2.81, m	2.98, m	2.81, m		2.65, m	3.09[a]		2.82, m	2.96[a]	2.82, m	2.81, m

Table 1. Continued

position	1	2	3	4	5	6	7	8	9	10	11
3′′	1.40, m	1.40[a]	1.40, m	7.33, m	1.61[a]	1.06, t (6.5)	1.10, t (7.5)	1.44, m	1.31[a]	1.41, m	1.42, m
	1.64, m	1.68[a]	1.64, m	7.38, m	2.16[a]	1.08, t (6.5)		1.62, m	1.42[a]	1.65, m	1.65, m
					2.30[a]				1.66[a]		
4′′	0.85, t (7)	0.87, t (7)	0.85, t (7.5)	7.45[a]	0.95, t (7)			0.85, t (7)	0.86, t (7)	0.85, t (7)	0.85, t (7.5)
	0.89, t (7)		0.89, t (7.5)		0.96, t (7)			0.89, t (7)		0.89, t (7)	0.89, t (7.5)
5′′	1.04, d (7)	1.02, d (7)	1.04, d (6)	7.45[a]				1.04, t (7)	1.02, d (7)	1.04, d (7)	1.04, d (7)
	1.06, d (7)	1.13, d (7)	1.05, d (6)					1.06, t (7)	1.12, d (7)	1.06, d (7)	1.06, d (7)
6′′				7.45[a]							
7′′				7.33, m							
				7.38, m							
1′′′											
2′′′								2.18, m	2.17, m		2.04, t (7)
3′′′	7.85, dd (8, 2)	7.85,		7.83,	7.84, brd (8)	7.84, brd (8)	7.85, dd (8, 2)	1.29, m	1.31[a]	6.71, m	1.41, m
		dd (7.5, 1.5)		dd (7.5, 2)							
				7.85,				1.49, m	1.44[a]		
				dd (7.5, 2)							
4′′′	7.27, t (8)	7.28, t (7.5)		7.26[a]	7.28, t (8)	7.27, t (8)	7.28, t (8)	0.77, t (7)	0.76, t (7)	1.57, d (7)	0.79, t (7.5)
5′′′	7.48, tt (8, 2)	7.49, tt (7.5, 7.5)		7.45[a]	7.49, tt (8, 2)	7.49, tt (8, 2)	7.49, tt (8, 2)	0.96, d (7)	0.94, d (7)	1.64, s	
6′′′	7.27, t (8)	7.28, t (7.5)		7.26[a]	7.28, t (8)	7.27, t (8)	7.28, t (8)				
7′′′	7.85, dd (8, 2)	7.85,		7.83,	7.84, brd (8)	7.84, brd (8)	7.85, dd (8, 2)				
		dd (7.5, 1.5)		dd (7.5, 2)							
				7.85, dd (7.5, 2)							

[a] Unclear signal pattern due to overlapping.

Figure 1. Structures of **1**−**11**.

similar to those of **1** except for the lack of signals for an acetyl group at the C-8 position. The methine proton signals at δ 3.75 (overlapped, H-8) and 3.25 (overlapped, H-8) suggested that **2** is the hydroxyl analogue of **1**, as shown.

Meehanine C (**3**) had the molecular formula $C_{35}H_{55}N_3O_{14}$ (see Experimental Section). The ^{1}H and ^{13}C NMR spectra of **3** were similar to those of **1**. The ^{1}H NMR spectroscopic data at δ 3.65 (overlapped, Glc-6) and 3.84 (dd, J = 11, 1.5 Hz, Glc-6) suggested that the benzoate of **1** was absent in **3**. From these data, the structure of **3** was determined.

Meehanine D (**4**) had the molecular formula $C_{44}H_{55}N_3O_{15}$ (see Experimental Section). The ^{1}H and ^{13}C NMR spectra of **4** were similar to those of **1**. The ^{1}H NMR signals at δ 7.33 (m), 7.38 (m), and 7.45 (overlapped) and the ^{13}C NMR signals at δ 127.1, 128.2, 129.5, 130.6, 130.7, and 130.8 suggested the presence of another monosubstituted benzene ring. Hence, compound **4** contains a benzamide moiety instead of the 2-methylbutyramide moiety of **1**.

Meehanine E (**5**) had the molecular formula $C_{41}H_{57}N_3O_{15}$ (see Experimental Section). The ^{1}H and ^{13}C NMR spectra of **5** were similar to those of **1**. The ^{1}H NMR signals at δ 0.95 (t, J = 7 Hz), 0.96 (t, J = 7 Hz), 1.61 (overlapped), 2.16 (overlapped), 2.30 (overlapped), 2.20−2.60 (overlapped), and 2.65 (m) and the ^{13}C NMR signals at δ 14.2, 14.3, 20.0, 20.1, 35.6, 175.6, and 175.7 suggested that **5** possesses a butyramide moiety instead of the 2-methylbutyramide moiety of **1**. Hence, the structure of **5** was formulated as shown.

Meehanine F (**6**) had the molecular formula $C_{41}H_{57}N_3O_{15}$ (see Experimental Section). The ^{1}H and ^{13}C NMR spectra of **6** were similar to those of **1**. The ^{1}H NMR signals at δ 1.06 (t, J = 6.5 Hz), 1.08 (t, J = 6.5 Hz), 2.87 (sep, 6.5), and 3.09 (overlapped) and the ^{13}C NMR signals at δ 19.4, 19.7, 20.1, 20.2, 30.7, 31.2, 179.7, and 179.8 suggested that **6** has an isobutyramide moiety instead of a 2-methylbutyramide moiety as in **1**. Hence, the structure of **6** was formulated as shown.

Table 2. ^{13}C NMR Spectroscopic Data (δ_C, 400 MHz, CD_3OD) for Compounds **1**−**11**

position	1	2	3	4	5	6	7	8	9	10	11
2	174.7	175.0	174.7	174.7	174.7, 174.8	174.7, 174.8	174.6, 174.7	174.7	174.9, 175.0	174.7, 174.8	174.7, 174.8
3	46.5, 46.7	46.8, 47.0	46.5, 46.6	46.5, 46.6	46.6, 46.8	46.5, 46.7	46.5, 46.6	46.5, 46.7	46.9, 47.0	46.6, 46.8	46.6, 46.8
4	61.6, 61.8	61.4, 62.0	61.6, 61.8	61.5, 61.8	61.9	61.8	61.7	61.6, 61.8	61.5, 62.1	61.7, 61.9	61.7, 61.9
6	46.1, 46.9	46.4	46.0, 46.8	46.9	46.3, 47.0	46.3, 46.9	46.1, 46.9	46.0, 46.9	46.4	46.1, 47.0	46.1, 47.0
7	33.0, 33.2	35.3, 36.1	33.0, 33.2	33.3	33.1, 33.3	33.1, 33.2	33.0, 33.1	33.1, 33.2	35.4, 36.1	33.1, 33.3	33.1, 33.3
8	74.8, 75.8	71.6, 75.0	74.8, 75.6	74.7, 75.7	75.1, 75.9	74.9, 75.9	74.9, 75.7	74.8, 75.7	71.6, 75.0	74.9, 75.8	74.9, 75.7
9	50.7, 52.9	54.9, 55.9	50.7, 53.0	50.6, 55.2	50.6, 53.3	50.8, 53.2	50.6, 53.5	50.7, 53.0	54.9, 55.9	50.8, 53.0	50.8, 53.0
11	44.4, 45.3	44.9, 45.9	44.4, 45.4	43.9	44.2, 45.8	44.3, 45.5	44.2, 45.6	44.4, 45.4	44.8, 46.0	44.5, 45.4	44.5, 45.4
12	29.7, 32.0	29.7, 31.4	29.7, 32.0	31.1, 32.8	29.9	29.8, 31.7	29.8, 30.9	29.7, 31.9	29.5, 31.4	29.8, 32.0	29.8, 32.0
13	36.9, 37.1	37.1, 37.5	37.0, 37.2	36.9, 37.1	37.0, 37.2	36.9, 37.1	37.0, 37.1	37.0, 37.2	37.1, 37.5	37.0, 37.2	37.0, 37.2
Ac C=O	172.3, 172.6		172.3, 172.6	172.2, 172.8	172.2, 172.8	172.2, 172.6	172.1, 172.7	172.3, 172.6		172.3, 172.7	172.3, 172.7
Ac CH_3	21.2		21.2	21.2, 21.3	21.1, 21.3	21.1, 21.2	21.0, 21.1	21.2		21.3	21.2
1′	137.7	137.9	137.9	137.6, 137.7	137.8	137.8	137.8	137.9	138.0, 138.1	138.9	138.0
2′	128.5	128.5	128.6	128.5	128.5	128.5, 128.6	128.5	128.6	128.5	128.6	128.7
3′	117.5	117.6	117.8	117.6	117.6	117.6	117.6	117.6	117.6	117.7	117.7
4′	156.5	156.5	156.9	156.6	156.6	156.6	156.6	156.8	156.8	156.6	157.0
5′	117.5	117.6	117.8	117.6	117.6	117.6	117.6	117.6	117.6	117.7	117.7
6′	128.5	128.5	128.6	128.5	128.5	128.5, 128.6	128.5	128.6	128.5	128.6	128.7
Rha-1	98.8	98.8	98.9	98.8	98.9	98.8	98.8	98.9	98.9	98.8	99.0
-2	81.8	81.8	82.0	81.8	81.9	81.8	81.8	81.9	82.0	81.9	82.1
-3	72.0	72.0	72.2	72.0	72.1	72.0	72.0	72.1	72.1	72.1	72.1
-4	74.1	74.2	74.3	74.2, 74.3	74.2	74.2	74.1	74.2	74.2	74.2	74.2
-5	70.4	70.4	70.6	70.4	70.5	70.4	70.4	70.4	70.4	70.5	70.5
-6	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.1
Glc-1	106.7	106.7	106.9	106.7	106.8	106.7	106.7	106.7	106.8	106.8	106.8
-2	75.7	75.5	75.5	75.5	75.8	75.8	75.5	75.6	75.4	75.7	75.6
-3	77.8	77.8	78.1	77.8	77.9	77.8	77.8	77.8	77.8	77.9	77.8
-4	71.6	71.7	71.4	71.7	71.7	71.7	71.6	71.6	71.6	71.8	71.7
-5	75.5	75.8	78.0	75.5	75.5	75.5	75.3	75.4	75.6	75.5	75.4
-6	65.2	65.2	62.7	65.2	65.3	65.2	65.2	64.3	64.3	64.8	64.6
1″	179.1	179.7, 181.2	179.1	174.1, 174.3	175.6, 175.7	179.7, 179.8	176.4	179.1	179.7, 181.1	179.1, 179.2	179.2
2″	38.1, 38.7	37.9, 38.8	38.1, 38.7	130.6	35.6	30.7, 31.2	26.8	38.1, 38.7	37.9, 38.8	38.2, 38.8	38.2, 38.8
3″	27.5, 28.1	27.9, 28.4	27.5, 28.1	127.1, 128.2	20.0, 20.1	19.4, 19.7, 20.1, 20.2	9.9, 10.1	27.5, 28.1	27.9, 28.3	27.6, 28.2	27.6, 28.2
4″	12.4	12.2, 12.4	12.4, 12.5	129.5	14.2, 14.3			12.4, 12.5	12.2, 12.4	12.5	12.5
5″	17.8, 18.5	17.9, 18.5	17.8, 18.4	130.7, 130.8				17.8, 18.4	17.9, 18.5	17.9, 18.5	17.8, 18.5
6″				129.5							
7″				127.1, 128.2							
1‴	167.7	167.8		167.8	167.8	167.8	167.8	177.9	177.9	169.3	175.0
2‴	131.1	131.2		131.2	131.2	131.2	131.1	42.3	42.3	129.4	35.1, 36.8
3‴	130.5	130.5		130.5	130.6	130.5	130.5	27.5	27.8	137.9	19.4, 19.5
4‴	129.5	129.5		129.7	129.6	129.5	129.5	12.0	12.0	14.4	14.0
5‴	134.1	134.1		134.1	134.2	134.1	134.1	16.9	17.0	12.1	
6‴	129.5	129.5		129.7	129.6	129.5	129.5				
7‴	130.5	130.5		130.5	130.6	130.5	130.5				

Meehanine G (**7**) had the molecular formula $C_{40}H_{55}N_3O_{15}$ (see Experimental Section). The ^1H and ^{13}C NMR spectra of **7** were similar to those of **1**. However, the ^1H NMR signals at δ 1.10 (d, $J = 7.5$ Hz) and 2.47 (q, $J = 7.5$ Hz) and the ^{13}C NMR signals at δ 9.9, 10.1, 26.8, and 176.4 were supportive of **7** having a propanamide moiety instead of a 2-methylbutyramide moiety as in **1**. Hence, the structure of **7** was formulated as shown.

Meehanine H (**8**) had the molecular formula $C_{40}H_{63}N_3O_{15}$ (see Experimental Section). The ^1H and ^{13}C NMR spectra of **8** were similar to those of **1**. The ^1H NMR data at δ 0.77 (t, $J = 7$ Hz), 0.96 (d, $J = 7$ Hz), 1.29 (m), 1.49 (m), and 2.18 (m) and the ^{13}C NMR peaks at δ 12.0, 16.9, 27.5, 42.3, and 177.9 suggested that **8** has a 2-methybutyrate moiety instead of a benzoate moiety of **1**. Hence, the structure of **8** was formulated as shown.

Meehanine I (**9**) had the molecular formula $C_{38}H_{61}N_3O_{14}$ (see Experimental Section). The ^1H and ^{13}C NMR spectra of **9** were similar to those of **8**. The protons at δ 3.80 (overlapped, H-8) and 3.19 (overlapped, H-8) suggested that **9** has a hydroxyl group instead of an acetyl group of **8**, and the structure of this compound was determined as shown.

Meehanine J (**10**) had the molecular formula $C_{40}H_{61}N_3O_{15}$ (see Experimental Section). The ^1H and ^{13}C NMR spectra of **10** were similar to those of **8**. The ^1H NMR signals at δ 1.57 (d, $J = 7$ Hz), 1.64 (s), and 6.71 (m) and the ^{13}C NMR signals at δ 12.1, 14.4, 129.4, 137.9, and 169.3 suggested that **10** has a *trans*-2-methyl-2-butenoate moiety instead of a 2-methylbutyrate moiety as in **8**. Hence, the structure of **10** was formulated as shown.

Meehanine K (**11**) had the molecular formula $C_{39}H_{61}N_3O_{15}$ (see Experimental Section). The ^1H and ^{13}C NMR spectra of **11** were similar to those of **8**. The ^1H NMR signals at δ 0.79 (t, $J = 7.5$ Hz), 1.41 (m), and 2.04 (t, $J = 7$ Hz) and the ^{13}C NMR signals at δ 14.0, 19.4, 19.5, 35.1, 36.8, and 175.0 suggested that **11** has a butyrate moiety instead of a 2-methylbutyrate moiety of **8**. Hence, the structure of **11** was formulated as shown.

The CD spectra of **1**−**3** and **5**−**11** showed a negative Cotton effect at 210−230 nm, suggesting the absolute stereochemistry of C-4 to be *S* in these compounds.[18] Compound **4** did not show a Cotton effect at 210−230 nm. The optical rotation of **4** was negative, similar to those of **1**−**3** and **5**−**11**. Accordingly, the absolute configuration of C-4 of compound **4** was assumed to be *S*.

Acid hydrolysis of **1** gave an aglycone (**1a**), that of **8** gave 2-methylbutyric acid and **1a**, and that of **1a** gave 2-methylbutyric acid.

The absolute stereochemistry of C-8 of the aglycone moiety was investigated by means of the Mosher's method.[19] *N*-Acetylation of **1a** gave a 5-*N*-acetylated aglycone (**1b**). Treatment of **1b** with (*R*)-(−)- and (*S*)-(+)-MTPA chloride under moderate conditions gave the 8-*O*-esters of (*S*)-(−)-MTPA (**1c**) and (*R*)-(+)-MTPA (**1d**), respectively. The value of the ^1H NMR chemical shift differences [$\Delta\delta$ (ppm) = δ **1c** − δ **1d**] suggested that the absolute configuration of C-8 was *R* (Table 4).

The configuration of the 2-methylbutyryl moiety was investigated by means of comparison of the amide, for which the moiety was derivatized with the chiral reagent (*S*)-1-(1-naphthyl)ethylamine with authentic diastereomeric amides by HPLC.[20,21] Accordingly, the stereochemistry of the 2-methylbutyric acid, a component of both **8** and **1a**, was suggested to be (*S*)-2-methylbutyric acid. It

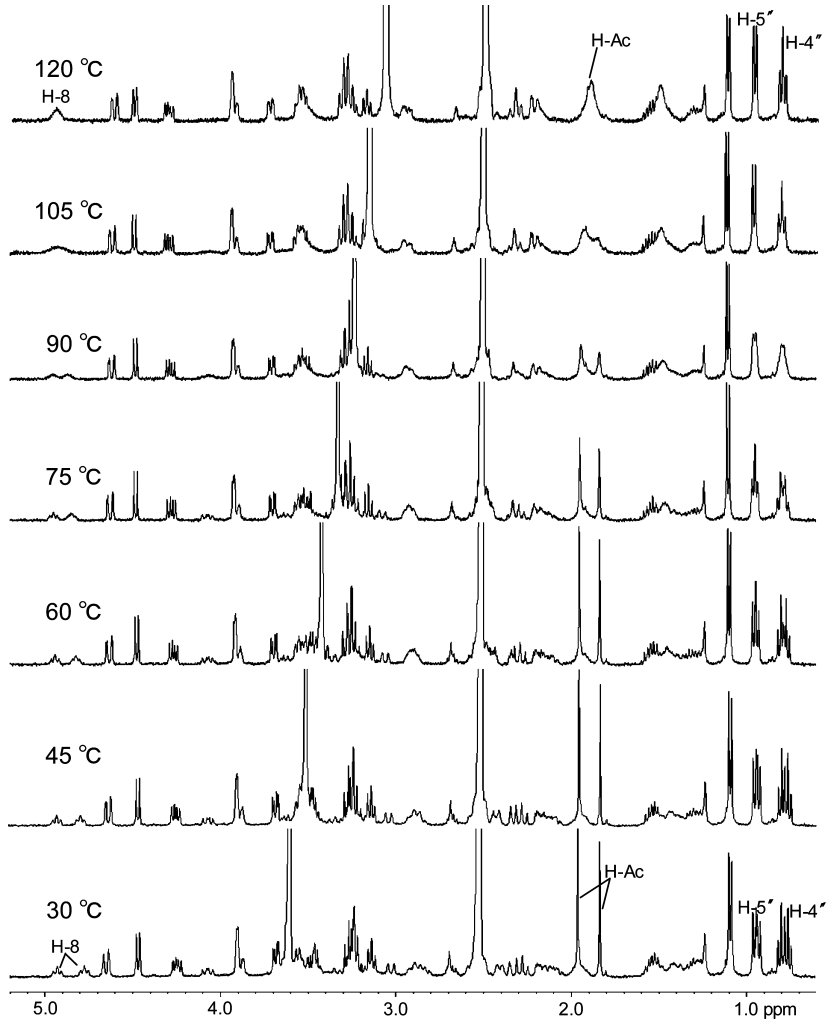

Figure 2. Temprature dependence of ^{1}H NMR spectra of **1** in DMSO-d_6−D_2O (9:1) between 30 and 120 °C.

was concluded that the absolute stereochemistry of the 2-methylbutyryl moieties at Glu-6-*O*- in **8** and 10-*N*- in **1a** was *S*.

Acid hydrolysis of **2** and **9** gave an aglycone (**1a**). The ^{1}H NMR and ^{13}C NMR spectra of **2**−**7** and **9**−**11** were in part almost superimposable with those of **1** or **8**.

In conclusion, the absolute stereochemistry of C-8 in compounds **1**−**11** and the 2-methylbutyramide and 2-methylbutyrate configurations in compounds containing these moieties were determined as shown (Figure 1).

Experimental Section

General Experimental Procedures. Optical rotations were measured on a JASCO P-2300 polarimeter. CD spectra were recorded on a JASCO J-700 spectropolarimeter. ^{1}H NMR (400 MHz) and ^{13}C NMR (100 MHz) spectra were recorded on a JEOL JNM-AL400 spectrometer, and chemical shifts are given as δ values with TMS as an internal standard at 30 °C. Inverse-detected heteronuclear correlations were measured using HMQC (optimized for $^1J_{C-H}$ = 145 Hz) and HMBC (optimized for $^nJ_{C-H}$ = 8 Hz) pulse sequences with a pulsed field gradient. HRFABMS data were obtained on a JEOL JMS700 mass spectrometer, using *m*-nitrobenzyl alcohol or glycerol matrix. Preparative HPLC was performed on a JASCO 2089 instrument.

Plant Material. *Meehania urticifolia* was collected in July 2007 in Sendai, Japan. The plant was identified by Dr. Koji Yonekura, Tohoku University, Sendai, Japan. A voucher specimen is deposited at the herbarium of Tohoku Pharmaceutical University, No. 20070727.

Extraction and Isolation. The powdered whole plants (760 g) of *M. urticifolia* were extracted with methanol (12 L) twice at room temperature for a month. The methanol extract was concentrated at reduced pressure, suspended in water (1.5 L), and extracted with ether (1.0 L) three times. The water layer (98.52 g) occurred as a red-brown syrup. It was dissolved in water, and the aqueous solution was passed through a porous polymer gel column (Mitsubishi Diaion HP-20, 70 × 180 mm) and eluted with water, 10%, 45%, 90% MeOH, and MeOH. The 90% MeOH eluate (5.5 g) was chromatographed on a reversed-phase column using ODS (Cosmosil 140C_{18}−OPN, Nacalai Tesque, 150 g) and was eluted with 20%, 30%, 40%, 50%, 60%, and 80% MeOH (fractions 1A−1F). Fraction 1C (1.214 g) was subjected to preparative LPLC [column, Yamazen, Ultra Pack ODS-SM-50C-M, 37 × 100 mm; solvent, methanol−0.2% TFA (50:50); detector, UV 210 nm] to give 10 fractions (2A−2J). Fractions 2B and 2C (220.6 mg) were subjected to preparative LPLC [column, Yamazen, Ultra Pack ODS-SM-50C-M, 37 × 100 mm; solvent, methanol−0.2% TFA (50:50 → 60:40); detector, UV 210 nm] and HPLC [columns, Tosoh, ODS-100V, 20 × 250 mm; solvent, acetonitrile−water (30:70); detector, UV 210 nm, Shiseido, Capcell-Pak Ph, 20 × 250 mm; solvent, acetonitrile−water (30:70 or 22.5:77.5); detector, UV 210 nm and Kanto Chemical, Mightysil RP-18 GP, 10 × 250 mm; solvent, acetonitrile−water (25:75); detector, UV 210 nm] to yield compounds **2** (4.4 mg), **6** (8.0 mg), **7** (4.4 mg), and **9** (2.6 mg). Fraction 1D (801.0 mg) was subjected to preparative LPLC [column, Yamazen, Ultra Pack ODS-SM-50C-M, 37 × 100 mm; solvent, methanol−water (55:45); detector, UV 210 nm], to give nine fractions (3A−3I). Fractions 3D and 3E (184.8 mg) were subjected to preparative HPLC [columns, Tosoh, ODS-100V, 20 × 250 mm; solvent, acetonitrile−water (30:70); detector, UV 210 nm, Shiseido, Capcell-Pak Ph, 20 × 250 mm; solvent, acetonitrile−water (30:70); detector, UV 210 nm and Kanto Chemical, Mightysil RP-18 GP, 10 × 250 mm; solvent, acetonitrile−water (22.5:77.5 or 30:70); detector, UV 210 nm] to yield compounds **1** (42.6 mg), **3** (2.6 mg), **4** (2.8 mg), **5** (7.7 mg), **8** (34.1 mg), **10** (2.0 mg), and **11** (4.4 mg). Fraction 3F (155.5 mg) was subjected to preparative HPLC [columns,

Table 3. ^{1}H NMR Spectroscopic Data [δ_H (J in Hz), 400 MHz, DMSO-d_6−D_2O (9:1)] for Compound **1**

position	fast exchange (120 °C)	conformation I (30 °C)	conformation II (30 °C)
3	2.21, brd (14)	2.13−2.32[a]	2.13−2.32[a]
	2.34, brdd (14, 14)		
4	3.93[a]	3.89[a]	3.89[a]
6	2.20[a]	2.03−2.21[a]	2.03−2.21[a]
	2.54[a]	2.37−2.60[a]	2.37−2.60[a]
7	1.40−1.55[a]	1.56, m	1.52, m
8	4.95, m	4.93, brt (9)	4.77, brt (9)
9	3.15−3.30[a]	4.07, m	3.63[a]
		3.27, (m)	
11	3.40−3.60[a,b]	2.80−3.65[a,b]	2.80−3.65[a,b]
12	1.51[a]	1.23−1.40[a]	1.36−1.60[a]
		1.90−2.00[a]	2.05−2.21[a]
13	3.40−3.60[a,b]	2.80−3.65[a,b]	2.80−3.65[a,b]
Ac CH_3	1.90, s	1.84, s	1.96, s
2′, 6′	7.11, brd (8.5)	7.13, brd (8.5)	7.13, brd (8.5)
3′, 5′	6.88, brd (8.5)	6.90, brd (8.5)	6.90, brd (8.5)
Rha-1	5.49, brs	5.56, brs	5.56, brs
−2	3.95, dd (3.5, 1.5)	3.90, dd (3.5, 1.5)	3.90, dd (3.5, 1.5)
−3	3.73, dd (9.5, 3.5)	3.68, dd (9.5, 3.5)	3.68, dd (9.5, 3.5)
−4	3.29[a]	3.53[a]	3.53[a]
−5	3.29[a]	3.46[a]	3.46[a]
−6	1.12, d (6.5)	1.09, d (6.5)	1.09, d (6.5)
Glc-1	4.50, d (7.5)	4.47, d (7.5)	4.47, d (7.5)
−2	3.18, dd (8, 7.5)	3.24, dd (8, 7.5)	3.24, dd (8, 7.5)
−3	3.29[a]	3.24[a]	3.24[a]
−4	3.29[a]	3.24[a]	3.24[a]
−5	3.56[a]	3.56[a]	3.56[a]
−6	4.31, dd (11.5, 6.5)	4.25, dd (11.5, 6.5)	4.25, dd (11.5, 6.5)
	4.62, dd (11.5, 2)	4.65, dd (11.5, 2)	4.65, dd (11.5, 2)
2″	2.60[a]	2.53[a]	2.67, m
3″	1.32, m	1.28[a]	1.28[a]
	1.57, m	1.54[a]	1.54[a]
4″	0.81, t (7.5)	0.76, t (7.5)	0.80, t (7.5)
5″	0.97, d (7)	0.93, d (7)	0.95, d (7)
3‴, 7‴	7.84, brd (8)	7.80, brd (7.5)	7.80, brd (7.5)
4‴, 6‴	7.34, brdd (8, 7.5)	7.31, brdd (7.5, 7.5)	7.31, brdd (7.5, 7.5)
5‴	7.53, brt (7.5)	7.54, brt (7.5)	7.54, brt (7.5)

[a] Unclear signal pattern due to overlapping. [b] Data were obtained from the ^{1}H−^{1}H COSY spectra.

Table 4. NMR Spectroscopic Data (400 MHz, CD_3OD) for Compounds **1a**−**1d**

	1a		**1b**	**1c**		**1d**		**1c**−**1d**	
position	δ_H (J in Hz)	δ_C	δ_H (J in Hz)	δ_H (J in Hz)		δ_H (J in Hz)		$\Delta\delta_H$	
			major	major (73)[a]	minor (27)[a]	major (69)[a]	minor (31)[a]	major	minor
2		171.7, 171.8							
3	2.89, m	39.0, 39.3	3.05, m	2.83, m	2.95, m	2.66, m	2.84, m	+0.17	+0.11
	3.25, m		3.12, m	3.15, dd (16, 3.5)	3.15, m	3.09[b]	3.09[b]	+0.06	+0.06
4	4.80[b]	60.2, 60.3	5.75, dd (11.5, 3.5)	5.68, dd (11.5, 3.5)	5.77, dd (11.5, 3.5)	5.62, dd (12.5, 3.5)	5.71, dd (12.5, 2.5)	+0.06	+0.06
6	3.18−3.28[b]	41.9, 42.3	2.60−2.85[b]	2.58, m	2.58[b]	2.30[b]	2.40[b]	+0.28	+0.18
			3.60−3.75[b]	3.65[b]	3.65[b]	3.35[b]	3.55[b]	+0.30	+0.10
7	1.72−2.05[b]	30.1, 30.8	1.57[b]	2.01[b]	2.00[b]	1.97[b]	1.95[b]	+0.04	+0.05
			1.89, m						
8	3.89, m	68.9, 69.5	3.81, m	5.28, m	5.12, m	5.33, m	5.24, m	−0.05	−0.01
	4.02, m								
9	3.26[b]	50.7, 52.7	2.77[b]	2.94, dd (15.5, 8.5)	2.74[b]	3.08[b]	2.86[b]	−0.14	−0.12
	3.37[b]		3.54, m	3.81, dd, 15.5, 2.5)	4.40, m	3.95, dd (15, 3.5)	4.50, m	−0.14	−0.10
	3.49[b]								
	3.52[b]								
11	3.75, m	45.5, 47.2	3.65[b]	3.66[b]		3.72[b], m		−0.06	
12	1.94−2.05[b]	31.8	1.45−1.65[b]	1.58[b]		1.50−1.60[b]			
				2.16[b]		2.24[b]		−0.08	
				2.61[b]		2.60[b]		+0.01	
13	3.04, m	37.7, 38.1	2.28−2.75[b]	2.85[b]		2.87[b]		−0.02	
	3.50, m			3.55[b]		3.64[b]		−0.09	
5-*N*-Ac CH_3			2.51, s	2.40, s	2.50, s	2.35, s	2.46, s	+0.05	+0.04
1′		126.7							
2′	7.37, brd (8.5)	117.1	7.34, brd (8.5)	7.27, brd (8.5)		7.17, brd (8.5)		+0.10	
3′	6.89, brd (8.5)	130.7	7.15, brd (8.5)	7.15, brd (8.5)		7.13, brd (8.5)		+0.02	
4′		160.2							
5′	6.89, brd (8.5)	130.7	7.15, brd (8.5)	7.15, brd (8.5)		7.13, brd (8.5)		+0.02	
6′	7.37, brd (8.5)	117.1	7.34, brd (8.5)	7.27, brd (8.5)		7.17, brd (8.5)		+0.10	
1″		179.9, 180.2							
2″	2.80, m	38.3, 38.5	2.82, m	2.83[b]	2.74[b]	2.84, m	2.72[b]	−0.01	+0.02
3″	1.43, m	28.4, 28.8	1.39, m	1.43, m	1.40[b]	1.42, m	1.39[b]	+0.01	+0.01
	1.66, m		1.73, m	1.68, m	1.65[b]	1.70, m	1.67[b]	−0.02	−0.02
4″	0.88, t (7)	12.2, 12.3	0.87, t (7.5)	0.91, t (7.5)	0.85, t (7.5)	0.91, t (7.5)	0.85, t (7.5)	0	0
	0.90, t, (7)								
5″	1.07, d, (6.5)	18.0, 18.3	1.05, d (6.5)	1.04, d, (7)	1.13, d (7)	1.03, d (7)	1.07, d (7)	+0.01	+0.05
	1.11, d, (6.5)								

[a] Percentages from peak area of H-8. [b] Unclear signal pattern due to overlapping.

Tosoh, ODS-100V, 20 × 250 mm; solvent, acetonitrile−water (35:65); detector, UV 210 nm and Shiseido, Capcell-Pak Ph, 20 × 250 mm; solvent, acetonitrile−water (30:70); detector, UV 210 nm] to yield compounds **1** (15.6 mg) and **8** (5.1 mg).

Meehanine A (1): colorless, amorphous powder; $[\alpha]_D^{20}$ −4.2 (*c* 0.26, MeOH); CD (*c* 0.050, MeOH) $\lambda(\theta)$ 247 (4000), 226 (−30 100), 203 (32 000) nm; ^{1}H NMR and ^{13}C NMR, Tables 1 and 2; HRFABMS *m/z* 846.4029 $[M + H]^+$ (calcd for $C_{42}H_{60}N_3O_{15}$, 846.4026).

Meehanine B (2): colorless, amorphous powder; $[\alpha]_D^{20}$ −9.2 (*c* 0.37, MeOH); CD (*c* 0.052, MeOH) $\lambda(\theta)$ 246 (3300), 222 (−14 700), 202 (2300) nm; ^{1}H NMR and ^{13}C NMR, Tables 1 and 2; HRFABMS *m/z* 804.3929 $[M + H]^+$ (calcd for $C_{40}H_{58}N_3O_{14}$, 804.3920).

Meehanine C (3): colorless, amorphous powder; $[\alpha]_D^{20}$ −8.1 (*c* 0.12, MeOH); CD (*c* 0.060, MeOH) $\lambda(\theta)$ 252 (2600), 224 (−72 300), 205 (65 200) nm; ^{1}H NMR and ^{13}C NMR, Tables 1 and 2; HRFABMS *m/z* 742.3761 $[M + H]^+$ (calcd for $C_{35}H_{56}N_3O_{14}$, 742.3764).

Meehanine D (4): colorless, amorphous powder; $[\alpha]_D^{22}$ −12.9 (*c* 0.31, MeOH); CD (*c* 0.093, MeOH) $\lambda(\theta)$ 234 (4100), 203 (−2500) nm; ^{1}H NMR and ^{13}C NMR, Tables 1 and 2; HRFABMS *m/z* 864.3541 $[M - H]^-$ (calcd for $C_{44}H_{54}N_3O_{15}$, 864.3556).

Meehanine E (5): colorless, amorphous powder; $[\alpha]_D^{23}$ −10.8 (*c* 0.72, MeOH); CD (*c* 0.072, MeOH) $\lambda(\theta)$ 247 (2000), 224 (−29 300), 203 (15400) nm; ^{1}H NMR and ^{13}C NMR, Tables 1 and 2; HRFABMS *m/z* 832.3871 $[M + H]^+$ (calcd for $C_{41}H_{58}N_3O_{15}$, 832.3869).

Meehanine F (6): colorless, amorphous powder; $[\alpha]_D^{22}$ −7.1 (*c* 1.04, MeOH); CD (*c* 0.052, MeOH) $\lambda(\theta)$ 238 (4000), 222 (−13 500), 203 (7400) nm; ^{1}H NMR and ^{13}C NMR, Tables 1 and 2; HRFABMS *m/z* 830.3710 $[M - H]^-$ (calcd for $C_{41}H_{56}N_3O_{15}$, 830.3713).

Meehanine G (7): colorless, amorphous powder; $[\alpha]_D^{21}$ −8.4 (*c* 0.57, MeOH); CD (*c* 0.057, MeOH) $\lambda(\theta)$ 242 (3700), 220 (−12 900), 201 (4600) nm; ^{1}H NMR and ^{13}C NMR, Tables 1 and 2; HRFABMS *m/z* 818.3711 $[M + H]^+$ (calcd for $C_{40}H_{56}N_3O_{15}$, 818.3713).

Meehanine H (8): colorless, amorphous powder; $[\alpha]_D^{20}$ −1.0 (*c* 0.31, MeOH); CD (*c* 0.049, MeOH) $\lambda(\theta)$ 247 (3900), 222 (−27 00), 204 (22 200) nm; ^{1}H NMR and ^{13}C NMR, Tables 1 and 2; HRFABMS *m/z* 824.4157 $[M - H]^-$ (calcd for $C_{40}H_{62}N_3O_{15}$, 824.4183).

Meehanine I (9): colorless, amorphous powder; $[\alpha]_D^{22}$ −7.3 (*c* 0.30, MeOH); CD (*c* 0.030, MeOH) $\lambda(\theta)$ 248 (6200), 223 (−20 500), 200 (10 100) nm; ^{1}H NMR and ^{13}C NMR, Tables 1 and 2; HRFABMS *m/z* 784.4236 $[M + H]^+$ (calcd for $C_{38}H_{62}N_3O_{14}$, 784.4234).

Meehanine J (10): colorless, amorphous powder; $[\alpha]_D^{20}$ −6.8 (*c* 0.41, MeOH); CD (*c* 0.040, MeOH) $\lambda(\theta)$ 255 (3800), 222 (−27 600), 203 (27 600) nm; ^{1}H NMR and ^{13}C NMR, Tables 1 and 2; HRFABMS *m/z* 824.4208 $[M + H]^+$ (calcd for $C_{40}H_{62}N_3O_{15}$, 824.4183).

Meehanine K (11): colorless, amorphous powder; $[\alpha]_D^{21}$ −6.9 (*c* 0.32, MeOH); CD (*c* 0.042, MeOH) $\lambda(\theta)$ 253 (4700), 223 (−22 400), 205 (23 900) nm; ^{1}H NMR and ^{13}C NMR, Tables 1 and 2; HRFABMS *m/z* 812.4175 $[M + H]^+$ (calcd for $C_{39}H_{62}N_3O_{15}$, 812.4183).

Acid Hydrolysis of 1 and *N*-Acetylation of Aglycone (1a). Compound **1** (45 mg) was dissolved in 7% HCl (2 mL) and stirred for 1 h at 60 °C. After cooling, the reaction mixture was passed through an Amberlite IRA400 column, and the eluate was concentrated. The residue was subjected to preparative HPLC [column, Kanto Chemical, Mightysil RP-18 GP, 10 × 250 mm; solvent, methanol−water (20:80); detector, UV 210 nm] to yield compound **1a** (15.4 mg). Compound **1a** (12.7 mg) was dissolved in saturated sodium bicarbonate solution (2 mL) and stirred with acetic anhydride (120 μL) for 1 h at 0 °C. The reaction mixture was passed through a Diaion HP-20 column (20 × 70 mm), and the 90% MeOH eluate was concentrated. The residue was subjected to preparative HPLC [column, YMC, ODS-AM, 10 × 30 mm; solvent, acetonitrile−water (30:70); detector, UV 210 nm] to yield compound **1b** (5.0 mg). Compound **1a**: colorless, amorphous powder; $[\alpha]_D^{22}$ −18.1 (*c* 0.53, MeOH); CD (*c* 0.028, MeOH) $\lambda(\theta)$ 249 (1021), 227 (−31 500), 202 (10396) nm; ^{1}H NMR and ^{13}C NMR, Table 4; FABMS *m/z* 392 $[M + H]^+$, 414 $[M + Na]^+$. Compound **1b**: colorless, amorphous powder; ^{1}H NMR, Table 4; EIMS *m/z* 433 (17) $[M]^+$, 415 (10) $[M - H_2O]^+$, 390 (29) $[M - Ac]^+$, 233 (31), 147 (100), 57 (92), 43 (74).

MTPA Ester of 1b. To a solution of **1b** (2 mg each) in pyridine (100 μL) was added (*R*)-(−)-MTPA chloride or (*S*)-(+)-MTPA chloride (2 μL), and the mixture was stirred for 1 h at 0 °C. The solvent was subjected to preparative HPLC [column, YMC, ODS-AM, 10 × 300 mm; solvent, methanol−water (7:3); detector UV, 210 nm] to give the 8-*O*-(*S*)-(−)-MTPA ester of **1b** (**1c**, 1 mg, FABMS: *m/z* 650 $[M + H]^+$) and the 8-*O*-(*R*)-(+)-MTPA ester of **1b** (**1d**, 1 mg, FABMS: *m/z* 648 $[M - H]^-$) as colorless, amorphous powders. ^{1}H NMR: Table 4.

Acid Hydrolysis of 8 and 1a and Determination of the Stereochemistry of 2-Methylbutyric Acid. Compound **8** (10 mg) was dissolved in 7% HCl (1 mL) and stirred for 1 h at 60 °C. After cooling, the solution was partitioned between $CHCl_3$ (3 mL) twice. From the $CHCl_3$ layer, 2-methylbutyric acid was obtained. From the 7% HCl layer, **1a** (2.4 mg) was obtained as described for **1**. Compound **1a** (2.0 mg) was dissolved in 7% HCl (1 mL) and stirred for 3 h at 90 °C. Then, the solution was extracted with CH_2Cl_2 (3 mL) twice. The $CHCl_3$ layer from **8** and the CH_2Cl_2 layer from **1a** were washed with H_2O and dried over 3 Å molecular sieves. To the solutions were added 1-hydroxybenzotriazole monohydrate, *N*,*N*′-dicyclohexylcarbodiimide, and (*S*)-1-(1-naphthyl)ethylamine (10 mg each). After the mixtures had been stirred for 3 h at room temperature, filtration and concentration gave residues, which were purified by a silica gel column [Wakogel C-200, Wako Pure Chemical Industry, Ltd., 20 × 20 mm, eluted with hexane, hexane−EtOAc (9:1, 8:2, 5:5) and EtOAc]. The 8:2 fractions were analyzed by HPLC and detected at 280 nm. Analytical HPLC was performed on a Cosmosil 5C18-AR-II column (4.6 × 250 mm) at 20 °C using acetonitrile−water (40:60) as the solvent. Peaks were detected with a Tosoh UV8010 UV detector. (*S*)-2-Methyl-*N*-[(*S*)-1-(1-naphthyl)ethyl]butyramide (t_R 36.1 min) was identified as the product resulting from the 2-methylbutyryl moiety of **1a** and **8** by comparing their retention times with those of the authentic samples, (*S*)-2-methyl-*N*-[(*S*)-1-(1-naphthyl)ethyl]butyramide (t_R 36.1 min) and (*R*)-2-methyl-*N*-[(*S*)-1-(1-naphthyl)ethyl]butyramide (t_R 37.7 min).[20,21]

Sugar Identification. Each compound [**1**−**11** (1.0 mg)] was refluxed with 7% HCl (1 mL) for 2 h. After cooling, the reaction mixture was passed through an Amberlite IRA400 column, and the eluate was concentrated. The residues were dissolved in pyridine (0.5 mL) and stirred with L-cysteine methyl ester (5 mg) for 1.5 h at 60 °C, and then *o*-tolyl isothiocyanate (20 μL) was added to the mixture and heated at 60 °C for 1.5 h. The reaction mixtures were analyzed by HPLC and detected at 250 nm. Analytical HPLC was performed on a Shiseido Capcell Pak C_{18} column (4.6 × 250 mm) at 20 °C using CH_3CN−0.2% TFA in H_2O (25:75) as the solvent. Peaks were detected with a Tosoh UV8010 UV detector. D-Glucose (t_R 18.5 min) and L-rhamnose (t_R 29.7 min) were identified as the sugar moieties of **1**−**11** by comparing their retention times with those of the authentic samples of D-glucose (t_R 18.5 min), L-glucose (t_R 17.0 min), L-rhamnose (t_R 29.7 min), and D-rhamnose (using D-cysteine methyl ester and L-rhamnose, t_R 15.3 min).[17]

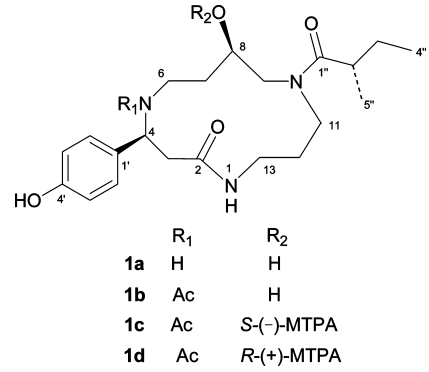

Figure 3. Structures of **1a**−**1d**.

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Supporting Information Available: NMR spectra, tables of HMBC data for compounds **1**−**11** and **1a**, and the NOE data of **1** and **1a**. This material is available free of charge via the Internet at http://pubs.acs.org.

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