Triterpenoid Saponins of *Acanthopanax nipponicus* Leaves

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Five new triterpenoid saponins, nipponosides A−E (**1**, **3**−**6**), were isolated from *Acanthopanax nipponicus* leaves, along with a known saponin, kalopanaxsaponin G (**2**). Nipponosides A−E were characterized as the 28-*O*-α-L-rhamnopyranosyl(1→4)-*β*-D-glucopyranosyl(1→6)-*β*-D-glucopyranosyl ester of 3-oxohederagenin, oleanolic acid 3-*O*-*β*-D-glucopyranoside, gypsogenin 3-*O*-*β*-D-glucopyranoside, 3*β*,23,29-trihydroxyolean-12-en-28-oic acid, and 3*β*,20α,23-trihydroxy-30-*nor*-olean-12-en-28-oic acid, respectively. The structures of these new compounds were based on chemical and spectral methods.

There are nine species belonging to the genus *Acanthopanax* (Araliaceae) in Japan, namely, *A. divaricatus* (Sieb. et Zucc.) Seemann, *A. hypoleucus* Makino, *A. sciadophylloides* Franch. et Savat, *A. senticosus* (Rupr. et Maxim.) Harms, *A. sieboldianus* Franch. et Savat, *A. spinosus* Miq., *A. trichodon* Franch. et Savat., *A. nikaianus* Koidz., and *A. nipponicus* Makino.[1] We have investigated the constituents of the leaves of the first seven of these species and have found that they may be classified into three groups according to their saponin constituents or lack thereof. The first group produces oleanane saponins exclusively and comprises *A. hypoleucus*,[2] *A. senticosus*,[3,4] *A. sieboldianus*,[5] and *A. spinosus*.[6−8] The second group, constituted by *A. divaricatus*, has no oleanane saponins but accumulates lupane saponins.[9,10] The species in the third group, *A. sciadophylloides* [11] and *A. trichodon*,[12] contain no saponins at all. Herein, we describe a phytochemical investigation from a chemotaxonomic point of view, which has led to the isolation and the characterization of six oleanane saponins from *A. nipponicus*.

Results and Discussion

Compounds **1**−**6** were isolated from the crude saponin mixture obtained from *A. nipponicus* leaves, as described in the Experimental Section. Of these, **2** was identified as kalopanaxsaponin G [hederagenin 28-*O*-α-L-rhamnopyranosyl(1→4)-*β*-D-glucopyranosyl(1→6)-*β*-D-glucopyranoside], previously isolated in this laboratory from the stembark of *Kalopanax pictus* (Araliaceae).[13]

Compounds **1** and **3**−**6** were found to have several chemical and physical properties similar to **2**. Thus, they afforded glucose (Glc) and rhamnose (Rha) as their sugar components on acidic hydrolysis and provided an anomeric mixture of methyl α-L-rhamnopyranosyl(1→4)-*β*-D-glucopyranosyl(1→6)-α- and *β*-D-glucopyranosides (**7**) on the selective cleavage reaction of the C-28 glycoside linkage with lithium iodide and methanol in 2,6-lutidine.[2,14] Their ^{13}C NMR spectral data showed 18 signals due to the C-28 linked α-L-rhamnopyranosyl(1→4)-*β*-D-glucopyranosyl(1→6)-*β*-D-glucopyranosyl (RGG) carbons and the C-28 signal as an ester linkage (*δ* 176.3−176.5).[13] Furthermore, their negative FABMS data exhibited an ion peak due to the fragment ion ([M − H − 470]$^-$) resulting from the pseudomolecular ion ([M − H]$^-$) by loss of the ester-linked RGG moiety (470 atomic mass units (amu)).

Compound **1** (nipponoside A) exhibited in the negative FABMS prominent ion peaks at *m*/*z* 939 and 469, each 2 amu smaller than those of **2**. The ^{13}C NMR spectrum of **1** showed 48 carbon signals, 18 of which were assignable to the RGG carbons at C-28 [13] (Table 1) on comparison of the ^{13}C NMR spectrum of **2**. The remaining 30 signals were similar to those due to a hederagenin moiety of **2**, except for four carbons, which were assigned to C-2, C-3, C-4, and C-24 using ^{1}H−^{1}H COSY, HMQC, and HMBC experiments. Among them, a signal appearing at *δ* 216.9 was ascribable to a carbonyl carbon instead of the C-3 carbinyl carbon signal (*δ* 73.9) of hederagenin. Thus, the aglycon of **1** was assumed to be 3-oxohederagenin (**8**). Finally, the 30 carbon signals were found to be superimposable on those of 3-oxohederagenin methyl ester (**8a**).[15] On reduction with sodium borohydride in methanol at room temperature, **1** provided **2**. Thus, nipponoside A (**1**) was deduced to be 3-oxohederagenin 28-*O*-α-L-rhamnopyranosyl(1→4)-*β*-D-glucopyranosyl(1→6)-*β*-D-glucopyranoside. This is the first example of a 3-oxohederagenin glycoside from a natural source.

Compound **3** (nipponoside B) exhibited in the FABMS ion peaks at *m*/*z* 1087 and 617, but no fragment peak corresponding to the aglycon. The ^{13}C NMR spectrum of **3** indicated 54 signals, of which 24 were assigned to the *β*-D-glucopyranosyl[2] and ester-linked RGG carbons (Table 1). On a selective cleavage reaction of the C-28 glycosyl linkage, **3** gave a prosapogenin (**3a**) along with **7**. The prosapogenin **3a**, still containing a *β*-D-glucopyranosyl unit,[13] afforded glucose and oleanolic acid on acidic hydrolysis. Accordingly, **3a** was established as oleanolic acid 3-*O*-*β*-D-glucopyranoside. Thus, nipponoside B (**3**) was established as 3-*O*-*β*-D-glucopyranosyl oleanolic acid 28-*O*-α-L-rhamnopyranosyl(1→4)-*β*-D-glucopyranosyl(1→6)-*β*-D-glucopyranoside.

Compound **4** (nipponoside C) showed FABMS ion peaks at *m*/*z* 1101 and 631, each 14 amu larger than those of **3**. The ^{13}C NMR spectrum of **4** showed 47 carbon signals, which were similar to those of **3** except for five signals assignable to C-3, C-4, C-5, C-23, and C-24. Among them, a signal at *δ* 206.9 was ascribable to an aldehyde carbon instead of the C-23 methyl carbon signal (*δ* 28.2) in the case of **3** (Table 1). The 30 signals due to the aglycon moiety were found to be superimposable on those reported for the gypsogenin moiety in its 3,28-*O*-bisdesmoside, thladioside

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Table 1. ^{13}C NMR Signals of Saponins **1**−**6**, **3a**, **5a**, and **8** in Pyridine-d_5[a]

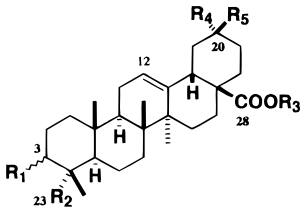
carbon	**1**	**2**	**3**	**4**	**5**	**6**	**8**[b]	**3a**	**5a**
C-1	36.3	38.9	38.7	38.1	38.8	38.8	36.3	38.7	38.7
C-2	37.9	27.7	26.6	25.0	27.6	27.6	37.8	26.5	27.6
C-3	216.9	73.9	88.9	81.6	73.8	73.8	216.8	88.9	73.9
C-4	52.7	42.9	39.5	55.4	42.8	42.8	52.7	39.5	42.8
C-5	46.7	48.7	55.8	47.9	48.6	48.5	46.5	55.8	48.7
C-6	20.0	18.7	18.5	20.4	18.6	18.6	19.9	18.5	18.6
C-7	32.2	32.6	33.1	32.3	32.8	32.8	32.2	33.3	32.9
C-8	39.8	40.0	39.9	40.1	39.8	39.9	39.6	39.7	39.7
C-9	47.1	48.2	48.0	47.6	48.1	48.1	47.2	48.0	48.1
C-10	36.6	37.3	37.0	36.0	37.2	37.1	36.6	37.0	37.2
C-11	23.9	23.7	23.8	23.6	23.8	23.7	23.6	23.8	23.8
C-12	122.8	123.0	122.9	122.5	122.9	123.0	122.6	123.0	122.9
C-13	144.1	144.2	144.1	144.1	144.3	143.6	144.1	145.0	145.2
C-14	42.3	42.2	42.1	41.6	42.1	42.1	42.1	42.2	42.2
C-15	28.3	28.4	28.3	28.2	28.3	28.2	28.0	28.3	28.4
C-16	23.4	23.9	23.4	23.2	23.4	23.5	23.8	23.8	23.8
C-17	47.1	47.1	47.0	46.9	47.4	47.0	47.0	46.7	47.2
C-18	41.8	41.7	41.7	42.1	41.1	44.0	41.9	42.0	41.4
C-19	46.2	46.3	46.2	46.1	40.9	47.8	46.0	46.6	41.3
C-20	30.4	30.8	30.7	30.7	36.3	69.6	30.8	31.0	36.6
C-21	34.0	34.1	34.0	33.9	28.8	35.9	33.9	34.3	29.1
C-22	32.5	33.1	32.5	32.4	32.0	34.4	32.7	33.2	32.7
C-23	68.1	68.1	28.2	206.9	68.0	67.8	68.2	28.3	68.1
C-24	17.9	13.1	17.2	10.3	13.0	13.0	17.9	17.1	13.0
C-25	15.4	16.1	15.6	15.6	16.0	16.0	15.3	15.5	15.9
C-26	17.3	17.7	17.5	17.4	17.6	17.5	17.0	17.4	17.5
C-27	25.8	26.1	26.1	26.0	26.0	25.9	25.9	26.2	26.1
C-28	176.5	176.5	176.5	176.4	176.5	176.3	178.0	180.0	180.9
C-29	33.1	33.0	33.9	33.0	73.6	25.6	33.1	33.3	73.5
C-30	23.7	23.7	23.7	23.6	19.7		23.7	23.8	19.7
COO*Me*							51.6		
3-*O*-sugar									
Glc-C									
1			106.9	104.7				106.8	
2			75.8	75.2				75.7	
3			78.3	78.6				78.6	
4			71.9	71.5				72.0	
5			78.0	78.2				78.0	
6			63.1	62.8				63.0	
28-*O*-sugars									
Glc-C									
1	95.7	95.7	95.6	95.6	95.6	95.7			
2	73.9	73.6	73.9	73.9	74.0	74.0			
3	78.3	78.4	78.3	78.5	78.2	78.2			
4	70.9	71.0	70.9	70.8	70.8	70.8			
5	78.0	78.0	78.0	78.0	77.9	77.9			
6	69.2	69.3	69.2	69.2	69.2	69.3			
Glc-C									
1	104.9	104.9	104.8	104.8	104.9	104.9			
2	75.3	75.3	75.3	75.3	75.3	75.2			
3	76.5	76.6	76.5	76.5	76.5	76.5			
4	78.7	78.8	78.7	78.7	78.7	78.7			
5	77.1	77.2	77.1	77.1	77.1	77.1			
6	61.3	61.2	61.3	61.2	61.2	61.2			
Rha-C									
1	102.7	102.8	102.7	102.7	102.7	102.7			
2	72.8	72.6	72.8	72.7	72.7	72.7			
3	72.6	72.8	72.5	72.5	72.5	72.5			
4	74.0	74.1	74.0	73.8	73.5	73.4			
5	70.3	70.4	70.3	70.2	70.2	70.3			
6	18.5	18.5	18.5	18.5	18.5	18.5			

[a] The signals were assigned by comparison with data of related compounds. Assignments were confirmed by DEPT, $^1H-^1H$ COSY, HMQC, and HMBC experiments for **1**. [b] Data taken from Miyakoshi et al.[15]

H1.[16] Thus, nipponoside C (**4**) was characterized as 3-*O*-*β*-D-glucopyranosyl gypsogenin 28-*O*-α-L-rhamnopyranosyl-(1→4)-*β*-D-glucopyranosyl(1→6)-*β*-D-glucopyranoside.

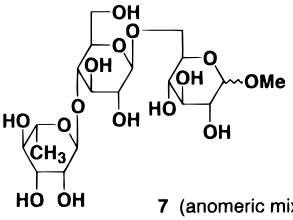
The FABMS of **5** (nipponoside D) showed ion peaks at *m*/*z* 957 and 487, both 16 amu greater than analogous data for **2**. The ^{13}C NMR spectrum of **5** was similar to that of **2** except for certain E-ring signals, including a carbinyl carbon signal at *δ* 73.5 instead of the 29- or 30-CH_3 carbon signal (*δ* 33.0 or 23.7, respectively) of **2**, suggesting the aglycon of **5** (**5a**) to be 29- or 30-hydroxylated hederagenin. The E-ring ^{13}C NMR signals of **5** were found to be coincident with those reported for a 29-hydroxyoleanane derivative, spinoside C5 (**9**),[7] but not for a 30-hydroxyoleanane derivative, spinoside C2 (**10**).[8] Accordingly, the aglycon of **5** was deduced to be 29-hydroxyhederagenin (i.e., 3*β*,23,29-trihydroxyolean-12-en-28-oic acid). Thus, nipponoside D (**5**) was assigned as 29-hydroxyhederagenin 28-*O*-α-L-rhamnopyranosyl(1→4)-*β*-D-glucopyranosyl(1→6)-*β*-D-

glucopyranoside, which is the C-5 epimer of spinoside C5 (**9**). The aglycon of **5** was a new sapogenol and was named nipponogenin D.



	R_1	R_2	R_3	R_4	R_5
1	=O	CH_2OH	-Glc^6-Glc^4-Rha	CH_3	CH_3
2	β OH	CH_2OH	-Glc^6-Glc^4-Rha	CH_3	CH_3
3	β OGlc	CH_3	-Glc^6-Glc^4-Rha	CH_3	CH_3
4	β OGlc	CHO	-Glc^6-Glc^4-Rha	CH_3	CH_3
5	β OH	CH_2OH	-Glc^6-Glc^4-Rha	CH_2OH	CH_3
6	β OH	CH_2OH	-Glc^6-Glc^4-Rha	OH	CH_3
8	=O	CH_2OH	H	CH_3	CH_3
9	α OH	CH_2OH	-Glc^6-Glc^4-Rha	CH_2OH	CH_3
10	α OH	CH_2OH	-Glc^6-Glc^4-Rha	CH_3	CH_2OH
11	α OH	CH_2OH	-Glc^6-Glc^4-Rha	OH	CH_3
3a	β OGlc	CH_3	H	CH_3	CH_3
5a	β OH	CH_2OH	H	CH_2OH	CH_3
6a	β OH	CH_2OH	H	OH	CH_3
8a	=O	CH_2OH	CH_3	CH_3	CH_3

Glc: β-D-glucopyranosyl, Rha: α-L-rhamnopyranosyl



7 (anomeric mixture)

In the FABMS, compound **6** (nipponoside E) exhibited the presence of ion peaks at *m/z* 943 and 473, 14 amu smaller than analogous peaks of **5**, suggesting **6** to be a nortriterpene glycoside related to **5**. The ^{13}C NMR spectrum of **6** showed 47 signals, including those due to the RGG carbons. The remaining 29 signals were similar to those of a 29-hydroxyhederagenin moiety except for the signals due to the carbons around the E-ring. Thus, tertiary carbinyl carbon signal (δ 69.6) appeared in the ^{13}C NMR spectrum of **6**, while the primary carbinyl C-29 (δ 73.5) and quaternary C-20 signals (δ 36.3) of **5** were not present, suggesting the aglycon of **6** to be a 29- or 30-nortriterpene having a tertiary hydroxyl group at C-20. The ^{13}C NMR signals in ring E in **6** were found to be superimposable on those of the 3α,20α,23-trihydroxy-30-*nor*-olean-12-en-28-oic acid moiety (20α-hydroxyl-30-*nor*-3-*epi*-hederagenin) in the glycoside, spinoside C6 (**11**).[8] Thus, nipponoside E (**6**) was characterized as 20α-hydroxyl-30-*nor*-hederagenin 28-*O*-α-L-rhamnopyranosyl(1→4)-*β*-D-glucopyranosyl(1→6)-*β*-D-glucopyranoside, which is an epimer of spinoside C6 at C-3. The aglycon of **6**, 3*β*,20α,23-trihydroxy-30-*nor*-olean-12-en-28-oic acid (**6a**), has been accorded that trivial name, nipponogenin E.

In conclusion, six oleanane saponins (**1**−**6**) from *A. nipponicus* leaves have been isolated and characterized. So that a complete chemotaxonomic perspective of the saponins may be obtained, further investigations on the remaining Japanese *Acanthopanax* species, *A. nikaianus*, are in progress.

Experimental Section

General Experimental Procedures. Optical rotations were determined in MeOH on a JASCO DIP 140 digital polarimeter at 25 °C. IR spectra were recorded in KBr disks on a JASCO IR 810 spectrometer. NMR spectra were recorded in C_5D_5N containing TMS as internal standard on a JEOL JNM GX-400 spectrometer (^1H, 400 MHz; ^{13}C, 100 MHz). Chemical shifts were assigned by means of DEPT and 2D NMR techniques ($^1H-^1H$ COSY, HMQC, and HMBC). MS spectra were obtained on a JEOL JMS SX-102A spectrometer using glycerol as matrix. GC was carried out on a Shimadzu GC-7A apparatus equipped with a FID detector and a glass column (3 mm × 2.1 m) packed with 5% OV-17 at 155 °C. TLC was carried out on precoated Si gel 60 plates (Merck), and column chromatography on Si gel 60 (0.063−0.2 mm, Merck), RP-2 (Merck), Sephadex LH-20 (Pharmacia), Chromatorex ODS (DM-1020T, Fuji-Silysia) or Diaion HP-20 (Mitsubishi Chemical Corporation).

Plant Material. The plant was grown at Tokyo Metropolitan Medicinal Plant Garden, Tokyo, Japan, and was collected in May 1992. A voucher specimen (no. 1996-03) has been deposited in the Herbarium of the School of Pharmaceutical Sciences, Showa University, Japan.

Extraction and Isolation. The dried leaves (1.35 kg) of *A. nipponicus* were extracted with MeOH at room temperature followed by removal of the solvent by evaporation to give a dried MeOH extract (155 g). A portion of the extract (50 g) was suspended in H_2O and the suspension partitioned with Et_2O (16.7 g). The H_2O layer was chromatographed on Diaion HP-20, eluting with H_2O (12.7 g), 30% MeOH (0.56 g), 70% MeOH (9.61 g), MeOH (1.32 g), and Me_2CO (0.24 g), successively. The 70% MeOH eluate was chromatographed on Si gel with $CHCl_3$−MeOH−H_2O (70:25:2) to give six fractions: fractions 1 (0.29 g), 2 (2.07 g), 3 (2.57 g), 4 (1.82 g), 5 (0.53 g), and 6 (2.48 g). Fraction 2 was subjected to ODS chromatography with 60% MeOH to give **1** (0.47 g). Fraction 4 was chromatographed on ODS with 60% MeOH and then on Si gel with $CHCl_3$−MeOH−H_2O (10:5:1) to give **2** (0.13 g). Fraction 6 was separated by chromatography on Sephadex LH-20 with MeOH, then Si gel with $CHCl_3$−MeOH−H_2O (10:6:1 and 14:6:1) and finally ODS with 60% MeOH, to give **3** (0.18 g), **4** (0.06 g), **5** (0.21 g), and **6** (0.07 g).

Nipponoside A (1): white powder, $[\alpha]^{25}_D$ −1.4° (*c* 0.50, MeOH); IR (KBr) ν_{max} 3400, 2925, 1740, 1680, 1460, 1390, 1060 cm^{-1}; ^1H NMR (C_5D_5N) δ 0.84, 0.88, 0.93, 1.03, 1.22, 1.22 (3H each, s, *tert*-Me), 1.67 (3H, d, J = 6.2 Hz, Rha H-6), 4.96 (1H, d, J = 7.1 Hz, outer Glc H-1), 5.42 (1H, t-like, H-12), 5.81 (1H, s, Rha H-1), 6.21 (1H, d, J = 8.1 Hz, 28-*O*-Glc H-1); ^{13}C NMR (C_5D_5N), Table 1; FABMS (negative) *m/z* 939 [M − H]$^-$, 469 [M − H − 470]$^-$; *anal*. C 60.55%, H 8.47%, calcd for $C_{48}H_{76}O_{18}$·(1/2)H_2O, C 60.68%, H 8.17%.

Kalopanax Saponin G (2): white powder, $[\alpha]^{25}_D$ −4.0° (*c* 0.50, MeOH); IR (KBr) ν_{max} 3400, 2925, 1730, 1060, 1040 cm^{-1}; ^1H NMR (C_5D_5N) δ 0.85, 0.88, 1.00, 1.05, 1.13, 1.17 (3H each, s, *tert*-Me), 1.68 (3H, d, J = 6.2 Hz, Rha H-6), 4.97 (1H, d, J = 7.1 Hz, outer Glc H-1), 5.42 (1H, t-like, H-12), 5.82 (1H, s, Rha H-1), 6.22 (1H, d, J = 8.1 Hz, 28-*O*-Glc H-1); ^{13}C NMR (C_5D_5N), Table 1; FABMS (negative) *m/z* 941 [M − H]$^-$, 471 [M − H − 470]$^-$. The identification was performed by direct comparison with an authentic specimen.[13]

Nipponoside B (3): white powder, $[\alpha]^{25}_D$ −2.7° (*c* 0.50, MeOH); IR (KBr) ν_{max} 3400, 2925, 1720, 1060, 1030 cm^{-1}; ^1H NMR (C_5D_5N) δ 0.84, 0.87, 0.88, 0.99, 1.07, 1.23, 1.29 (3H each, s, *tert*-Me), 1.67 (3H, d, J = 6.2 Hz, Rha H-6), 4.90 (1H, 3-*O*-Glc H-1, overlapped with HOD), 4.95 (1H, d, J = 7.1 Hz, outer Glc H-1), 5.39 (1H, t-like, H-12), 5.81 (1H, s, Rha H-1), 6.20 (1H, d, J = 7.0 Hz, 28-*O*-Glc H-1); ^{13}C NMR (C_5D_5N), Table 1;

FABMS (negative) *m/z* 1087 [M − H]$^-$, 617 [M − H − 470]$^-$; *anal*. C 55.98%, H 8.25%, calcd for $C_{54}H_{88}O_{22}$·4H_2O, C 55.85%, H 8.33%.

Nipponoside C (4): white powder, $[\alpha]^{25}_D$ −7.0° (*c* 0.50, MeOH); IR (KBr) ν_{max} 3400, 1720, 1060, 1040 cm^{-1}; ^{1}H NMR (C_5D_5N) δ 0.92, 0.96, 0.96, 1.11, 1.28, 1.39 (3H each, s, *tert*-Me), 1.76 (3H, d, J = 6.2 Hz, Rha H-6), 4.89 (1H, d, J = 7.7 Hz, outer Glc H-1), 5.00 (1H, 3-*O*-Glc H-1, overlapped with HOD), 5.46 (1H, t-like, H-12), 5.91 (1H, s, Rha H-1), 6.28 (1H, d, J = 7.0 Hz, 28-*O*-Glc H-1), 9.81 (1H, s, H-23); ^{13}C NMR (C_5D_5N), Table 1; FABMS (negative) *m/z* 1101 [M − H]$^-$, 631 [M − H − 470]$^-$; *anal*. C 55.89%, H 8.22%, calcd for $C_{54}H_{86}O_{23}$·3H_2O, C 56.04%, H 8.01%.

Nipponoside D (5): white powder, $[\alpha]^{25}_D$ −4.5° (*c* 0.61, MeOH); IR (KBr) ν_{max} 3400, 2925, 1740, 1060, 1040 cm^{-1}; ^{1}H NMR (C_5D_5N) δ 1.08, 1.13, 1.14, 1.22, 1.26 (3H each, s, *tert*-Me), 1.76 (3H, d, J = 6.2 Hz, Rha H-6), 5.11 (1H, d, J = 8.1 Hz, outer Glc H-1), 5.53 (1H, t-like, H-12), 5.91 (1H, s, Rha H-1), 6.32 (1H, d, J = 8.1 Hz, 28-*O*-Glc H-1); ^{13}C NMR (C_5D_5N), Table 1; FABMS (negative) *m/z* 957 [M − H]$^-$, 487 [M − H − 470]$^-$; *anal*. C 59.21%, H 8.57%, calcd for $C_{48}H_{77}O_{19}$·H_2O, C 59.00%, H 8.16%.

Nipponoside E (6): white powder, $[\alpha]^{25}_D$ −2.9° (*c* 0.10, MeOH); IR (KBr) ν_{max} 3400,1740, 1060, 1040 cm^{-1}; ^{1}H NMR (C_5D_5N) δ 1.06, 1.12, 1.21, 1.22, 1.52 (3H each, s, *tert*-Me), 1.76 (3H, d, J = 6.2 Hz, Rha H-6), 5.56 (1H, t-like, H-12), 5.91 (1H, s, Rha H-1), 6.31 (1H, d, J = 8.1 Hz, 28-*O*-Glc H-1); ^{13}C NMR (C_5D_5N), Table 1; FABMS (negative) *m/z* 943 [M − H]$^-$, 473 [M − H − 470]$^-$; *anal*. C 57.01%, H 8.22%, calcd for $C_{47}H_{76}O_{19}$·(5/2)H_2O, C 57.01%, H 8.25%.

Identification of Sugar Components of 1−6. A solution of each saponin (a few milligrams) in 1 M HCl in 50% 1,4-dioxane (2 mL) was heated at 80 °C for 4 h. The reaction mixture was neutralized with Ag_2CO_3, filtered, and then extracted with $CHCl_3$. After concentration, the H_2O layer was examined by TLC with $CHCl_3$−MeOH−H_2O (6:4:1) and compared with authentic samples, and glucose (R_f 0.19) and rhamnose (R_f 0.34) were detected all cases. The sugar components in the H_2O layer were also analyzed on GLC as TMS ethers,[17] and glucose (t_R 20.8, 32.6) and rhamnose (t_R 5.9, 7.7) were also detected.

Selective Cleavage of the Ester Glycoside Linkages of 1−6. A solution of **3** (120 mg) and LiI (140 mg) in 2,6-lutidine (8 mL) and dry MeOH (2 mL) was refluxed for 17 h under an N_2 atmosphere. After cooling, the reaction mixture was diluted with 50% MeOH (3 mL), deionized with Amberlite MB-3 (H^+, OH^- form), and evaporated to dryness. The residue was chromatographed on Si gel with $CHCl_3$−MeOH−H_2O (14:6:1) to give **3a** (68 mg) and **7** (17 mg), with the latter identified as a mixture of methyl α-L-rhamnopyranosyl(1→4)-β-D-glucopyranosyl(1→6)-α- and β-D-glucopyranosides, respectively, by direct comparison with an authentic sample.[5] In the same reaction, 3-oxohederagenin (**1a**) and nipponogenin E (**5a**) were obtained from **1** and **5**, respectively, as their aglycon or prosapogenin along with **7**, whereas **4** and **6** gave **7** as the only product.

Compound 3a: a white powder, $[\alpha]^{25}_D$ +20.0° (*c* 0.10, MeOH); IR (KBr) ν_{max} 3400, 1460, 1380, 1080,1030 cm^{-1}; ^{1}H NMR (C_5D_5N) δ 0.86, 0.99, 1.02, 1.04 (3H each, s, *tert*-Me), 1.34 (9H, s, *tert*-Me × 3), 3.33 (1H, dd, J = 3.8, 14.0 Hz, H-18), 3.43 (1H, dd, J = 4.5, 12.0 Hz, H-3), 4.05 (1H, m, Glc H-5), 4.07 (1H, dd, J = 9.0, 7.7 Hz, Glc H-2), 4.28 (1H, dd, J = 9.0, 9.0 Hz, Glc H-3), 4.33 (1H, dd, J = 9.0, 9.0 Hz, Glc H-4), 4.46 (1H, dd, J = 5.1, 11.4 Hz, Glc H-6a), 4.59 (1H, dd, J = 2.2, 11.4 Hz, Glc-H6b), 4.97 (1H, d, J = 7.7 Hz, Glc H-1), 5.51(1H, t-like, H-12); ^{13}C NMR (C_5D_5N), Table 1; FABMS (negative) *m/z* 617 [M − H]$^-$. On acid hydrolysis, **3a** gave oleanolic acid [TLC, *n*-hexane−Me_2CO (2:1), R_f 0.42] and glucose, which were detected as mentioned above.

Compound 5a: white powder, $[\alpha]^{25}_D$ +45.1° (*c* 0.67, C_5H_5N); ^{1}H NMR (C_5D_5N) δ 1.05, 1.11, 1.13, 1.29, 1.32 (3H each, s, *tert*-Me), 3.78 (1H, d, J = 10 Hz, H-23a), 4.23 (1H, d, J = 10 Hz, H-23b), 4.25 (1H, dd, J = 5, 10 Hz, H-3), 5.59 (1H, *t*-like, H-12); ^{13}C NMR (C_5D_5N), Table 1; FABMS (negative) *m/z* 487 [M − H]$^-$.

$NaBH_4$ Reduction of Nipponoside A (1). A solution of **1** (40 mg) and $NaBH_4$ (20 mg) in MeOH (10 mL) was stirred for 20 min at room temperature. After decomposition of excess reagent with Me_2CO (1 mL), the mixture was deionized with Amberlite MB-3 (H^+, OH^- form) and concentrated to dryness in vacuo. The residue was passed through RP-2 eluting with H_2O and MeOH, successively. The MeOH eluates gave the reduction product of **1** (30 mg), which was identified as **2** by co-TLC and NMR spectroscopy.

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