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Two chromone-secoiridoid glycosides and three indole alkaloid glycosides from *Neonauclea sessilifolia*

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Dedicated to Professor Meinhart H. Zenk on the occasion of his 70th birthday

Abstract

From the dried roots of *Neonauclea sessilifolia*, two new chromone-secoiridoid glycosides, sessilifoside and 7″-*O*-β-D-glucopyranosylsessilifoside, and three novel indole alkaloid glycosides, neonaucleosides A, B, and C, were isolated along with the main known glycosides, 5-hydroxy-2-methylchromone-7-*O*-β-D-apiofuranosyl-(1→6)-β-D-glucopyranoside, sweroside, loganin, grandifloroside, and quinovic acid 3β-*O*-β-D-quinovopyranoside-28-*O*-β-D-glucopyranoside. The structures of these new glycosides were determined by spectroscopic and chemical means. Neonaucleoside A and its C-3 epimer were prepared from secologanin and tryptamine.

Keywords: *Neonauclea sessilifolia*; Rubiaceae; Roots; Structure elucidation; Secoiridoid glycosides; Indole alkaloid glycosides; Sessilifoside; Neonaucleosides A–C

1. Introduction

Neonauclea sessilifolia (Roxb.) Merr. (=*Nauclea sessilifolia* Roxb., *Adina sessilifolia* (Roxb.) Hook. f., *Nauclea sericea* Wall. ex G. Don), belonging to Rubiaceae, grows in Southeast Asia 7–30 m in height (Lo et al., 1999). Previous phytochemical investigations of some *Neonauclea* plants resulted in the isolation of some alkaloids and anthraquinones (Johns et al., 1970; Atta-ur-Rahman et al., 1988; Tosa et al., 1998), but no phytochemical study on *N. sessilifolia* has been reported. From our interests in chemical constituents of Rubiaceae plants, especially alkaloidal glycosides in polar fraction (Itoh et al., 2002), we examined the *n*-BuOH-soluble fraction of the roots of *N. sessilifolia* to isolate five new glycosides. The structure elucidation of these glycosides is reported here.

2. Results and discussion

The *n*-BuOH fraction of the dried roots of *N. sessilifolia* was separated by a combination of chromatographic procedures to afford five new glycosides **1**–**5**, along with the known compounds, loganin (Kawai et al., 1988), sweroside (Cambie et al., 1990), *epi*-vogeloside (Recio-Iglesias et al., 1992), secologanin dimethylacetal (Kawai et al., 1988), grandifloroside (Chapelle, 1976), methyl grandifloroside (Chapelle, 1976), loganetin (Jensen et al., 1979), strictosamide (Erdelmeier et al., 1991), desoxycordifoline (Brown et al., 1978), 5,7-dihydroxy-2-methylchromone (Brown et al., 1975), 5-hydroxy-2-methylchromone-7-*O*-β-D-apiofuranosyl-(1→6)-β-D-glucopyranoside (Abe and Yamauchi, 1993), scopolin (Tsukamoto et al., 1985), hymexelsin (Rao et al., 1988), 3,4-di-*O*-caffeoylquinic acid (Nishizawa et al., 1988), quinovic acid 3β-*O*-β-D-glucopyranoside-28-*O*-β-D-glucopyranoside (Aquino et al., 1988), quinovic acid 3β-*O*-β-D-quinovopyranoside-28-*O*-β-D-glucopyranoside (Arriaga et al., 1990), and quinovic acid 3β-*O*-β-D-glucopyranosyl-(1→4)-α-L-rhamnopyranoside-28-*O*-β-D-glucopyranoside (Fan and He, 1997).

Sessilifoside (**1**) was isolated as an amorphous powder. It showed UV maxima at 232 sh, 251, 259 sh, 294, and 327 sh nm and IR bands at 3421, 1697, 1655, 1618, and 1508 cm^{-1}. The ^{1}H NMR spectrum of **1** exhibited a doublet for an olefinic proton at δ 7.68 (J=2.5 Hz), signals for terminal vinyl group at δ 5.29 (*dd*, J=10.0, 1.5 Hz), 5.31 (*dd*, J=17.0, 1.5 Hz), and 5.61 (*dt*,

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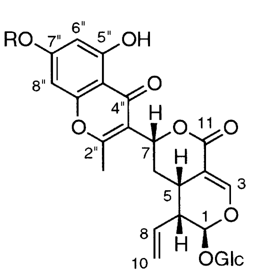
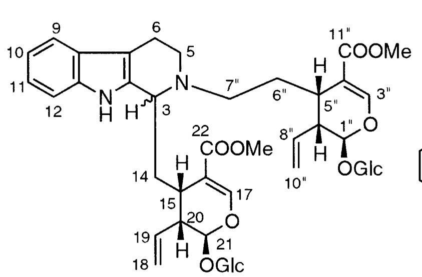
$J = 17.0$, 10.0 Hz), a doublet for an acetal proton at δ 5.59 ($J = 1.5$ Hz), and a doublet for an anomeric proton at δ 4.71 ($J = 8.0$ Hz), indicating the presence of secologanin-type secoiridoid glucoside moiety in the molecule. Furthermore a double doublet at δ 5.84 ($J = 12.0$, 2.5 Hz) was assigned to H-7 in the secoiridoid unit by COSY correlations of H-5- H_2-6- H-7, suggesting its structural similarity to vogeloside (**6**) or *epi*-vogeloside (**7**) (Recio-Iglesias et al., 1992). A singlet for vinyl methyl group at δ 2.45 and a pair of doublets for *meta*-coupled aromatic protons at δ 6.17 and 6.28 ($J = 2.0$ Hz), together with its ^{13}C NMR spectrum (Table 1), suggested that compound **1** possessed the carbon framework of 5,7-dihydroxy-2-methylchromone, which has been isolated in this study. The linkage of C-7 of the secoiridoid glucoside moiety and C-3″ of the chromone moiety was demonstrated by the HMBC correlations between H-7 of secoiridoid glucoside moiety and C-2″, 3″, and 4″ of chromone moiety. The *R*-configuration of C-7 was confirmed by the coupling constants between H-7 and H_2-6 and the NOESY correlation between H-5 and H-7 (Recio-Iglesias et al., 1992). Thus, sessilifoside (**1**) was deduced as a shown structure.

The second new glycoside **2** was obtained as an amorphous powder. The NMR spectral features of **2** were closely similar to those of **1** except for the presence of signals arising from an additional β-D-glucopyranosyl unit, which was identified as being the D-form by acid hydrolysis of **2** (Hara et al., 1986). The attachment of the second glucosyl unit at the C-7″ hydroxyl group of the chromone moiety was confirmed by the HMBC correlation between H-1‴ and C-7″ and the NOESY correlation between H-1‴ and H-8″. Accordingly, the glycoside **2** was assigned as 7″-*O*-β-D-glucopyranosylsessilifoside.

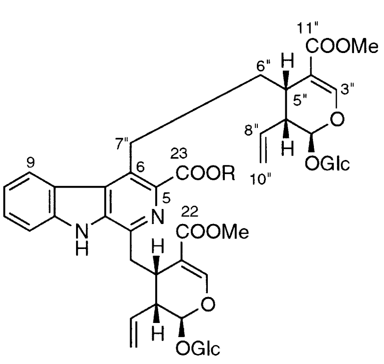
Sessilifoside (**1**) and 7″-*O*-β-D-glucopyranosylsessilifoside (**2**) represent the first chromone linked secoiridoid



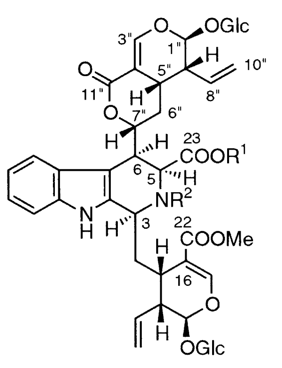
1: R=H
2: R=Glc



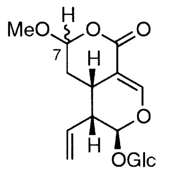
3: 3*S*
10: 3*R*



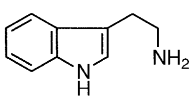
4: R=H
18: R=Me



5: R¹=R²=H
19: R¹=Me, R²=H
20: R¹=R²=Me



6: 7*R*
7: 7*S*



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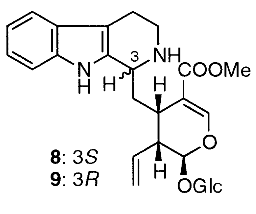
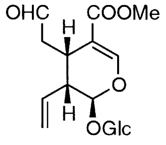


8: 3*S*
9: 3*R*



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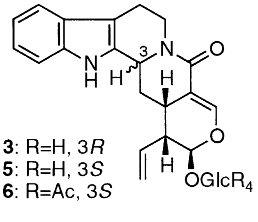
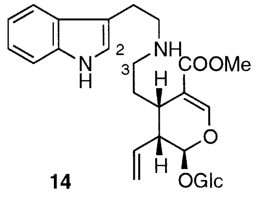


13: R=H, 3*R*
15: R=H, 3*S*
16: R=Ac, 3*S*



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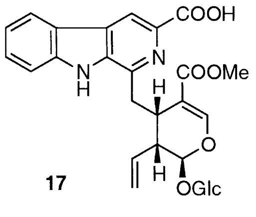

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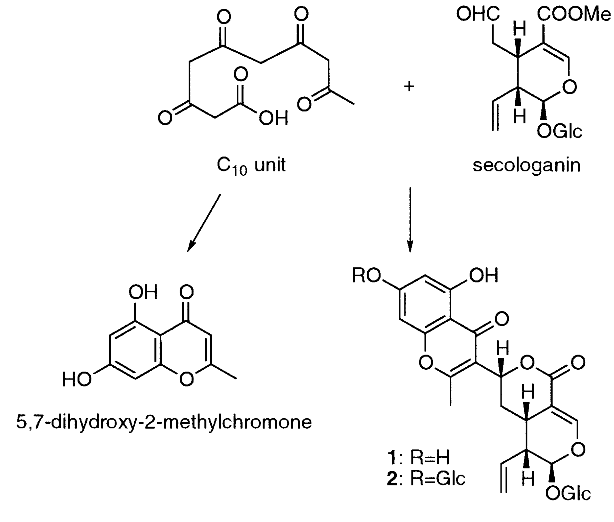
glucosides. The compounds could be biosynthesized through an aldol type condensation of secologanin with the C_{10} unit by acetate-malonate pathway (Scheme 1), as hydrangenosides had been assumed to be formed from secologanin and the C_{15} unit by shikimate-malonate route (Inouye et al., 1980).

Neonaucleoside A (**3**) was also obtained as an amorphous powder. Its HR-SIMS measurement showed a pseudomolecular ion $[M–H]^-$ at 901.3605, consistent with a molecular formula $C_{44}H_{58}N_2O_{18}$. Its ^1H NMR spectrum exhibited two doublets for two olefinic protons at δ 7.42 (*d*, $J=1.0$ Hz) and 7.57 *(brs)*, signals for two terminal vinyl groups at δ 5.23 (*dd*, $J=10.5$, 1.5 Hz), 5.36 (*brd*, $J=17.0$ Hz), 5.75 (*ddd*, $J=17.0$, 10.5, 9.0 Hz), 5.29 (*dt*, $J=10.5$, 1.5 Hz), 5.41 (*dt*, $J=17.5$, 1.5 Hz), and 5.84 (*ddd*, $J=17.5$, 10.5, 7.0 Hz), two doublets for acetal protons at δ 5.46 (*d*, $J=5.0$ Hz) and 5.58 (*d*, $J=7.0$ Hz), two doublets for anomeric protons at δ 4.65 and 4.73 (each *d*, $J=8.0$ Hz), and two singlets for two carbomethoxyl groups at δ 3.66 and 3.71, indicating two secoiridoid glucoside units. Further signals for four aromatic protons at δ 6.96 (*td*, $J=7.5$, 1.0 Hz), 7.04 (*td*, $J=7.5$, 1.0 Hz), 7.27 (*brd*, $J=7.5$ Hz), 7.38 (*brd*, $J=7.5$ Hz) and eight sp^2 carbon signals at δ 107.0, 111.9, 118.6, 119.7, 122.1, 128.2, 137.9 (× 2) and two sp^3 methylene carbon signals at δ 17.4 and 43.1 demonstrated the presence of a tetrahydro-β-carboline nucleus. These spectral features suggested that compound **3** consisted of an indole alkaloid glucoside such as strictosidine (**8**) (Smith, 1968; Nagakura et al., 1979; Patthy-Lukáts et al., 1997) or vincoside (**9**) (Nagakura et al., 1979) bound to an additional secoiridoid glucoside moiety. The linkage of C-7″ of the second secoiridoid glucoside unit at *N*-4 in the indole alkaloid glucoside was determined by the ^{13}C NMR spectrum of **3**, which showed a signal for C-7″ at δ 51.3 as a methylene carbon and by a HMBC correlation between H-7″ and C-5.



Scheme 1. Proposed biosynthetic sequence for sessilifosides.

The stereochemistry at C-3 of **3** was confirmed by the synthesis of **3** and its C-3 epimer **10**. Condensation of tryptamine (**11**) and secologanin (**12**) at pH 4 for 3 days followed by treatment with additional **12** and sodium cyanoborohydride at pH 6 afforded **3**, **8**, **10**, vincosamide (**13**) (Erdelmeier et al., 1991), and **14**. Compound **10** had the same molecular formula as **3** and its spectral data were quite similar to those of **3** except for the NMR signals assigned to C-3, 5, 14, 15, 5″, 6″ and H-3, 5, 5″, 6″. These findings revealed that **10** must be C-3 epimer of **3**. The NMR spectral data of **14** showed an indole unit and a secoiridoid glucoside unit. A singlet at δ 7.19 was assigned to H-2 in indole unit and a two-protons multiplet at δ 3.04 was assigned to H_2-7 in the secoiridoid glucoside unit, i. e. H_2-3 in **14**. These spectral data as well as detailed 2D NMR experiments and SI mass spectrum demonstrated that **14** was a reduced compound of the imine derived from tryptamine (**11**) and secologanin (**12**). Compound **8** was confirmed to be strictosidine with C-3*S* configuration by lactamization to strictosamide (**15**), followed by acetylation to strictosamide tetraacetate (**16**) (Blackstock et al., 1972; Stöckigt and Zenk, 1977). Condensation of strictosidine (**8**) with **12** in the presence of sodium cyanoborohydride yielded **3**, but not **10**. Thus, neonaucleoside A (**3**) was formulated as shown.

Neonaucleoside B (**4**), $C_{45}H_{54}N_2O_{20}$, was also isolated as an amorphous powder. Its spectral features were closely related to those of desoxycordifoline (**17**) (Brown et al., 1978), which is also a constituent of the plant material, but with an additional secoiridoid unit. Glycoside **4** was treated with (trimethylsilyl)diazomethane to give **18**. In the ^1H NMR spectrum of **4**, signals of two carbomethoxyl groups appeared at δ 3.41 and 3.69, which were correlated to C-22 and C-11″ in its HMBC spectrum, respectively, while in the spectrum of **18**, an additional carbomethoxyl signal was observed at δ 3.98, which was correlated to C-23 in its HMBC spectrum. Accordingly, the newly formed carbomethoxyl group in **18** originated from a carboxyl group at C-5. When ^{13}C NMR spectral data of **4** and **18** were compared with those of **17**, significant differences were observed in the signals around C-6. While a methine carbon signal at δ 116.4 was assigned to C-6 in **17**, a quaternary carbon signal at δ 135.1 in **4** was assigned to C-6, suggesting the attachment of the second secoiridoid glucoside at C-6 of desoxycordifoline (**17**) moiety. The site of linkage in the second secoiridoid glucoside was revealed to be C-7 by the correlations between H_2-7″ and C-5, 6, and 7 in the HMBC spectra of **4** and **18** and the interactions between H-9 and H_2-7″, H_2-6″, and H-5″ in the ROESY experiments of **4** and **18**. Accordingly, the structure of neonaucleoside B was represented by **4**.

Neonaucleoside C (**5**) was isolated as a colorless crystalline solid, mp > 300 °C and the molecular formula of $C_{44}H_{54}N_2O_{20}$ was deduced from its HR-SIMS. The ^1H

and ^{13}C NMR spectral features of **5** were similar to those of **3** and showed the presence of a tetrahydro-β-carboline unit and two secoiridoid units in the molecule. However, the ^{13}C NMR spectrum of **5** differed remarkably in that one methoxyl and three carbonyl carbons were observed and that C-5 and C-6 appeared as methine carbons. Methylation of **5** with (trimethylsilyl)diazomethane afforded two methylated compounds **19** and **20**. The ^{1}H NMR spectra of the two compounds demonstrated two methoxyl groups in **19** and **20**, but with an additional *N*-methyl group in **20**, suggesting that a carbomethoxyl, a carboxyl group and a secondary amino group were present in **5**. HMBC correlation between OMe (δ 3.66) and C-22 (δ 167.5) in **5** as well as HMBC correlations between OMe (**19**: δ 3.71; **20**: δ 3.57) and C-22 (**19**: δ 169.8; **20**: δ 169.3), and between OMe (**19**: δ 3.84; **20**: δ 3.78) and C-23 (**19**: δ 174.8; **20**: δ 174.0) in **19** and **20** demonstrated the presence of a carbomethoxyl group at C-16 and a carboxyl group at C-5 in **5**. A remaining carbonyl carbon was ascribed to a lactone ring of the second secoiridoid glucose unit as in **1** by ^{1}H and ^{13}C NMR data and 2D-NMR experiments of **5**, **19** and **20**. The linkage of C-7″ of the secoiridoid glucoside unit to C-6 of tetrahydro-β-carboline unit was revealed by COSY correlation between H-6 and H-7″, HMBC correlation between H-5 and C-7″ and ROESY correlations between H-9 and H-7″ and between H-9 and H_2-6″ in **5**, **19** and **20**.

The stereochemistry was determined by the biogenetic consideration as well as the following spectral data. The ROESY correlation between H-3 and H-5 suggested that both H-3 and H-5 adopted axial orientations. The coupling constants around 3.5 Hz between H-5 and H-6 in **5**, **19**, and **20** therefore showed that H-6 take up an equatorial orientation. Assuming that the tetrahydro-β-carboline moiety is derived from L-tryptophane, the absolute configuration at C-5 would be *S*. And following this, C-6 was assigned to have the *R*-configuration. Similarly, a ROESY correlation between H-5″ and H-7″ together with obvious *trans*-diaxial couplings to one of the protons at C-6″, allowed to assign the 7″(*R*)-configuration for **5** (Recio-Iglesias et al., 1992). Accordingly, neonaucleoside C (**5**) was deduced as shown structure.

Neonaucleosides A-C (**3**–**5**) were quite unique glycosides. These compounds are the first examples of indole alkaloid glycosides linked with a second secoiridoid glucoside unit.

3. Experimental

3.1. General

UV spectra were recorded on a Shimadzu UV-2500PC spectrophotometer and IR spectra on a Shimadzu FTIR-8200 spectrophotometer. Optical rotations were measured on a Jasco DIP-370 digital polarimeter and CD spectra on a Shimadzu-AVIV 62 A DS circular dichroism spectrometer. ^{1}H (500 and 300 MHz) and ^{13}C (125 and 75 MHz) NMR spectra were recorded on a Varian VXR-500 and Varian Gemini-300 spectrometers with TMS as an internal standard. MS and HR-MS were obtained with a Hitachi M-4100 mass spectrometer. Glycerol was used for SIMS and HR-SIMS as the matrix. MPLC was carried out with Wakosil 40C18. TLC was performed on precoated Kieselgel $60F_{254}$ plates (Merck).

3.2. Plant material

The roots of *Neonauclea sessilifolia* were collected at Surat Thani, Thailand and identified by Dr. Tem Smitinand, Forest Herbarium, Royal Forest Department, Bangkok, Thailand. A voucher specimen (NST-592) is deposited in the laboratory of the Nippon Shinyaku Institute for Botanical Research.

3.3. Extraction and isolation

Dried roots (1.58 kg) of *N. sessilifolia* were extracted with hot MeOH and the MeOH extracts were evaporated in vacuo. A part (21.4 g) of the residue (173 g) was resuspended in H_2O and extracted successively with $CHCl_3$ and *n*-BuOH. The residue from *n*-BuOH layers (10.0 g) was fractionated on reversed-phase MPLC. Elution with H_2O–MeOH mixtures of indicated MeOH content gave 9 fractions, 1 (20%, 1.69 g), 2 (20%, 556 mg), 3 (25%, 162 mg), 4 (30%, 472 mg), 5 (35–40%, 607 mg), 6 (50%, 366 mg), 7 (50%, 720 mg), 8 (60%, 2.18 g), and 9 (80%, 1.11 g). Fr. 1 was submitted to reversed-phase MPLC eluted with MeOH–H_2O (3:17, 1:4, 3:7), and was further purified by prep. HPLC (μBondasphere 5μ C18-100Å, MeOH–H_2O, 7:13) and prep. TLC ($CHCl_3$–MeOH, 4:1) to afford 5-hydroxy-2-methylchromone-7-*O*-β-D-apiofuranosyl-(1→6)-β-D-glucopyranoside (312 mg), sweroside (520 mg), loganin (160 mg), scopolin (11.7 mg), hymexelsin (34.0 mg), **7** (10.0 mg), and loganetin (5.2 mg). Fr. 2 was purified by prep. HPLC (MeOH-H_2O, 7:13) to give 5-hydroxy-2-methylchromone-7-*O*-β-D-apiofuranosyl-(1→6)-β-D-glucopyranoside (153 mg), loganin (116 mg), and **7** (41.6 mg). Frs. 3–9 were further purified by a combination of silica gel CC ($CHCl_3$–MeOH, 93:7-3:2), prep. HPLC (MeOH–H_2O, 7:13, 9:11, 1:1, 11:9, 3:2, 3:1, or 4:1) and prep. TLC ($CHCl_3$–MeOH, 7:3 or 4:1; $CHCl_3$–MeOH-H_2O, 70:30:3; AcOEt–C_6H_6–EtOH, 4:1:2), respectively. Fr. 3 yielded 3,4-di-*O*-caffeoylquinic acid (48.5 mg); fr. 4: 5,7-dihydroxy-2-methylchromone (8.8 mg), **17** (145 mg), **2** (9.5 mg), and secologanin dimethylacetal (3.6 mg); fr. 5: grandifloroside (206 mg); fr. 6: **5** (82.0 mg), **1** (5.7 mg), and methyl grandifloroside (11.0 mg); fr. 7: **4** (57.9 mg), quinovic acid 3β-*O*-β-D-glucopyranoside-28-

O-β-D-glucopyranoside (73.6 mg), and strictosamide (13.1 mg); fr. 8. quinovic acid 3β-*O*-β-D-quinovopyranoside-28-*O*-β-D-glucopyranoside (1.09 g), **3** (19.6 mg), and quinovic acid 3β-*O*-β-D-glucopyranosyl-(1→4)-α-L-rhamnopyranoside-28-*O*-β-D-glucopyranoside (37.6 mg).

3.4. *Sessilifoside (**1**)*

Amorphous powder. $[\alpha]_D^{26}$ −151° (*c* 0.3, MeOH). UV λ_{max}^{MeOH} nm (log ε): 232 sh (4.25), 251 (4.33), 259 sh (4.30), 294 (3.75), 327 sh (3.58). IR ν_{max}^{KBr} cm^{-1}: 3421, 1697, 1655, 1618, 1508. ^{1}H NMR: Table 1. ^{13}C NMR: Table 1. HR-SIMS Found 547.1457 [M–H]$^{-}$; $C_{26}H_{27}O_{13}$ requires 547.1452. NOESY: H-5/H-7; H-1/H-1′. HMBC: H-1′ to C-1; H-7 to C-2″, 3″, 4″; Me-2″ to C-2″, 3″.

3.5. *7″-O-β-D-Glucopyranosylsessilifoside (**2**)*

Amorphous powder. $[\alpha]_D^{22}$ −165° (*c* 0.7, MeOH). UV λ_{max}^{MeOH} nm (log ε): 245 (4.39), 251 (4.40), 261 sh (4.35), 291 sh (3.77), 313 (3.64). IR ν_{max}^{KBr} cm^{-1}: 3405, 1694, 1655, 1616, 1505. ^{1}H NMR: Table 1. ^{13}C NMR: Table 2. Negative ion SIMS *m*/*z*: 709 [M–H]$^{-}$, 547. HR-SIMS Found 709.1988 [M–H]$^{-}$; $C_{32}H_{37}O_{18}$ requires 709.1981. NOESY: H-5/H-7; H-1/H-1′; H-8″/H-1‴. HMBC: H-1 to C-1′; H-1′ to C-1; H-6 (δ 2.17) to H-3″; H-7 to H-2″,

Table 1
^{13}C (125 MHz) and ^{1}H (500 MHz) NMR spectral data of **1** and **2** in CD_3OD

	1		**2**	
Position	δ_C	δ_H	δ_C	δ_H
1	98.1	5.59 *d* (1.5)	98.1	5.60 *d* (1.5)
3	154.5	7.68 *d* (2.5)	154.5	7.69 *d* (2.5)
4	105.6		105.6	
5	28.7	3.34 *m*	28.6	3.27–3.53 *m*
6	30.0	1.87 *ddd* (13.5, 4.5, 2.5) 2.18 *td* (13.5, 12.0)	29.9	1.88 *ddd* (13.5, 4.5, 2.5) 2.17 *td* (13.5, 12.0)
7	75.1	5.84 *dd* (12.0, 2.5)	75.0	5.85 *dd* (12.0, 2.5)
8	133.3	5.61 *dt* (17.0, 10.0)	133.3	5.61 *dt* (17.0, 10.0)
9	43.9	2.74 *ddd* (9.5, 5.5, 1.5)	43.8	2.75 *ddd* (10.0, 5.5, 1.5)
10	121.1	5.29 *dd* (10.0, 1.5) 5.31 *dd* (17.0, 1.5)	121.1	5.29 *dd* (10.0, 2.0) 5.31 *dd* (17.0, 2.0)
11	168.6		168.5[a]	
1′	99.8	4.71 *d* (8.0)	99.7	4.71 *d* (8.0)
2′	74.8	3.23 *dd* (9.0, 8.0)	74.7[b]	3.23 *dd* (9.5, 8.0)
3′	77.9	3.39 *t* (9.0)	77.8[c]	3.27–3.53 *m*
4′	71.6	3.29 *dd* (10.0, 9.0)	71.2[d]	3.27–3.53 *m*
5′	78.5	3.34 *m*	78.4[e]	3.27–3.53 *m*
6′	62.7	3.67 *dd* (12.0, 6.0) 3.90 *dd* (12.0, 2.0)	62.4[f]	3.67[g] *dd* (12.0, 5.5) 3.90 *dd* (12.0, 2.0)
2″	167.5		168.1[a]	
3″	118.2		118.6	
4″	181.6		181.8	
5″	163.5		163.1	
6″	100.2	6.17 *d* (2.0)	101.1	6.47 *d* (2.0)
7″	166.2		164.9	
8″	94.7	6.28 *d* (2.0)	95.7	6.64 *d* (2.0)
9″	159.2		158.7	
10″	104.9		106.6	
Me	18.9	2.45 *s*	19.0	2.48 *s*
1‴			101.6	5.03 *d* (7.5)
2‴			74.8[b]	3.27–3.53 *m*
3‴			77.9[c]	3.27–3.53 *m*
4‴			71.6[d]	3.27–3.53 *m*
5‴			78.5[e]	3.27–3.53 *m*
6‴			62.7[f]	3.71[g] *dd* (12.0, 5.5) 3.90 *dd* (12.0, 2.0)

[a–g] Values with the same superscript are interchangeable.

3″, 4″; Me-2″ to C-2″, 3″; H-1‴ to C-7″; H-8″ to C-6″, 7″, 9″, 10″.

3.6. Neonaucleoside A (3)

Amorphous powder. $[\alpha]_D^{28}$ −133° (*c* 1.0, MeOH). UV λ_{max}^{MeOH} nm (log ε): 227 (4.54), 273 (3.73), 283 sh (3.72), 290 sh (3.64). IR ν_{max}^{KBr} cm^{-1}: 3400, 1697, 1636. ^{1}H NMR: Table 2. ^{13}C NMR: Table 5. Negative ion SIMS *m/z*: 901 [M–H]$^-$, 739. HR-SIMS Found 901.3605 [M–H]$^-$; $C_{44}H_{57}N_2O_{18}$ requires 901.3608. ROESY: H-21/H-1′; H-1″/H-1‴. HMBC: H-15 to C-3, 22; H-17 to C-22; OMe (δ 3.71) to C-22; H-21 to C-1′; H-1′ to C-21; H-3″ to C-11″ H-7″(δ 2.80- 2.90) to C-5; H-5″ to C-7″, 11″; OMe (δ 3.66) to C-11″; H-1″ to C-1‴; H-1‴ to C-1″.

3.7. Neonaucleoside B (4)

Amorphous powder. $[\alpha]_D^{28}$ −212° (*c* 1.0, MeOH). UV λ_{max}^{MeOH} nm (log ε): 238 (4.58), 263 (4.43), 290 sh (3.89), 304 (3.73), 335 sh (3.56), 349 (3.65), 387 sh (3.21). IR ν_{max}^{KBr} cm^{-1}: 3384, 1697, 1624. ^{1}H NMR: Table 3. ^{13}C NMR: Table 5. HR-SIMS Found 941.3177 [M-H]$^-$; $C_{45}H_{53}N_2O_{20}$ requires 941.3193. ROESY: H-9/H$_2$-7″;

Table 2
^{1}H NMR spectral data of **3**, **10** and **14** in CD_3OD at 500 MHz

H	**3**	**10**	**14**
2			7.19 *s*
3	4.08 *m*	3.91 *m*	3.04 *m*
3			3.04 *m*
5	3.20–3.39 *m*	3.08 *dd* (13.0, 6.0)	3.29 *t* (7.5)
5	3.20–3.39 *m*	3.26–3.35 *m*	3.29 *t* (7.5)
6	2.55 *brd* (15.0)	2.58 *m*	3.16 *t* (7.5)
6	2.80–2.90 *m*	2.90 *ddd* (16.0, 11.0, 6.0)	3.16 *t* (7.5)
9	7.38 *brd* (7.5)	7.40 *brd* (8.0)	7.58 *brd* (8.0)
10	6.96 *td* (7.5, 1.0)	6.98 *td* (8.0, 1.0)	7.05 *td* (8.0, 1.0)
11	7.04 *td* (7.5, 1.0)	7.06 *td* (8.0, 1.0)	7.13 *td* (8.0, 1.0)
12	7.27 *brd* (7.5)	7.32 *brd* (8.0)	7.37 *brd* (8.0)
14	1.93 *m*	1.95 *m*	1.87 *ddd* (14.0, 8.5, 7.0)
14	2.07 *m*	2.13 *m*	1.97 *dt* (14.0, 7.0)
15	3.20–3.39 *m*	3.23 *m*	2.80 *brtd* (7.0, 5.5)
17	7.57 *brs*	7.55 *brs*	7.54 *d* (0.5)
18	5.29 *dt* (10.5, 1.5)	5.21 *brd* (10.5)	5.28 *brd* (10.5)
18	5.41 *dt* (17.5, 1.5)	5.22 *brd* (17.0)	5.32 *brd* (17.0)
19	5.84 *ddd* (17.5, 10.5, 7.0)	5.80 *ddd* (17.0, 10.5, 8.5)	5.75 *ddd* (17.0, 10.5, 8.5)
20	2.80–2.90 *m*	2.67–2.74 *m*	2.63 *ddd* (8.5, 6.5, 5.5)
21	5.58 *d* (7.0)	5.63 *d* (6.5)	5.54 *d* (6.5)
22-OMe	3.71 *s*	3.73 *s*	3.69 *s*
1′	4.73 *d* (8.0)	4.71 *d* (8.0)	4.69 *d* (8.0)
2′	3.19[a] *dd* (9.0, 8.0)	3.22 *dd* (9.0, 8.0)	3.18 *dd* (9.0, 8.0)
3′	3.20–3.39 *m*	3.38 *t* (9.0)	3.37 *t* (9.0)
4′	3.20–3.39 *m*	3.26–3.35 *m*	3.25 *t* (9.0)
5′	3.20–3.39 *m*	3.26–3.35 *m*	3.32 *ddd* (9.0, 6.5, 2.0)
6′	3.62[b] *dd* (12.0, 6.0)	3.65[d] *dd* (12.0, 5.0)	3.65 *dd* (12.0, 6.5)
6′	3.87[c] *dd* (12.0, 2.0)	3.86[e] *dd* (12.0, 2.0)	3.91 *dd* (12.0, 2.0)
1″	5.46 *d* (5.0)	5.45 *d* (5.5)	
3″	7.42 *d* (1.0)	7.42 *d* (1.0)	
5″	2.95 *quint* (5.0)	2.77 *m*	
6″	1.62 *m*	1.67 *m*	
6″	2.31 *m*	2.04 *m*	
7″	2.75 *m*	2.67–2.74 *m*	
7″	2.80–2.90 *m*	2.67–2.74 *m*	
8″	5.75 *ddd* (17.0, 10.5, 9.0)	5.71 *ddd* (17.0, 10.0, 9.0)	
9″	2.80–2.90 *m*	2.58 *m*	
10″	5.23 *dd* (10.5, 1.5)	5.11 *brd* (17.0)	
10″	5.36 *brd* (17.0)	5.17 *dd* (10.5, 1.5)	
11″-OMe	3.66 *s*	3.67 *s*	
1‴	4.65 *d* (8.0)	4.65 *d* (8.0)	
2‴	3.22[a] *dd* (9.0, 8.0)	3.17 *dd* (9.0, 8.0)	
3‴	3.20–3.39 *m*	3.26–3.35 *m*	
4‴	3.20–3.39 *m*	3.26–3.35 *m*	
5‴	3.20–3.39 *m*	3.26–3.35 *m*	
6‴	3.64[b] *dd* (12.0, 6.0)	3.66[d] *m*	
6‴	3.87[c] *dd* (12.0, 2.0)	3.91[e] *dd* (11.5, 2.0)	

[a–e] Values with the same superscript are interchangeable.

H-9/H$_2$-6″; H-9/H-5″; H-21/H-1′; H-1″/H-1‴. HMBC: H$_2$-14 to C-2, 3; H-15 to C-3, 14; H-17 to C-22; OMe (δ 3.41) to C-22; H-3″ to C-11″; OMe (δ 3.69) to C-11″; H$_2$-7″ to C-5, 6, 7; H-21 to C-1′; H-1′ to C-21; H-1″ to C-1‴; H-1‴ to C-1″.

3.8. Neonaucleoside C (5)

Colorless crystalline solid. mp >300 °C (H$_2$O). $[\alpha]_D^{28}$ −326° (*c* 0.2, Py). UV λ_{max}^{MeOH} nm (log ε): 220 (4.61), 243 (4.34), 282 sh (3.84), 288 (3.74). IR ν_{max}^{KBr} cm^{-1}: 3421, 1690, 1626, 1508. ^{1}H NMR: Table 4. ^{13}C NMR: Table 5. HR-SIMS Found 929.3180 [M-H]$^-$; C$_{44}$H$_{53}$N$_2$O$_{20}$ requires 929.3193. COSY: H-6/H-7″. ROESY: H-3/H-5; H-3/H-15; H-21/H-1′; H-9/H-6; H-9/H$_2$-6″; H-9/H-7″; H-5″/H-7″; H-1″/H-1‴; H-3″/H-1‴. HMBC: H-17 to C-1, 16, 22; OMe to C-22; H-5 to C-6, 23, 7″; H-21 to C-1′; H-1′ to C-21; H-3″ to C-1″, 4″, 5″, 11″; H-1″ to C-1‴; H-1‴ to C-1″.

3.9. Acid hydrolysis of 7-O-β-D-glucopyranosylsessilifoside (2)

Glycoside **2** (1 mg) was heated at 95 °C with dioxane (0.5 ml) and 5% H$_2$SO$_4$ (0.5 ml) for 1 h. After neutralization with Amberlite IRA-400 (OH$^-$ form), the

Table 3
^{1}H NMR spectral data of **4**, **17** and **18** in CD$_3$OD at 500 MHz

H	**4**	**17**	**18**
6		8.81 *s*	
9	8.23 *brd* (8.0)	8.29 *brd* (8.0)	8.19 *brd* (8.0)
10	7.35 *brt* (8.0)	7.38 *m*	7.29 *td* (8.0, 1.0)
11	7.65 *brt* (8.0)	7.67 *m*	7.57 *td* (8.0, 1.0)
12	7.68 *brd* (8.0)	7.67 *m*	7.64 *brd* (8.0)
14	3.44 *dd* (14.0, 8.0)	3.56 *m*	3.31 *m*
14	3.52 *dd* (14.0, 6.0)	3.56 *m*	3.47 *dd* (14.0, 6.5)
15	3.58 *ddd* (8.0, 6.0, 4.5)	3.61 *m*	3.55 *brq* (6.5)
17	7.56 *s*	7.55 *s*	7.51 *d* (0.5)
18	5.05–5.09 *m*	5.08–5.12 *m*	5.00 *brd* (17.0)
18	5.05–5.09 *m*	5.08–5.12 *m*	5.03 *dd* (10.0, 1.0)
19	5.84 *ddd* (17.0, 10.5, 8.5)	5.90 *ddd* (17.0, 11.0, 8.5)	5.88 *ddd* (17.0, 10.0, 6.0)
20	2.67 *ddd* (8.5, 7.0, 4.5)	2.69 *td* (7.5, 5.0)	2.66 *ddd* (7.5, 7.0, 6.0)
21	5.77 *d* (7.0)	5.84 *d* (7.5)	5.77 *d* (7.0)
22-OMe	3.41 *s*	3.32 *s*	3.35 *s*
23-OMe			3.98 *s*
1′	4.76 *d* (8.0)	4.79 *d* (8.0)	4.76 *d* (8.0)
2′	3.22^a *dd* (9.0, 8.0)	3.23 *dd* (9.0, 8.0)	3.22 *dd* (9.0, 8.0)
3′	3.32–3.42 *m*	3.41 *t* (9.0)	3.24–3.41 *m*
4′	3.27^b *t* (9.5)	3.28 *dd* (10.0, 9.0)	3.24–3.41 *m*
5′	3.32–3.42 *m*	3.38 *ddd* (10.0, 6.5, 2.0)	3.24–3.41 *m*
6′	3.65^c *dd* (12.0, 6.0)	3.69 *dd* (12.0, 6.5)	3.70 *dd* (12.0, 6.0)
6′	3.83^d *dd* (12.0, 1.5)	3.96 *dd* (12.0, 2.0)	3.91 *dd* (12.0, 2.0)
1″	5.70 *d* (8.0)		5.61 *d* (7.5)
3″	7.63 *s*		7.62 *s*
5″	3.10 *brq* (6.0)		3.10 *brq* (6.0)
6″	2.02 *m*		1.99 *m*
6″	2.02 *m*		2.07 *m*
7″	3.66 *m*		3.44 *m*
7″	3.74 *m*		3.44 *m*
8″	5.99 *ddd* (17.0, 10.5, 8.5)		5.87 *ddd* (17.0, 10.5, 5.5)
9″	2.75 *ddd* (8.5, 8.0, 5.0)		2.75 *td* (7.5, 5.5)
10″	5.24 *brd* (10.5)		5.26 *brd* (10.5)
10″	5.34 *brd* (17.0)		5.37 *brd* (17.0)
11″-OMe	3.69 *s*		3.69 *s*
1‴	4.73 *d* (8.0)		4.71 *d* (8.0)
2‴	3.22^a *dd* (9.0, 8.0)		3.20 *dd* (9.0, 8.0)
3‴	3.32–3.42 *m*		3.24–3.41 *m*
4‴	3.27^b *t* (9.5)		3.24–3.41 *m*
5‴	3.32–3.42 *m*		3.24–3.41 *m*
6‴	3.67^c *dd* (12.0, 6.0)		3.59 *dd* (11.5, 5.5)
6‴	3.94^d *dd* (12.0, 1.5)		3.79 *dd* (11.5, 1.0)

[a–d] Values with the same superscript are interchangeable.

reaction mixture was concentrated and the residue was passed through a Sep-Pak C$_{18}$ cartridge with H$_2$O. The eluate was concentrated and the residue was treated with L-cysteine methyl ester hydrochloride (1 mg) in pyridine (0.125 ml) at 60 °C for 1 h. The solution was then treated with *N,O*-bis(trimethylsilyl)trifluoroacetamide (0.05 ml) at 60 °C for 1 h. The supernatant was applied to GLC; GLC conditions: column, Supelco SPB™-1, 30 m × 0.25 mm; column temperature, 230 °C; N$_2$ flow rate, 0.8 ml/min; t_R of derivatives, D-glucose 13.1 min, L-glucose 13.6 min. D-Glucose was detected from **2**.

*3.10. Condensation of tryptamine (**11**) with secologanin (**12**)*

A solution of secologanin (**12**) (50 mg, 0.13 mmol) and tryptamine–HCl (**11**) (50 mg, 0.25 mmol) in citrate-phosphate buffer (1.0 ml, pH 4.0) was incubated for 3 days at room temperature. To the reaction mixture adjusted to pH 5–6 with 5% aq NaHCO$_3$ **12** (50 mg) and NaBH$_3$CN (40 mg) were added. After stirring for 2 h at room temperature, the reaction mixture was subjected to a Sephadex LH-20 CC with MeOH as eluent

Table 4
^{1}H NMR spectral data of **5**, **19** and **20** at 500 MHz

H	**5**[a]	**19**[b]	**20**[b]
1	11.00 *brs*		
3	4.21 *brd* (11.0)	4.10 *brd* (10.5)	3.58 *brd* (8.0)
5	3.65-3.70 *m*	3.81 *d* (3.5)	3.47 *d* (4.0)
6	3.57 *brt* (3.0)	3.68 *td* (3.5, 1.5)	3.79 *m*
9	7.45 *brd* (8.0)	7.44 *brd* (8.0)	7.47 *brd* (8.0)
10	6.95 *td* (8.0, 1.0)	6.98 *td* (8.0, 1.0)	7.03 *td* (8.0, 1.0)
11	7.04 *td* (8.0, 1.0)	7.05 *td* (8.0, 1.0)	7.10 *td* (8.0, 1.0)
12	7.29 *brd* (8.0)	7.29 *brd* (8.0)	7.37 *brd* (8.0)
14	1.87 *brt* (11.0)	1.98 *ddd* (13.5, 10.5, 3.5)	1.97 *ddd* (14.5, 10.5, 2.5)
14	2.18 *brt* (11.0)	2.15 *ddd* (13.5, 10.0, 2.5)	2.46 *m*
15	2.90-3.10 *m*	3.14 *ddd* (10.0, 5.0, 3.5)	3.22-3.40 *m*
17	7.62 *s*	7.62 *s*	7.46 *d* (1.5)
18	5.23 *brd* (10.0)	5.23 *brd* (10.5)	5.31-5.34 *m*
18	5.35 *brd* (17.0)	5.35 *brd* (17.0)	5.31-5.34 *m*
19	5.81 *ddd* (17.0, 10.0, 7.5)	5.91 *ddd* (17.0, 10.5, 8.0)	5.82 *dt* (18.0, 9.5)
20	2.63 *ddd* (8.0, 7.5, 5.0)	2.68 *td* (8.0, 5.0)	2.86 *ddd* (9.5, 5.0, 4.0)
21	5.59 *d* (8.0)	5.74 *d* (8.0)	5.49 *d* (4.0)
22-OMe	3.66 *s*	3.71 *s*	3.57 *s*
23-OMe		3.84 *s*	3.78 *s*
NMe			2.44 *s*
1′	4.60 *d* (8.0)	4.76 *d* (8.0)	4.69 *d* (8.0)
2′	2.90-3.10 *m*	3.22 *dd* (9.0, 8.0)	3.22-3.40 *m*
3′	3.12-3.20 *m*	3.39 *t* (9.0)	3.22-3.40 *m*
4′	2.90-3.10 *m*	3.23[d] *t* (9.0)	3.22-3.40 *m*
5′	3.12-3.20 *m*	3.29[e] *ddd* (9.0, 5.5, 2.0)	3.22-3.40 *m*
6′	3.41[c] *dd* (11.0, 6.0)	3.63[f] *dd* (12.0, 5.5)	3.64[h] *dd* (12.0, 5.5)
6′	3.65-3.70 *m*	3.86[g] *dd* (12.0, 2.0)	3.85[i] *dd* (12.0, 2.0)
1″	5.40 *d* (1.5)	5.48 *d* (1.5)	5.51 *d* (1.5)
3″	7.42 *d* (2.5)	7.52 *d* (2.5)	7.54 *d* (2.5)
5″	2.90-3.10 *m*	2.89 *dddd* (13.0, 5.5, 4.0, 2.5)	2.85 *dddd* (14.0, 5.5, 4.5, 2.5)
6″	1.69 *brq* (13.0)	1.64 *ddd* (13.5, 4.0, 1.5)	1.61 *ddd* (14.0, 4.5, 2.5)
6″	1.91 *brd* (12.0)	2.10 *brq* (13.0)	2.49 *td* (14.0, 12.0)
7″	4.79 *brd* (12.0)	*	4.89 *m*
8″	5.20 *ddd* (17.0, 10.0, 8.5)	5.41 *dt* (17.0, 10.0)	5.57 *ddd* (16.5, 10.5, 9.0)
9″	2.58 *ddd* (8.5, 5.5, 1.5)	2.54 *ddd* (9.0, 5.5, 1.5)	2.60 *ddd* (9.0, 5.5, 1.5)
10″	5.07 *dd* (10.0, 2.5)	5.17 *dd* (10.0, 1.5)	5.21 *dd* (16.5, 1.5)
10″	5.26 *dd* (17.0, 2.5)	5.24 *dd* (17.0, 1.5)	5.23 *dd* (10.5, 1.5)
1‴	4.46 *d* (8.0)	4.62 *d* (8.0)	4.63 *d* (8.0)
2‴	2.90-3.10 *m*	3.12 *dd* (9.0, 8.0)	3.11 *dd* (9.0, 8.0)
3‴	3.12-3.20 *m*	3.34 *t* (9.0)	3.22-3.40 *m*
4‴	2.90-3.10 *m*	3.25[d]*t* (9.0)	3.22-3.40 *m*
5‴	3.12-3.20 *m*	3.34[e] *ddd* (9.0, 6.5, 2.0)	3.22-3.40 *m*
6‴	3.46[c] *dd* (11.0, 5.5)	3.65[f] *dd* (12.0, 6.5)	3.66[h] *dd* (12.0, 5.5)
6‴	3.65-3.70 *m*	3.93[g] *dd* (12.0, 2.0)	3.89[i] *dd* (12.0, 2.0)

[a] Measured in DMSO-d_6.

[b] Measured in CD$_3$OD.

[c] Values with the same superscript are interchangeable.

* Overlapped with HOD signal.

and the products were further purified by prep. TLC ($CHCl_3$–MeOH–H_2O, 70:30:1.5; $CHCl_3$–MeOH, 4:1; AcOEt–C_6H_6–EtOH, 4:1:2) to afford **3** (2.2 mg), strictosidine (**8**) (21.7 mg), **10** (5.4 mg), vincosamide (**13**) (5.9 mg), **14** (16.9 mg). Vincosamide (**13**) was identified with authentic sample (^1H NMR, UV, SIMS and CD $\lambda_{\max}^{\mathrm{MeOH}}$ nm ($\Delta\varepsilon$): 217 (+17.8), 232 (−15.2), 267 (−5.9)). **8**: $[\alpha]_D^{26}$ −206° (*c* 0.8, MeOH). UV $\lambda_{\max}^{\mathrm{MeOH}}$ nm (log ε): 224 (4.53), 274 (3.85), 281 (3.86), 289 (3.79). IR $\nu_{\max}^{\mathrm{KBr}}$ cm^{-1}: 3368, 1684, 1632. Negative ion SIMS *m*/*z*: 529 $[M–H]^-$, 497. **3**: ^1H NMR spectral data were identical with those of **3** from natural source. **10**: $[\alpha]_D^{22}$ −157° (*c* 0.2, MeOH). UV $\lambda_{\max}^{\mathrm{MeOH}}$ nm (log ε): 227 (4.62), 272 sh (3.81), 280 (3.82), 290 sh (3.72). IR $\nu_{\max}^{\mathrm{KBr}}$ cm^{-1}: 3400, 1697, 1636, 1437. ^1H NMR: Table 2. ^{13}C NMR: Table 5. Negative ion SIMS *m*/*z*: 901 $[M–H]^-$, 739. HR-SIMS Found 901.3607 $[M–H]^-$; $C_{44}H_{57}N_2O_{18}$ requires 901.3608. NOESY: H-3/H-20; H-1″/H-1‴. **14**: $[\alpha]_D^{21}$ −84° (*c* 1.0, MeOH). UV $\lambda_{\max}^{\mathrm{MeOH}}$ nm (log ε): 222 (4.09), 241 sh (4.57), 273 (3.77),

Table 5
^{13}C NMR spectral data of **3-5**, **10**, **14**, **17-20** at 125 MHz

C	**3**[a]	**10**[a]	**14**[a]	**4**[a]	**17**[a]	**18**[a]	**5**[b]	**19**[a]	**20**[a]
2	137.9	137.7	124.3	136.8	137.3	137.2	136.7	139.2	137.9
3	59.1	56.3	47.5	140.4	143.0	143.3	51.0	52.4	60.3
5	43.1	45.2	49.3	n.d.[i]	137.8	137.5[c]	59.8	60.1	67.5
6	17.4	18.2	23.5	135.1	116.4	133.7[c]	38.1	40.8	41.9
7	107.0	106.8	110.1	130.7	132.2	128.1[c]	106.0	106.9	106.2
8	128.2	128.4	128.1	122.4	122.6	122.6	126.6	127.9	127.1
9	118.6	118.7	118.9	125.3	123.4	124.7	118.6	119.0	118.5
10	119.7	119.8	120.1	122.2	122.4	121.4	118.6	120.1	120.4
11	122.1	122.2	122.8	130.3	131.3	129.0	120.8	122.2	122.6
12	111.9	112.0	112.6	113.5	113.5	113.2	111.1	112.1	112.4
13	137.9	137.7	138.3	143.7	144.0	142.5	136.1	138.1	138.4
14	36.7	35.3	28.0	33.5	34.0	35.2	36.5	38.6	35.7
15	31.5	30.6	31.9	34.3	34.9	34.4	30.3	32.4	29.5
16	112.5	112.0	109.9	110.3	110.1	111.0	110.0	111.8	112.0
17	154.2	154.4	154.7	154.6	154.8	154.2	153.0	154.7	153.6
18	119.7	119.8	120.2	120.0	119.9	119.4	119.2	119.6	120.8
19	136.1	135.8	135.0	135.1	135.2	135.6	134.7	136.1	135.9
20	45.5	45.4	45.1	45.5	45.7	45.7	44.1	46.3	45.2
21	98.1	97.9	97.5	97.5	97.4	97.4	95.9	97.7	99.0
22	169.8	170.1	169.6	169.3	169.3	169.5	167.5	169.8	169.3
23				n.d.[i]	167.4	169.5	171.3	174.8	174.0
OMe	51.9	52.1	52.0	51.9	51.9	51.8[d]	51.4	52.0	51.8
OMe						52.8		52.5	52.6
1′	100.3[c]	100.1	100.2	100.3	100.4	100.2	98.9	100.4	100.8
2′	74.6[d]	74.7[c]	74.7	74.6	74.7	74.7	73.0	74.6[c]	74.6
3′	78.0[e]	78.1	78.0	78.0	78.1	78.0	76.2[c]	77.8[d]	77.8[c]
4′	71.6[f]	71.6[d]	71.6	71.6	71.7	71.6	69.9[d]	71.5[e]	71.5[d]
5′	78.4[g]	78.4[e]	78.5	78.4[c]	78.7	78.6	77.2[e]	78.3[f]	78.4[e]
6′	62.8[h]	62.7[f]	62.8	62.8[d]	63.0	62.8	61.0	62.6[g]	62.6[f]
NMe									42.9
1″	98.4	97.9		98.0		98.0	95.3	97.8	97.8
3″	153.2	153.2		154.3		154.0	151.5	153.7	153.6
4″	111.9	111.9		111.3		111.8	104.3	106.1	106.4
5″	30.4	31.7		36.0		35.7	26.9	28.8	28.6
6″	27.8	28.8		31.4		31.9	28.4	29.0	27.1
7″	51.3	52.1		28.4		29.0	80.1	82.6	82.6
8″	135.6	135.5		136.4		136.3	131.9	133.3	133.7
9″	44.8	45.4		46.0		45.7	41.3	43.7	43.5
10″	119.9	119.8		119.1		119.2	120.1	120.6	120.4
11″	169.4	169.4		169.5		169.5	164.4	168.2	168.6
OMe	51.8	51.9		51.9		51.9[d]			
1‴	100.4[c]	100.2		100.3		100.3	97.9	99.5	99.5
2‴	74.7[d]	74.8[c]		74.6		74.7	73.0	74.7[c]	74.6
3‴	78.1[e]	78.1		78.0		78.0	76.6[c]	78.0[d]	78.2[c]
4‴	71.7[f]	71.7[d]		71.6		71.6	70.0[d]	71.7[e]	71.7[d]
5‴	78.5[g]	78.5[e]		78.6[c]		78.3	77.3[e]	78.6[f]	78.6[e]
6‴	62.9[h]	63.0[f]		62.9[d]		62.7	61.0	62.9[g]	62.8[f]

[a] Measured in CD_3OD.
[b] Measured in DMSO-d_6.
[c–h] Values with the same superscript in the same column are interchangeable.
[i] Signals were not detected.

281 (3.77), 290 (3.70). IR $\nu_{\max}^{\mathrm{KBr}}$ cm^{-1}: 3400, 1684, 1636, 1458, 1437. ^{1}H NMR: Table 2. ^{13}C NMR: Table 5. Negative ion SIMS *m/z*: 531 [M–H]$^{-}$, 369. HR-SIMS Found 531.2351 [M–H]$^{-}$; $C_{27}H_{35}N_2O_9$ requires 531.2344. NOESY: H_2-3/H_2-5; H_2-5/H_2-14; H_2-3/H-15; H_2-3/H-10; H-10/H-18 (δ 5.32); H-11/H-18 (δ 5.28); H-12/H-19. HMBC: H_2-5 to C-3.

*3.11. Preparation of strictosamide tetraacetate (**16**)*

A solution of strictosidine (**8**) (4.5 mg) in 10% aq Na_2CO_3 was warmed at 70 °C for 1 h. The reaction mixture was purified by Sephadex LH-20 CC (MeOH) and prep. TLC ($CHCl_3$–MeOH, 4:1) to give strictosamide (**15**) (1.5 mg). Spectral data of **15** were identical with those of an authentic sample (^{1}H NMR, UV, SIMS, CD $\lambda_{\max}^{\mathrm{MeOH}}$ nm ($\Delta\ \varepsilon$): 226 (−11.4), 270 (+13.5)). Strictosamide (**15**) (1.5 mg) was treated with Ac_2O-pyridine. The crude residue (1.7 mg) was purified by prep. TLC ($CHCl_3$–MeOH, 49:1) to give strictosamide tetraacetate (**16**) (1.1 mg). ^{1}H NMR ($CDCl_3$): δ 1.23, 1.88, 1.99, 2.07 (12H each s, 4 × Ac). CD $\lambda_{\max}^{\mathrm{MeOH}}$ nm ($\Delta\ \varepsilon$): 217 (−8.9), 240 (−3.2), 269 (+14.2).

*3.12. Preparation of neonaucleoside A (**3**) from strictosidine (**8**)*

A solution of strictosidine (**8**) (15.3 mg, 0.029 mmol) and secologanin (**12**) (11.2 mg, 0.029 mmol) in MeOH (0.5 ml) was adjusted to pH 5-6 with 5% HCl and treated with $NaBH_3CN$ (5.5 mg). The reaction mixture was stirred for 3 h at room temperature and purified by Sephadex LH-20 CC and prep. TLC ($CHCl_3$–MeOH, 4:1), giving rise to **3** (11.9 mg, 45.8%) with **8** (2.7 mg, 17.6%). Compound **3** was identified with **3** from natural source (^{1}H NMR, UV, IR, SIMS, and $[\alpha]_D^{20}-154°$ (*c* 0.7, MeOH)).

*3.13. Methylation of neonaucleoside B (**4**)*

A solution of **4** (10.0 mg) in MeOH (1.0 ml) was treated with 2.0 M $TMSCHN_2$ in *n*-hexane (0.1 ml). Concentrated reaction mixture was purified by prep. TLC ($CHCl_3$–MeOH–H_2O, 70:30:3) to give **18** (7.4 mg). $[\alpha]_D^{27}-207°$ (*c* 0.5, MeOH). UV $\lambda_{\max}^{\mathrm{MeOH}}$ nm (log ε): 220 sh (4.43), 239 (4.63), 262 (4.50), 271 sh (4.43), 290 sh (3.89), 303 (3.62), 335 (3.69), 346 (3.71). IR $\nu_{\max}^{\mathrm{KBr}}$ cm^{-1}: 3394, 1705, 1634. ^{1}H NMR: Table 3. ^{13}C NMR: Table 5. Positive ion SIMS *m/z*: 957 [M + H]$^{+}$. HR-SIMS Found 957.3495 [M + H]$^{+}$; $C_{46}H_{57}N_2O_{20}$ requires 957.3507. ROESY: H-21/H-1′; H-9/H_2-7″; H-9/H_2-6″; H-9/H-5″; H-1″/H-1‴. HMBC: H_2-14 to C-2, 3, 15; H-15 to C-3, 14, 16, 17, 20, 21, 22; H-17 to C-16, 21, 22; OMe (δ 3.35) to C-22; OMe (δ 3.98) to C-23; H-21 to C-1′; H-1′ to C-21; H_2-7″ to C-5, 6, 7; H-5″ to C-1″, 3″, 4″, 6″, 7″, 8″, 9″, 11″; H-3″ to C-1″, 4″, 5″, 11″; OMe (δ 3.69) to C-11″; H-1″ to C-1‴; H-1‴ to C-1″.

*3.14. Methylation of neonaucleoside C (**5**)*

A methanolic solution of **5** (9.8 mg) was treated with 2.0 M $TMSCHN_2$ in *n*-hexane (0.1 ml) to afford **19** (4.7 mg) and **20** (4.0 mg). **19**: $[\alpha]_D^{27}-187°$ (*c* 0.4, MeOH). UV $\lambda_{\max}^{\mathrm{MeOH}}$ nm (log ε): 225 (4.58), 246 sh (4.26), 281 sh (3.84), 289 (3.75). IR $\nu_{\max}^{\mathrm{KBr}}$ cm^{-1}: 3394, 1732, 1693, 1620. ^{1}H NMR: Table 4. ^{13}C NMR: Table 5. Negative ion SIMS *m/z*: 943 [M–H]$^{-}$, 782, 764. HR-SIMS Found 943.3330 [M–H]$^{-}$; $C_{45}H_{55}N_2O_{20}$ requires 943.3350. COSY: H-6/H-7″. ROESY: H-3/H-5; H-21/H-1′; H-9/H-6; H-9/H_2-6″; H-6/H_2-6″; H-1″/H-1‴. HMBC: H-14 (δ 1.98) to C-3, 20; H-14 (δ 2.15) to C-15; H_2-14 to C-16; H-15 to C-3, 14, 16, 20, 22; H-17 to C-15, 16, 21, 22; OMe (δ 3.71) to C-22; H-21 to C-1′; H-1′ to C-21; H-5 to C-3, 6, 7″; OMe (δ 3.84) to C-23; H-3″ to C-1″, 4″, 5″, 11″; H-1″ to C-1‴; H-1‴ to C-1″. **20**: $[\alpha]_D^{26}-137°$ (*c* 0.2, MeOH). UV $\lambda_{\max}^{\mathrm{MeOH}}$ nm (log ε): 224 (4.58), 243 sh (4.27), 283 sh (3.81), 289 (3.73). IR $\nu_{\max}^{\mathrm{KBr}}$ cm^{-1}: 3405, 1734, 1695, 1622. ^{1}H NMR: Table 4. ^{13}C NMR: Table 5. Negative ion SIMS *m/z*: 957 [M–H]$^{-}$, 795, 778. HR-SIMS Found 957.3526 [M–H]$^{-}$; $C_{46}H_{57}N_2O_{20}$ requires 957.3507. COSY: H-6/H-7″. ROESY: H-3/H-5; H-3/H-20; H-5/NMe; H-5/OMe (δ 3.78); H-21/H-1′; H-6/H-9; H-9/H-7″; H-5″/H-7″; H-1″/H-1‴. HMBC: H-17 to C-15, 16, 21, 22; OMe (δ 3.57) to C-22; H-21 to C-1′; H-1′ to C-21; NMe to C-3, 5; H-5 to C-6, 23, 7″; OMe (δ 3.78) to C-23; H-3″ to C-4″, 11″; H-1″ to C-1‴ H-1‴ to C-1″.

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