Sulfur-Containing Bis-iridoid Glucosides and Iridoid Glucosides from *Saprosma scortechinii*

Sui-Kiong Ling,[†] Akiko Komorita,[†] Takashi Tanaka,[†] Toshihiro Fujioka,[‡] Kunihide Mihashi,[‡] and Isao Kouno*[,†]

Faculty of Pharmaceutical Sciences, Nagasaki University, 1-14 Bunkyo-machi, Nagasaki 852-8521, Japan, and Faculty of Pharmaceutical Sciences, Fukuoka University, 8-19-1 Jyounan-ku Nanakuma, Fukuoka 814-0180, Japan

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Six new sulfur-containing bis-iridoid glucosides, saprosmosides A−F (**1**−**6**), were isolated from the leaves of *Saprosma scortechinii*. From the stems of this same plant, two new iridoid glucosides, 3,4-dihydro-3-methoxypaederoside (**8**) and 10-*O*-benzoyldeacetylasperulosidic acid (**12**), were isolated. Their structures were elucidated by means of chemical, NMR, and mass spectroscopic methods. Additionally, 11 known iridoid glucosides were isolated and characterized as deacetylasperuloside, asperuloside, paederoside (**7**), deacetylasperulosidic acid (**9**), scandoside, asperulosidic acid, 10-acetylscandoside, paederosidic acid (**10**), 6-*epi*-paederosidic acid (**11**), methylpaederosidate, and monotropein. The structures of the new bis-iridoid glucosides were formed by intermolecular esterification between the glucose and carboxyl groups of three monomeric iridoid glucosides (**7**, **9**, and **10**).

The genus *Saprosma* (Rubiaceae) is represented by about 30 species of shrubs or small trees, which are distributed in the Indo-Malesian region. In Malaysia, there are eight species found on limestone environments, from lowlands to hills or lower montane forests, and also in swamp forests. All parts of the plants in the genus are fetid when bruised, which causes them to be associated with *Paederia foetida* (Rubiaceae), and used medicinally as substitutes.[1] *Saprosma scortechinii* Bl. King & Gamble is a small tree endemic in the Malay Peninsula.[2] The plant is locally known as "sekentut", a term used to associate it with the unpleasant and fetid odor emitted by the bruised plant tissues. In the traditional medicinal system of Malaysia, the roots are employed in decoctions to treat fever by the native communities, while the young leaves are eaten as vegetables.[1] However, a literature survey indicated no previously reported chemical study on plants in the genus *Saprosma*. As part of the chemical study on Malaysian medicinal plants, the leaves and stems of *S. scortechinii* were investigated, which led to the isolation of several sulfur-containing bis-iridoid and iridoid glucosides. We wish to report herein the isolation and structural elucidation of the bis-iridoid glucosides (**1**−**6**) and iridoid glucosides (**8** and **12**).

Results and Discussion

Dried leaves and stems were separately extracted with methanol, and the resulting extracts were subjected to solvent partitioning. A combination of column chromatography followed by further purification led to the isolation of six new bis-iridoid glucosides (**1**−**6**) and two new iridoid glucosides (**8** and **12**), in addition to 11 known iridoid glucosides. These known compounds were identified by spectroscopic analysis and comparison of their data with literature values as deacetylasperuloside, asperuloside, paederoside (**7**), deacetylasperulosidic acid (**9**), scandoside, asperulosidic acid, 10-acetylscandoside, paederosidic acid (**10**), 6-*epi*-paederosidic acid (**11**), methylpaederosidate, and monotropein.[3−14] Full NMR assignments for **11**, which are lacking in the literature, are presented in the Experimental Section.

Compound **1** exhibited the molecular formula $C_{34}H_{44}O_{22}S$ (HRFABMS, *m*/*z* 835.1966 [M − H]$^-$). The IR spectrum showed absorptions at 3338, 1710, 1699, and 1631 cm^{-1}, corresponding to OH, C=O, and C=C functional groups. The ^{1}H and ^{13}C NMR spectra revealed the resonances of two distinct moieties that resembled parts of an iridoid glycoside structure, indicated as units A and B, and suggested this compound is a bis-iridoid glycoside (Tables 1 and 2). Two anomeric proton signals at δ 4.73 and 4.76 (both d, J = 8.0 Hz), along with the corresponding ^{13}C NMR signals, were consistent with the presence of two sugar units within the molecule. The complete assignments of all proton and carbon signals were based on ^{1}H−^{1}H COSY, HSQC, and HMBC experiments. Compound **1** contained two enol-ether moieties, and the UV absorption at 233 nm was typical for a C-4-substituted iridoid. The structure of unit A was determined to be similar to paederosidic acid (**10**). The methyl thiocarbonate group was identified on the basis of the methyl signal observed at δ 2.35 in the ^{1}H NMR spectrum, with the corresponding methyl carbon signal at δ 13.6, and a carbonyl signal at δ 172.9 in the ^{13}C NMR spectrum, which were similar to those of **10**. The characteristic IR band at 1710 cm^{-1} also supported the thiocarbonate moiety according to Suzuki and co-workers.[14] Moreover, the significant downfield shifts of H-10 and C-10 and the upfield shift of C-8 also suggested the location of the methyl thiocarbonate moiety at C-10. On the other hand, unit B was different from A in that the methylene protons and carbon were observed at a higher field, while the quaternary carbon at C-8 was observed at lower field compared to A. On the basis of these data, the structure of unit B was deduced to be similar to deacetylasperulosidic acid (**9**). The downfield shift of sugar methylene protons (δ 4.26, 4.29, H-6′) of unit B and the HMBC correlation between H-6′ of unit B and the carboxyl C-11 of unit A indicated that these two units were connected via an ester bond between C-11 of unit A and C-6′ of unit B. This structure was verified by alkaline hydrolysis of **1** to give **9**, accompanied by liberation of a gas with the characteristic odor of thiomethanol. Hydrolysis of the methyl thiocarbon-

* To whom correspondence should be addressed. Tel: +81-095-847-1111. Fax: +81-095-848-4387. E-mail: ikouno@net.nagasaki-u.ac.jp.
[†] Nagasaki University.
[‡] Fukuoka University.

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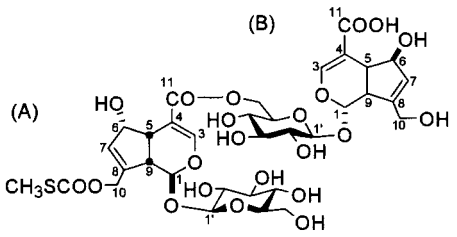

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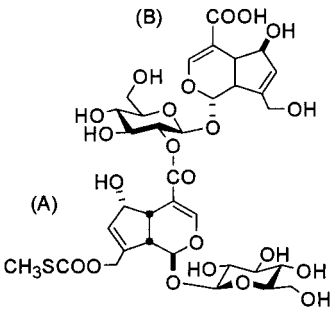

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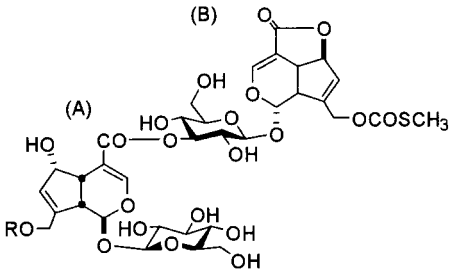

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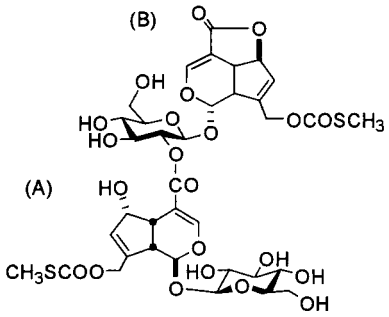

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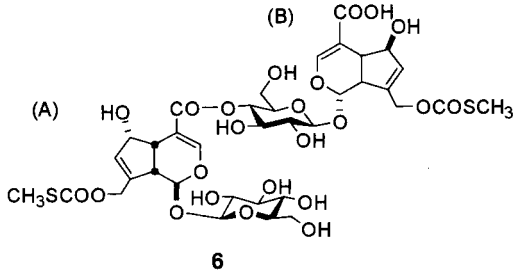
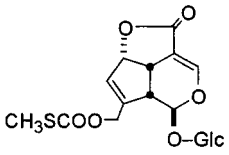


6

ate group was also observed for **10** under the same conditions. Consequently, the structure of **1** was deduced to be a bis-iridoid glucoside, as shown, and has been named saprosmoside A.

The molecular formula of compound **2** was determined to be the same as **1** on the basis of the HRFABMS data (*m*/*z* 835.1958 $[M - H]^-$). The IR spectrum also showed



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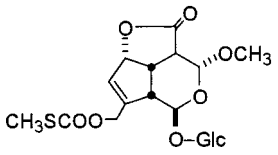

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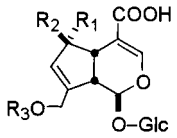

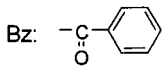

9: R_1 = OH; R_2, R_3 = H
10: R_1 = OH; R_2 = H; R_3 = CH_3SCO
11: R_1 = H; R_2 = OH; R_3 = CH_3SCO
12: R_1 = OH; R_2 = H; R_3 = Bz

similar absorptions at 3326, 1715, 1698, and 1644 cm^{-1}, corresponding to OH, C=O, and C=C units. The ^1H and ^{13}C NMR spectra (Tables 1 and 2) clearly indicated the dimeric character of this molecule by their similarities to compound **1**, which suggested that compound **2** has the same substructures as those of **1**, i.e., **9** and **10**. This was supported by alkaline hydrolysis of **2**, affording **9** and thiomethanol, and further confirmed by the unambiguous assignments of all the ^1H and ^{13}C NMR spectra of the substructures, which were carried out based on $^1H-^1H$ COSY, HSQC, and HMBC experiments. The connectivity between units A and B was found to be an ester bond between C-11 of unit A and C-2′ of unit B, on the basis of the HMBC correlation between H-2′ of unit B with C-11 of unit A and the downfield shift of H-2′ (δ 4.84). Consequently, structure **2**, derived from esterification of OH-2′ of deacetylasperulosidic acid by paederosidic acid, was assigned to saprosmoside B.

Compound **3** exhibited the molecular formula $C_{34}H_{42}O_{21}S$ on the basis of HRFABMS (*m*/*z* 841.1837 $[M + Na]^+$). In the IR spectrum, the functional groups of OH, C=O, and C=C were revealed by the absorptions at 3343, 1740, 1702, 1655, and 1630 cm^{-1}. The ^1H and ^{13}C NMR spectra also displayed signals typical of a dimeric iridoid glucoside (Tables 1 and 2). In the ^{13}C NMR spectrum, a set of signals with similar chemical shifts as in unit B of **1** and **2** suggested deacetylasperulosidic acid (**9**) as one of the building blocks (unit A), together with 18 more carbon signals which could be attributed to the other unit (unit B). Detailed 2D NMR experiments revealed the structure of paederoside (**7**) for unit B on the basis of the downfield shift of C-6 (δ 86.1) and the HMBC correlation between H-6 and C-11, indicating a lactone linkage between C-6 and C-11, and the presence of a methyl thiocarbonate moiety at C-10. Deacetylasperulosidic acid (**9**) and thiomethanol were obtained upon alkaline hydrolysis of **3**. Additional support was obtained by another experiment, where alkaline hydrolysis of **7** liberated **9** and thiomethanol. The connectivity between the two units was deduced to be an ester bond between C-11 of unit A and C-3′ of unit B, on the basis of the HMBC correlation between H-3′ of unit B and C-11 of unit A, in addition to the downfield shift of H-3′ (δ 5.06) of unit B. On the basis of the above results, the structure of **3** was determined, and this compound has been named saprosmoside C.

The HRFABMS of compound **4** revealed the molecular formula $C_{36}H_{44}O_{22}S_2$ (*m*/*z* 915.1841 $[M + Na]^+$). The IR spectrum showed absorptions at 3276, 1747, 1714, 1655, and 1632 cm^{-1}, again indicating OH, C=O, and C=C

Table 1. ^{1}H NMR Data for Compounds **1**−**6** (500 MHz, CD_3OD)

	1	**2**	**3**	**4**	**5**	**6**
unit A						
1	5.05 d (8.5)	5.07 d (9.0)	5.06 d (9.0)	5.05 d (9.0)	5.05 d (8.5)	5.05 d (9.0)
3	7.67 d (1.5)	7.75 d (1.5)	7.74 d (1.5)	7.74 d (1.5)	7.70 d (1.5)	7.72 d (2.0)
5	3.06 ddd	3.08 ddd	3.08 ddd	3.10 ddd	2.90 ddd	3.09 ddd
	(1.5, 6.0, 7.5)	(1.5, 4.5, 8.0)	(1.5, 6.0, 8.0)	(1.5, 6.2, 8.0)	(1.5, 5.5, 8.5)	(2.0, 6.0, 8.0)
6	4.82[a]	4.86[a]	4.85[a]	4.85[a]	4.80 m	4.86[a]
7	6.06 d (2.0)	6.04 s	6.02 d (2.5)	6.03 d (1.8)	6.00 d (1.8)	6.02 d (2.0)
9	2.64 dd (7.5, 8.5)	2.63 dd (8.0, 9.0)	2.60 dd (8.0, 9.0)	2.66 dd (8.0, 9.0)	2.72 t (8.5)	2.63 dd (8.0, 9.0)
10	4.96 d (14.0)	4.94 d (16.0)	4.21 d (16.0)	4.84 d (16.0)	5.16 dd (2.0, 15.0)	4.74 d (15.0)
	5.10 dd (1.0, 14.0)	5.12 d (16.0)	4.46 d (16.0)	4.90 d (16.0)	4.92 d (15.0)	5.10 d (15.0)
CH_3	2.35 s	2.34 s		2.34[b] s	2.34[c] s	2.34[d] s
1′	4.76 d (8.0)	4.73 d (9.0)	4.72 d (8.0)	4.74 d (8.0)	4.72 d (7.5)	4.72 d (8.0)
2′	3.23[a]	3.12 dd (8.0, 9.0)	3.24 dd (8.0, 9.0)	3.25 dd (8.0, 9.0)	3.28[a]	3.25 dd (8.0, 9.5)
3′	3.38[a]	3.39 dd (8.0, 9.5)	3.25[a]	3.38 t (9.0)	3.39[a]	3.38 dd (8.0, 9.5)
4′	3.25[a]	3.28[a]	3.26[a]	3.28[a]	3.28[a]	3.27[a]
5′	3.28 m	3.28[a]	3.38 m	3.28[a]	3.28[a]	3.27[a]
6′	3.64 dd (6.0, 12.0)	3.64 dd (6.0, 12.0)	3.73 dd (5.5, 12.0)	3.64 dd (6.0, 12.0)	3.65 dd (6.0, 12.0)	3.63 dd (6.0, 12.0)
	3.86 dd (2.0, 12.0)	3.84 dd (1.5, 12.5)	3.92 dd (2.0, 12.0)	3.86 dd (2.0, 12.0)	3.84 dd (2.0, 12.0)	3.86 dd (2.0, 12.0)
unit B						
1	4.99 d (9.0)	4.80 d (8.0)	5.95 d (1.5)	5.94 d (1.1)	5.78 d (1.6)	5.05 d (9.0)
3	7.57 d (1.0)	7.50 d (1.5)	7.30 d (2.0)	7.30 d (2.1)	7.16 d (2.1)	7.64 d (1.0)
5	3.00 ddd	3.00 ddd	3.67 m	3.65 m	3.45 ddd	3.03 ddd
	(1.0, 6.0, 7.5)	(1.5, 6.0, 7.5)			(2.0, 6.5, 6.5)	(1.0, 6.0, 8.0)
6	4.82[a]	4.84[a]	5.56 br d (6.0)	5.56 br d (5.5)	5.52 br d (6.5)	4.82[a]
7	5.98 d (2.0)	5.99 d (2.0)	5.74 br s	5.74 br s	5.71 br s	6.04 d (2.0)
9	2.57 dd (7.5, 9.0)	2.43 dd (7.5, 8.0)	3.35[a]	3.35[a]	3.25 m	2.68 dd (8.0, 9.0)
10	4.23 d (15.0)	4.22 d (16.0)	4.85[a]	4.95 d (16.0)	4.88 dd (1.0, 14.0)	4.94 d (15.0)
	4.42 dd (1.5, 15.0)	4.45 d (16.0)	4.91 dd (1.5, 14.5)	5.11 d (16.0)	4.79d (14.0)	5.10 d (15.0)
CH_3			2.35 s	2.35[b] s	2.35[c] s	2.36[d] s
1′	4.73 d (8.0)	4.95 d (8.0)	4.81 d (8.0)	4.81[a]	4.93 d (8.5)	4.80 d (8.0)
2′	3.23[a]	4.84[a]	3.40 dd (8.0, 9.5)	3.42 dd (8.0, 9.5)	4.78dd (8.5, 9.5)	3.38 dd (8.0, 9.5)
3′	3.42[a]	3.63 dd (8.5, 9.5)	5.06 t (9.5)	5.05 dd (9.0, 9.5)	3.68 dd (8.5, 9.5)	3.65 dd (9.0, 9.5)
4′	3.40[a]	3.39[a]	3.57 dd (9.5, 10.0)	3.57 dd (9.0, 10.0)	3.38 dd (8.5, 10.0)	4.84[a]
5′	3.52 m	3.36 m	3.47 m	3.49 m	3.44 m	3.52 m
6′	4.29 dd (2.0, 12.0)	3.68 dd (6.0, 12.5)	3.62 dd (6.0, 12.0)	3.75 dd (6.0, 12.0)	3.72 dd (6.0, 12.0)	3.56 dd (6.0, 12.0)
	4.46 dd (5.0, 12.0)	3.88 dd (2.5, 12.5)	3.84 dd (1.5, 12.0)	3.94 dd (2.0, 12.0)	3.94 dd (2.0, 12.0)	3.63 dd (2.0, 12.0)

[a] Signal patterns were unclear due to overlapping. [b−d]Values may be interchanged.

functional groups. A bis-iridoid structure was revealed by the presence of two sets of signals closely resembling those of paederoside (**7**) and paederosidic acid (**10**) in the ^{1}H and ^{13}C NMR spectra (Tables 1 and 2). The proton and carbon signals were fully assigned for the two units on the basis of 2D NMR experiments. Compound **4** was hydrolyzed in aqueous KOH to generate **9** and thiomethanol, which was consistent with the presence of **7** and **10** in the dimeric structure. An HMBC correlation between H-3′ of unit B and C-11 of unit A and the downfield shift of H-3′ (δ 5.05) of unit B established the connectivity for the two units at C-11 of unit A and C-3′ of unit B. Thus, this isolate was assigned structure **4** and has been named saprosmoside D.

Compound **5**, named saprosmoside E, was assigned the same molecular formula as **4** on the basis of the similar sodiated molecular ion peak observed in the HRFABMS (m/z 915.1849 $[M + Na]^+$). In the IR spectrum, similar absorption bands were observed at 3359, 1747, 1708, 1657, and 1635 cm^{-1}, indicating the presence of the same functional moieties. The ^{1}H and ^{13}C NMR spectra (Tables 1 and 2) also indicated the presence of two iridoid glucoside units similar to those in **4**. All the protons and carbons were assigned to the two units on the basis of ^{1}H−^{1}H COSY, HSQC, and HMBC experiments. The downfield shift of H-2′ of unit B (δ 4.78) and the HMBC correlation observed between C-11 of unit A and H-2′ of unit B established the position of linkage between the two units at C-11 of unit A and C-2′ of unit B. The identities of the two subunits were verified by chemical reaction: the ester bond connecting the two units, the lactone ring of unit B and the two methyl thiocarbonates, was cleaved by KOH in aqueous solution to liberate **9** and thiomethanol. Accordingly, structure **5** was assigned as saprosmoside E.

The molecular formula of compound **6** was determined to be $C_{36}H_{46}O_{23}S_2$ by HRFABMS (m/z 909.1799 $[M - H]^-$). The IR spectrum showed strong absorptions at 3309, 1712, and 1632 cm^{-1}. In the ^{1}H and ^{13}C NMR spectra (Tables 1 and 2), duplicate signals corresponding to those of paederosidic acid (**10**) were observed, which were consistent with the presence of a dimeric iridoid glucoside. Complete assignments based on 2D NMR experiments confirmed the presence of two paederosidic acid units. This was further verified by alkaline hydrolysis of **6**, where **9** and thiomethanol were obtained. The two subunits were linked with each other via an ester bond between C-11 of one unit designated as unit A and C-4′ of the other unit, unit B, based on the presence of a HMBC correlation between H-4′ of unit B and C-11 of unit A and the downfield shift of H-4′ (δ 4.82) in unit B. Thus, the structure of **6** was established as shown, and this compound has been named saprosmoside F.

Compound **8** exhibited the molecular formula $C_{19}H_{26}O_{12}S$, as determined by FABMS (m/z 479 $[M + H]^+$) and ^{13}C NMR spectroscopy. The ^{1}H and ^{13}C NMR spectra showed resonances typical of a cyclopentanopyran-type iridoid glucoside having a methyl thiocarbonate moiety similar to **7**, except for the absence of the olefinic signal attributable to C-3 and C-4 and the presence of signals due to an aliphatic methine (C-4), a methoxyl group, and an additional acetal carbon (C-3). The UV spectrum also did not show any characteristic enol-ether absorption. On the basis of the ^{1}H−^{1}H COSY, HSQC, and HMBC NMR spectra, additional resonances of the methine (δ 3.25) and acetal (δ 5.01)

Table 2. ^{13}C NMR Data for Compounds **1**−**6** (125 MHz, CD_3OD)

	1	2	3	4	5	6
unit A						
1	101.4	101.4	101.6	101.3	101.6	101.3
3	155.8	156.2	156.1	156.1	156.2	156.2
4	107.9	107.8	108.1	107.9	107.7	108.0
5	42.3	42.5	42.7	42.4	42.8	42.1
6	75.5	75.2	75.8	75.7	75.2	75.7
7	132.7	132.1	129.6	132.1	131.7	132.3
8	145.3	145.8	151.6	145.6	145.9	145.2
9	46.2	46.2	46.0	46.4	46.0	46.5
10	66.3	66.2	61.7	66.2	66.3	66.2
11	168.7	168.0	168.6	168.5	167.5	168.1
COO	172.9	172.8		172.8	172.9	172.8
CH_3	13.6	13.5		13.5[a]	13.6	13.5
1′	100.7	100.7	100.0	100.6	100.9	100.7
2′	75.0	74.9	74.9	74.9	74.9	74.9
3′	77.9	77.8	77.5	77.8	77.7	77.8
4′	71.6	71.6	71.6	71.5	71.5	71.5
5′	78.5	78.5	77.8	78.5	78.6	78.6
6′	63.0	62.9	62.4	63.0	63.0	63.0
unit B						
1	101.6	101.9	93.3	93.3	94.0	101.3
3	154.1	153.4	150.2	150.2	150.1	155.1
4	110.1	111.1	106.1	106.0	106.2	108.5
5	43.1	43.1	37.4	37.4	37.6	42.6
6	75.5	75.7	86.1	86.1	86.0	75.3
7	130.4	129.7	129.5	129.6	129.8	132.7
8	151.1	151.2	143.7	143.6	143.3	145.3
9	46.0	46.3	45.2	45.2	45.0	46.2
10	61.6	61.7	64.3	64.3	64.3	66.2
11	172.4	172.8	172.4	172.4	172.1	171.0
COO			172.6	172.6	172.6	172.8
CH_3			13.6	13.6[a]	13.6	13.5
1′	100.6	99.0	100.5	100.0	98.5	100.6
2′	75.0	74.8	73.0	72.9	74.4	74.9
3′	77.6	76.1	78.7	78.8	75.5	75.7
4′	71.5	71.5	69.9	69.9	71.6	72.3
5′	75.6	78.5	78.0	77.9	78.4	76.6
6′	64.0	62.6	62.8	62.4	62.6	62.6

[a] Values may be interchanged.

protons were assigned to H-4 and H-3, respectively. The location of the methoxyl group was determined to be at the C-3 position on the basis of mutual HMBC correlations with C-3. However, the stereochemistry at the C-3 position could not be interpreted unequivocally on the basis of the coupling constants ($J_{3,4}$ = 3.5 Hz). Therefore, a NOESY experiment was attempted in which a correlation was observed between H-3 and H-4, which established the α configuration of the methoxy substituent at C-3. The occurrence of a γ-lactone ring was indicated on the basis of the HMBC correlation between H-6 (δ 5.37, d, J = 6.5) and C-11 (δ 177.0). Two carbonyl bands at 1769 and 1712 cm^{-1} in the IR spectrum substantiated the presence of a γ-lactone unit and a thiocarbonate group, respectively. The methyl thiocarbonate moiety at C-10 was confirmed on the basis of the downfield shifts of both the proton and carbon signals of C-10 and the presence of HMBC correlations between the C-10 protons and the carbonyl carbon (δ 173.0) of the thiocarbonate group. According to these data, compound **8** was characterized as 3,4-dihydro-3-methoxypaederoside. Although this structure has not been reported before, it cannot be precluded that compound **8** is not an artifact formed during the isolation procedure.

The elemental composition of compound **12** was determined to be $C_{23}H_{26}O_{12}$ by FABMS (m/z 517 $[M + Na]^+$), ^{13}C NMR spectroscopy, and elemental analysis. The UV spectrum showed an absorption maximum at 230 nm, and the IR spectrum showed the presence of a conjugated ester group (1719 and 1633 cm^{-1}). The ^1H NMR spectrum indicated the presence of a benzoyl moiety [δ 7.49 (2H), 7.61 (1H), and 8.06 (2H)], and this was supported by the carbon resonances at δ 129.6, 130.6, 131.3, 134.4, and 167.7. The remaining signals in the ^1H NMR spectrum were very similar to those of **10** except for the chemical shifts of H-10 and the absence of signals due to a methyl thiocarbonate unit. Accordingly, compound **12** could be assigned as having the same cyclopentanopyran ring as that of **10**. The chemical shifts of H-10 (δ 5.04, d, J = 15.0 and 5.24, dd, J = 1.5, 15.0) suggested that the benzoyl group was attached to C-10 of **12**. This was confirmed by the HMBC correlation between H-10 and the carbonyl signal at δ 167.7. The structure of **12** was thus determined as 10-*O*-benzoyldeacetylasperulosidic acid. The methyl ester of compound **12** has been isolated previously from *Oldenlandia corymbosa*.[13]

Plants of the family Rubiaceae are known for the prominent occurrence of iridoids, which form a large group of plant constituents found usually as glycosides, and are considered to be of biogenetic and chemotaxonomic significance.[15] However, there are relatively few naturally occurring sulfur-containing iridoids. A literature review showed that paederoside and paederosidic acid, which were first isolated from *Paederia scandens*, still remain the only two naturally occurring sulfur-containing iridoid glycosides isolated so far. Recently, these two glucosides were also reported to be present in *Putoria calabrica* (Rubiaceae) by Calis and co-workers.[16] The biosynthetic mechanism of formation for these sulfur-containing iridoid glucosides is still not clear, but the sulfur atom might be incorporated via thiomethanol in the iridoid biosynthetic pathway.[14]

Experimental Section

General Experimental Procedures. Optical rotations were measured on a JASCO DIP-370 digital polarimeter. UV and IR spectra were recorded with JASCO V-560 and JASCO FT/IR-410 spectrometers, respectively. ^1H and ^{13}C NMR spectra were recorded in ppm (δ) in CD_3OD with TMS as the internal standard, employing Varian Unity Plus 500 and Varian Gemini 300 spectrometers operating at 500 and 300 MHz for ^1H and 125 and 75 MHz for ^{13}C. FABMS and HRFABMS were recorded using JEOL JMS DX-303 and JEOL JMS HX-110 spectrometers, with glycerol or *m*-NBA as the matrix. Column chromatography was performed with MCI gel CHP 20P (75−150 μm, Mitsubishi Chemical Industries, Ltd.), Chromatorex ODS (Fuji Silysia), Toyopearl HW-40, Sephadex LH-20, and silica gel 60 (0.040−0.063 mm, 0.063−0.200 mm, Merck). TLC was performed on precoated silica gel 60 F_{254} plates (0.2 mm thick, Merck) with $CHCl_3$−MeOH−H_2O (8:2:0.1 or 7:3:0.5 or 6:4:0.5), and spots were detected by UV illumination and by spraying with 10% H_2SO_4 followed by heating.

Plant Material. *Saprosma scortechinii* was collected from the Pasoh Forest Reserve, Negeri Sembilan, Malaysia, in March 2000. A voucher specimen (FRI 45413) has been deposited at the Herbarium of the Forest Research Institute Malaysia (FRIM), Kuala Lumpur, Malaysia.

Extraction and Isolation. Dried ground leaves (357 g) and stems (3 kg) were separately extracted with MeOH by soaking repeatedly (three times). The concentrated extracts (68 and 253 g, respectively) were suspended in H_2O and successively partitioned with ethyl acetate in the case of the leaves, and ethyl acetate and butanol in the case of the stems. The resulting fractions were each chromatographed over MCI gel CHP 20P, using H_2O with increasing proportions of MeOH (20−100%). The fractions obtained were further purified by a combination of column chromatography employing MCI gel CHP 20P, Chromatorex ODS, Toyopearl HW-40, Sephadex LH-20, and silica gel. The water-soluble fraction of the leaves afforded saprosmoside A (**1**, 113.4 mg), saprosmoside B (**2**, 18.6 mg), saprosmoside C (**3**, 50.2 mg), saprosmoside D (**4**, 111.8

mg), saprosmoside E (**5**, 134.7 mg), saprosmoside F (**6**, 45.0 mg), deacetylasperuloside (56.3 mg), asperuloside (253.5 mg), paederoside (**7**, 881.3 mg), deacetylasperulosidic acid (**9**, 24.5 mg), paederosidic acid (**10**, 480.8 mg), and monotropein (13.4 mg). From the stems, the butanol fraction afforded asperuloside (29.7 mg), paederoside (**7**, 36.2 mg), 3,4-dihydro-3-methoxypaederoside (**8**, 8.4 mg), deacetylasperulosidic acid (**9**, 5.8 mg), scandoside (5.8 mg), asperulosidic acid (52.3 mg), 10-acetylscandoside (76.8 mg), paederosidic acid (**10**, 982.7 mg), 6-*epi*-paederosidic acid (**11**, 213.8 mg), methylpaederosidate (192.2 mg), and 10-*O*-benzoyldeacetylasperulosidic acid (**12**, 21.0 mg). The known compounds were identified by comparison of their physical and spectral data with the literature values.

Saprosmoside A (**1**)**:** yellow amorphous powder; $[\alpha]^{27}_D$ −16.4° (*c* 0.18, MeOH); UV (MeOH) λ_{max} (log ϵ) 233 (4.25) nm; IR (dry film) ν_{max} 3338, 1710, 1699, 1631 cm^{-1}; ^{1}H NMR and ^{13}C NMR data, see Tables 1 and 2; HRFABMS *m*/*z* 835.1966 [M − H]$^-$, calcd for $C_{34}H_{43}O_{22}S$, 835.1966.

Saprosmoside B (**2**)**:** yellow amorphous powder; $[\alpha]^{27}_D$ −14.0° (*c* 0.21, MeOH); UV (MeOH) λ_{max} (log ϵ) 232 (4.28) nm; IR (dry film) ν_{max} 3326, 1715, 1698, 1644 cm^{-1}; ^{1}H NMR and ^{13}C NMR data, see Tables 1 and 2; HRFABMS *m*/*z* 835.1958 [M − H]$^-$, calcd for $C_{34}H_{43}O_{22}S$, 835.1966.

Saprosmoside C (**3**)**:** yellow amorphous powder; $[\alpha]^{27}_D$ −92.3° (*c* 0.15, MeOH); UV (MeOH) λ_{max} (log ϵ) 234 (4.05) nm; IR (dry film) ν_{max} 3343, 1740, 1702, 1655, 1630 cm^{-1}; ^{1}H NMR and ^{13}C NMR data, see Tables 1 and 2; HRFABMS *m*/*z* 841.1837 [M + Na]$^+$, calcd for $C_{34}H_{42}O_{21}SNa$, 841.1835.

Saprosmoside D (**4**)**:** yellow amorphous powder; $[\alpha]^{27}_D$ −88.9° (*c* 0.19, MeOH); UV (MeOH) λ_{max} (log ϵ) 233 (4.31) nm; IR (dry film) ν_{max} 3276, 1747, 1714, 1655, 1632 cm^{-1}; ^{1}H NMR and ^{13}C NMR data, see Tables 1 and 2; HRFABMS *m*/*z* 915.1841 [M + Na]$^+$, calcd for $C_{36}H_{44}O_{22}S_2Na$, 915.1661.

Saprosmoside E (**5**)**:** yellow amorphous powder; $[\alpha]^{27}_D$ −103.4° (*c* 0.15, MeOH); UV (MeOH) λ_{max} (log ϵ) 235 (4.24) nm; IR (dry film) ν_{max} 3359, 1747, 1708, 1657, 1635 cm^{-1}; ^{1}H NMR and ^{13}C NMR data, see Tables 1 and 2; HRFABMS *m*/*z* 915.1841 [M + Na]$^+$, calcd for $C_{36}H_{44}O_{22}S_2Na$, 915.1661.

Saprosmoside F (**6**)**:** yellow amorphous powder; $[\alpha]^{27}_D$ −10.0° (*c* 0.17, MeOH); UV (MeOH) λ_{max} (log ϵ) 232 (4.37) nm; IR (dry film) ν_{max} 3309, 1712, 1632 cm^{-1}; ^{1}H NMR and ^{13}C NMR data, see Tables 1 and 2; HRFABMS *m*/*z* 909.1799 [M − H]$^-$, calcd for $C_{36}H_{45}O_{23}S_2$, 909.1794.

3,4-Dihydro-3-methoxypaederoside (**8**)**:** yellow amorphous powder; $[\alpha]^{26}_D$ −63.3° (*c* 0.12, MeOH); UV (MeOH) λ_{max} (log ϵ) 202 (3.95) nm; IR (dry film) ν_{max} 3416, 1769, 1712, 1652 cm^{-1}; ^{1}H NMR (CD_3OD, 500 MHz) δ 5.98 (1H, s, H-7), 5.37 (1H, br d, J = 6.5 Hz, H-6), 5.09 (1H, d, J = 6.0 Hz, H-1), 5.08 (1H, d, J = 15.0 Hz, H-10a), 5.01 (1H, d, J = 3.5 Hz, H-3), 4.90 (1H, d, J = 15.0 Hz, H-10b), 4.68 (1H, d, J = 8.0 Hz, H-1′), 3.87 (1H, d, J = 12.0 Hz, H-6a′), 3.66 (1H, dd, J = 5.5, 12.0 Hz, H-6b′), 3.52 (3H, s, OCH_3), 3.40 (1H, m, H-5), 3.38 (1H, t, J = 9.0 Hz, H-3′), 3.30 (2H, m, H-4′, 5′), 3.25 (1H, m, H-4), 3.21 (1H, dd, J = 8.0, 9.0 Hz, H-2′), 3.00 (1H, dd, J = 6.0, 8.5 Hz, H-9), 2.35 (3H, s, CH_3); ^{13}C NMR (CD_3OD, 125 MHz) δ 177.0 (C-11), 173.0 (COO), 151.6 (C-8), 126.8 (C-7), 99.6 (C-1′), 98.6 (C-3), 96.7 (C-1), 87.7 (C-6), 78.2 (C-5′), 78.0 (C-3′), 74.9 (C-2′), 71.6 (C-4′), 65.2 (C-10), 62.8 (C-6′), 56.5 (OCH_3), 46.3 (C-9), 44.4 (C-4), 37.7 (C-5), 13.6 (CH_3); positive FABMS *m*/*z* 479 [M + H]$^+$, 501 [M + Na]$^+$.

6-*epi*-Paederosidic acid (**11**)**:** yellow amorphous powder; $[\alpha]^{26}_D$ −9.3° (*c* 0.11, MeOH); UV (MeOH) λ_{max} (log ϵ) 226 (4.25) nm; IR (dry film) ν_{max} 3498, 1705, 1651 cm^{-1}; ^{1}H NMR (CD_3OD, 500 MHz) δ 7.44 (1H, d, J = 1.5 Hz, H-3), 5.99 (1H, d, J = 1.5 Hz, H-7), 5.10 (1H, dd, J = 1.0, 15.0 Hz, H-10a), 4.97 (1H, d, J = 7.5 Hz, H-1), 4.94 (1H, d, J = 15.0 Hz, H-10b), 4.90 (1H, dd, J = 1.5, 6.5 Hz, H-6), 4.72 (1H, d, J = 7.5 Hz, H-1′), 3.85 (1H, dd, J = 2.0, 12.0 Hz, H-6a′), 3.64 (1H, dd, J = 6.0, 12.0 Hz, H-6b′), 3.40 (1H, t, J = 9.0 Hz, H-3′), 3.30 (2H, m, H-4′, 5′), 3.26 (1H, dd, J = 7.5, 9.0 Hz, H-2′), 3.06 (1H, ddd, J = 1.5, 6.5, 8.0 Hz, H-5), 2.58 (1H, dd, J = 7.5, 8.0 Hz, H-9), 2.34 (3H, s, CH_3); ^{13}C NMR (CD_3OD, 125 MHz) δ 175.8 (C-11), 172.9 (COO), 151.9 (C-3), 145.5 (C-8), 132.2 (C-7), 113.4 (C-4), 100.8 (C-1), 100.6 (C-1′), 78.4 (C-5′), 77.8 (C-3′), 76.0 (C-6), 75.0 (C-2′), 71.6 (C-4′), 66.5 (C-10), 63.0 (C-6′), 46.9 (C-9), 43.5 (C-5), 13.5 (CH_3); positive FABMS *m*/*z* 487 [M + Na]$^+$.

10-*O*-Benzoyldeacetylasperulosidic acid (**12**)**:** yellow amorphous powder; $[\alpha]^{26}_D$ −8.7° (*c* 0.14, MeOH); UV (MeOH) λ_{max} (log ϵ) 230 (4.59) nm; IR (dry film) ν_{max} 3465, 1719, 1633 cm^{-1}; ^{1}H NMR (CD_3OD, 500 MHz) δ 8.06 (2H, m, H-2″, H-6″), 7.63 (1H, d, J = 1.0 Hz, H-3), 7.61 (1H, s, H-4″), 7.49 (2H, m, H-3″, H-5″), 6.10 (1H, d, J = 1.5 Hz, H-7), 5.24 (1H, dd, J = 1.5, 15.0 Hz, H-10a), 5.11 (1H, d, J = 9.0 Hz, H-1), 5.04 (1H, d, J = 15.0 Hz, H-10b), 4.75 (1H, d, J = 8.0 Hz, H-1′), 3.86 (1H, dd, J = 2.0, 12.0 Hz, H-6a′), 3.63 (1H, dd, J = 6.0, 12.0 Hz, H-6b′), 3.39 (1H, dd, J = 8.5, 9.0 Hz, H-3′), 3.30 (2H, m, H-4′, 5′), 3.27 (1H, dd, J = 8.0, 9.5 Hz, H-2′), 3.08 (1H, ddd, J = 1.0, 6.0, 8.0 Hz, H-5), 2.71 (1H, dd, J = 8.0, 9.0 Hz, H-9); ^{13}C NMR (CD_3OD, 125 MHz) δ 170.0 (C-11), 167.7 (COO), 154.8 (C-3), 146.0 (C-8), 134.4 (C-4″), 132.0 (C-7), 131.3 (C-1″), 130.6 (C-2″, C-6″), 129.6 (C-3″, C-5″), 109.0 (C-4), 101.3 (C-1), 100.7 (C-1′), 78.6 (C-5′), 77.9 (C-3′), 75.5 (C-6), 75.0 (C-2′), 71.6 (C-4′), 64.3 (C-10), 63.0 (C-6′), 46.6 (C-9), 42.7 (C-5); positive FABMS *m*/*z* 517 [M + Na]$^+$; *anal.* C 53.10%, H 5.48%, calcd for $C_{23}H_{26}O_{12}\cdot1^1/_2H_2O$, C 52.98%, H 5.60%.

Alkaline Hydrolysis of Compounds 1−6, 7, and 10. A solution of each of the compounds (1−2 mg) in 2% KOH (5 mL) was stirred at room temperature for 1 h and neutralized with 2 N HCl. All reactions generated a characteristic odor of thiomethanol. The main product in each case was detected by TLC and identified by direct comparison with **9** ($CHCl_3$−MeOH−H_2O, 6:4:0.5, R_f 0.4).

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Supporting Information Available: ^{1}H and ^{13}C NMR spectral data of **7**, **9**, and **10**. This information is available free of charge via the Internet at http://pubs.acs.org.

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