Three New Naphthoquinone Derivatives from *Diospyros maritima* BLUME

Matsutake HIGA,* Nobue NOHA, Hiroto YOKARYO, Kazuhito OGIHARA, and Seiichi YOGI

College of Science, University of the Ryukyus; Nishihara, Okinawa 903–0213, Japan.
Received November 6, 2001; accepted February 10, 2002

Three new naphthoquinone derivatives, 6-(1-ethoxyethyl)plumbagin (16), ethylidene-3,3′-biplumbagin (17), and ethylidene-3,6′-biplumbagin (18), were isolated, in addition to six known naphthoquinones, isozeylanone (10), 3,3′-biplumbagin (11), chitranone (12), methylene-3,3′-biplumbagin (13), 2,3-epoxyplumbagin (14), and 3,8′-biplumbagin (15), from the fruits of *Diospyros maritima* BLUME (Ebenaceae). The structures of the new compounds were established by spectroscopic methods. The eight naphthoquinones 11—18 were examined for ichthyotoxic activity and germination inhibitory activity. The quinones 11, 12, and 14—16 showed strong ichthyotoxic activity and the quinone 14 mild germination inhibitory activity.

Key words *Diospyros maritima*; Ebenaceae; naphthoquinone; 6-(1-ethoxyethyl)plumbagin; ethylidene-3,3′-biplumbagin; ethylidene-3,6′-biplumbagin

Diospyros maritima BLUME (Ebenaceae) is a shrub growing in Southeast Asia. We previously reported the isolation of nine naphthoquinone derivatives **1**—**9** from the fruits of this plant.[1] In a continuing investigation of the naphthoquinone constituents of this plant, we obtained three new naphthoquinone derivatives **16**—**18** and six known naphthoquinone derivatives **10**—**15** from the fruits. This paper reports the isolation and structure elucidation of the new naphthoquinones **16**—**18** and the biological activities such as ichthyotoxic activity and germination inhibitory activity of quinones **11**—**18**.

Results and Discussion

Structure Elucidation After chromatographic separation, the ethanol extract of the fresh fruits of *D. maritima* yielded, six known naphthoquinone derivatives, isozeylanone (**10**),[2] 3,3′-biplumbagin (**11**),[3] chitranone (**12**),[4,5] methylene-3,3′-biplumbagin (**13**),[5] 2,3-epoxyplumbagin (**14**),[6] 3,8′-biplumbagin (**15**),[7,8] and three new quinones **16**—**18**, in addition to quinones **1**—**8**, friedelin, β-amyrin, and lupeol.

Quinone **14**, pale yellow needles, mp 92—93 °C, is 2,3-epoxyplumbagin. We have prepared 2,3-epoxyplumbagin by the treatment of plumbagin (**4**) with sodium perborate.[6] This is the first report of quinone **14** as a natural product.

Quinone **15**, orange plates, mp 204—205 °C, is 3,8′-biplumbagin. 3,8′-Biplumbagin has been obtained as one of the products of the reaction between plumbagin (**4**) and its hydroquinone by Sankaram *et al*.[7] This is also the first report of quinone **15** as a natural product.

New quinone **16**, orange needles, mp 73 °C, $[\alpha]_D^{30}$ −0.06°, has the molecular formula $C_{15}H_{16}O_4$ based on high-resolution MS (HR-MS) (M^+ *m/z* 260.1049, required 260.1037). The IR [ν_{max} (KBr) cm^{-1}: 1670, 1641, 1607] and UV [λ_{max} ($CHCl_3$) nm (log ε): 266 (4.05), 415 sh (3.62), 434 (3.64)] spectra showed the characteristics of juglone (5-hydroxy-1,4-naphthoquinone) derivatives. The ^{1}H-NMR spectrum (Table 1) revealed the presence of one quinonoid methyl [δ 2.19 (3H, d, J=1.5 Hz)], one quinonoid proton [δ 6.79 (1H, q, J=1.5 Hz)], one pair of *ortho*-coupled aromatic protons [δ 7.67 (1H, d, J=7.8 Hz), δ 7.77 (1H, d, J=7.8 Hz)], one hydrogen-bonded hydroxyl [δ 12.31 (1H, s)], one ethylidene group [δ 1.43 (3H, d, J=6.4 Hz, >CHC$\underline{H}_3$), δ 4.92 (1H, q, J=6.4 Hz, >C$\underline{H}$CH$_3$)], and one ethoxyl group [δ 1.23 (3H, t, J=7.0 Hz, –OCH$_2$C$\underline{H}_3$), δ 3.40, 3.46 (each 1H, dq, J=9.2, 7.0 Hz, –OC$\underline{H}_2$CH$_3$)] in quinone **16**. The magnetic nonequivalence of the two methylene protons of the ethoxyl group is attributable to the presence of an adjacent asymmetric center. This ^{1}H-NMR spectrum indicates that quinone **16** is a plumbagin (**4**) derivative with an 1-ethoxyethyl group (–CH(CH$_3$)OCH$_2$CH$_3$) substitution. Since one quinonoid proton and one pair of *ortho*-coupled aromatic protons were observed, the location of the 1-ethoxyethyl group must be at C-6 or C-8. The heteronuclear multiple-bond correlation (HMBC) spectrum (Fig. 1) showed long-range correlations between the methyl protons of the ethylidene group and C-6, and between OH-5 and C-6. This HMBC spectrum indicates that the 1-ethoxyethyl group is located at C-6. Thus quinone **16** is characterized as 6-(1-ethoxyethyl)plumbagin.

New quinone **17**, orange-red plates, mp 200—201 °C, has the molecular formula $C_{24}H_{18}O_6$ based on HR-MS (M^+ *m/z* 402.1113, required 402.1103). The IR [ν_{max} (KBr) cm^{-1}: 1663, 1634, 1615, 1577] and UV [λ_{max} ($CHCl_3$) nm (log ε): 248 (4.20), 275 (4.27), 421 (3.85)] spectra showed the characteristics of juglone derivatives. The ^{1}H-NMR spectrum (Table 1) revealed the presence of two quinonoid methyls [δ 2.36 (6H, s)], two pairs of three adjacent aromatic protons [δ 7.20 (2H, dd, J=7.8, 1.1 Hz), δ 7.55 (2H, t, J=7.8 Hz), δ 7.60 (2H, dd, J=7.8, 1.1 Hz)], two hydrogen-bonded hydroxyls [δ 12.05 (2H, s)], and one ethylidene group [δ 4.62 (1H, q, J=7.5 Hz, >C$\underline{H}$CH$_3$), δ 1.76 (3H, d, J=7.5 Hz, >CHC$\underline{H}_3$)] in quinone **17**. These spectral data show that quinone **17** is a symmetric dimer of plumbagin (**4**) linked by an ethylidene bridge. Since no quinonoid proton was observed, the position of the dimeric linkage must be 3-3′. The HMBC spectrum (Fig. 1) showed long-range correlations between the methyl protons of the ethylidene group and C-3,3′. These HMBC correlations indicate that the ethylidene group is located at C-3 and C-3′. On the basis of this evidence, quinone **17** was characterized as ethylidene-3,3′-biplumbagin.

New quinone **18**, orange-red plates, mp 185—186 °C, $[\alpha]_D^{28}$ −1.50°, has the molecular formula $C_{24}H_{18}O_6$ based on HR-MS (M^+ *m/z* 402.1089, required 402.1103). The IR [ν_{max} (KBr) cm^{-1}: 1666, 1638, 1609, 1577] and UV [λ_{max} ($CHCl_3$) nm (log ε): 257sh (4.29), 273 (4.33), 427 (3.93)] spectra showed the characteristics of juglone derivatives. The ^{1}H-NMR spectrum (Table 1) revealed the presence of two

* To whom correspondence should be addressed. e-mail: matuhiga@sci.u-ryukyu.ac.jp

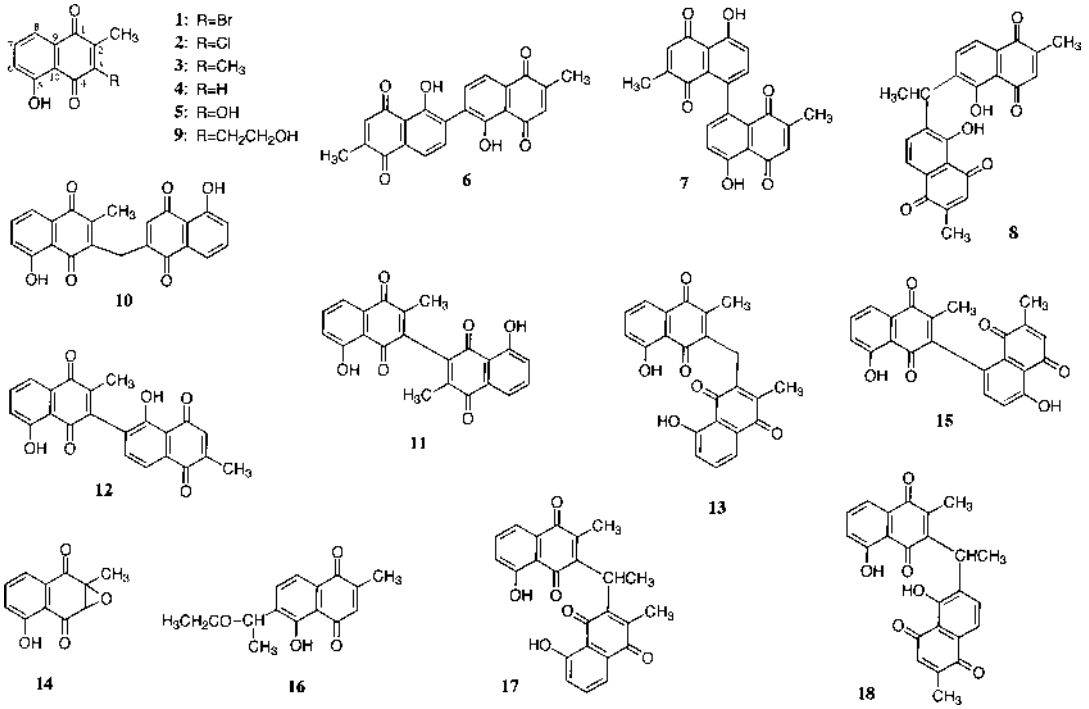

Chart 1

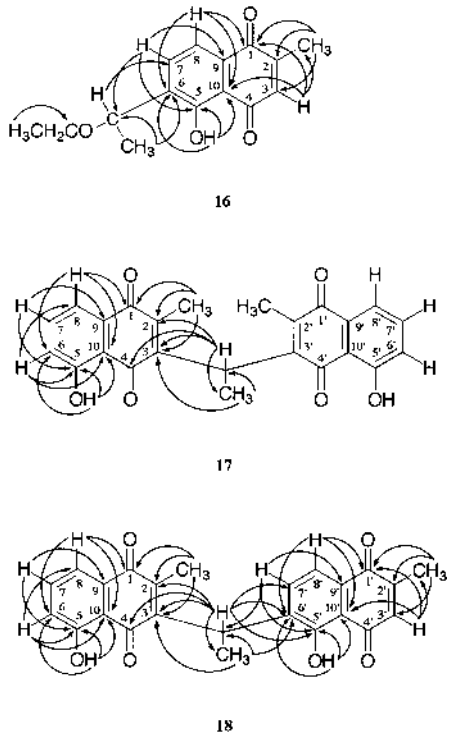

Fig. 1. HMBC Correlation for Compounds **16**—**18**

Table 1. ^{1}H-NMR Spectral Data for Compounds **16**—**18**[a] (500 MHz, $CDCl_3$, δ)

	16	**17**	**18**
H-3	6.79 (q, 1.5)		
H-6		7.20 (dd, 7.8, 1.1)	7.17 (dd, 7.9, 1.4)
H-7	7.77 (d, 7.8)	7.55 (t, 7.8)	7.53 (t, 7.9)
H-8	7.67 (d, 7.8)	7.60 (dd, 7.8, 1.1)	7.58 (dd, 7.9, 1.4)
H-3′			6.74 (q, 1.5)
H-6′		7.20 (dd, 7.8, 1.1)	
H-7′		7.55 (t, 7.8)	7.91 (d, 8.0)
H-8′		7.60 (dd, 7.8, 1.1)	7.70 (d, 8.0)
CH_3-2	2.19 (d, 1.5)	2.36 (s)	2.21 (s)
CH_3-2′		2.36 (s)	2.17 (d, 1.5)
OH-5	12.31 (s)	12.05 (s)	12.05 (s)
OH-5′		12.05 (s)	12.35 (s)
>C$\underline{H}$$CH_3$	4.92 (q, 6.4)	4.62 (q, 7.5)	4.74 (q, 7.1)
>CH$C\underline{H_3}$	1.43 (d, 6.4)	1.76 (d, 7.5)	1.71 (d, 7.1)
–O$C\underline{H_2}CH_3$	3.40 (dq, 9.2, 7.0)		
	3.46 (dq, 9.2, 7.0)		
–$OCH_2C\underline{H_3}$	1.23 (t, 7.0)		

Multiplicity and coupling constants (J, Hz) are shown in parentheses. *a*) Assignments were made on the basis of heteronuclear multiple quantum coherence (HMQC) and HMBC spectra.

quinonoid methyls [δ 2.17 (3H, d, J=1.5 Hz), δ 2.21 (3H, s)], one quinonoid proton [δ 6.74 (1H, q, J=1.5 Hz)], three adjacent aromatic protons [δ 7.17 (1H, dd, J=7.9, 1.4 Hz) δ 7.53 (1H, t, J=7.9 Hz), δ 7.58 (1H, dd, J=7.9, 1.4 Hz)], one pair of *ortho*-coupled aromatic protons [δ 7.70 (1H, d, J=8.0 Hz), δ 7.91 (1H, d, J=8.0 Hz)], two hydrogen-bonded hydroxyls [δ 12.35 (1H, s), δ 12.05 (1H, s)], and one ethylidene group [δ 4.74 (1H, q, J=7.1 Hz, >C$\underline{H}$$CH_3$), δ 1.71 (3H, d, J=7.1 Hz, >CH$C\underline{H_3}$)] in quinone **18**. These spectral data indicate that quinone **18** is an unsymmetric dimer of plumbagin (**4**) linked by an ethylidene bridge. Since only one quinonoid proton was observed, the position of the dimeric linkage in one plumbagin moiety must be C-3. The presence of *ortho*-coupled aromatic protons shows that the position of the dimeric linkage in the other plumbagin moiety must be C-6 or C-8. Thus quinone **18** is ethylidene-3,6′-biplumbagin or ethylidene-3,8′-biplumbagin. The HMBC spectrum (Fig. 1) showed long-range correlations between the methyl protons of the ethylidene group and C-3,6′. These HMBC data indicate that the location of the ethylidene group is C-3 and

Table 2. Ichthyotoxic and Germination Inhibitory Activities of Compounds **11**—**18**

Compound	MLC[a] (ppm)	Germination inhibitory ratio (%)[b] Concentration (ppm)		
		100	10	1
Juglone[c]	0.2	100	74	0
3,3′-Biplumbagin (**11**)	1.0	2	0	
Chitranone (**12**)	0.5	4	0	
Methylene-3,3′-biplumbagin (**13**)	>10	0		
2,3-Epoxyplumbagin (**14**)	3.0	86	4	0
3,8′-Biplumbagin (**15**)	3.0	2	0	
6-(1-Ethoxyethyl)plumbagin (**16**)	0.9	0		
Ethylidene-3,3′-biplumbagin (**17**)	>10	0		
Ethylidene-3,6′-biplumbagin (**18**)	>10	0		

a) MLC: minimum lethal concentration. *b*) Control=0. Complete inhibition=100. *c*) 5-hydroxy-1,4-naphthoquinone, a well-known fish toxin in walnuts.[9,10]

Table 3. ^{13}C-NMR Spectral Data for Compounds **16**—**18**[a] (125 MHz, $CDCl_3$, δ)

	16	**17**	**18**
C-1	184.71	184.51	184.66
C-2	149.69	145.81	145.16
C-3	135.34	147.43	147.53
C-4	190.69	189.87	189.44
C-5	158.38	161.33	161.27
C-6	140.40	124.01	123.85
C-7	132.41	135.94	135.77
C-8	119.40	118.89	118.79
C-9	130.70	131.78	132.01
C-10	114.64	114.96	115.04
C-1′		184.51	184.70
C-2′		145.81	149.74
C-3′		147.43	135.28
C-4′		189.87	190.58
C-5′		161.33	159.04
C-6′		124.01	138.43
C-7′		135.94	134.91
C-8′		118.89	118.91
C-9′		131.78	130.16
C-10′		114.96	114.20
CH_3-2	16.47	13.05	12.74
CH_3-2′		13.05	16.46
>$\underline{C}HCH_3$	70.96	35.69	32.76
>$CH\underline{C}H_3$	22.19	18.66	16.49
–$O\underline{C}H_2CH_3$	64.51		
–$OCH_2\underline{C}H_3$	15.40		

a) Assignments were made on the basis of HMQC and HMBC spectra.

C-6′. Based on the above evidence, the quinone **18** was characterized as ethylidene-3,6′-biplumbagin.

Biological Activities Two kinds of bioassay, the ichthyotoxicity and seed germination tests, were performed with the eight compounds **11**—**18** isolated from *D. maritima*. The ichthyotoxicity test was carried out using guppies (*Poecilia* (*Lebites*) *reticulata* PETERS), and the seed germination test using lettuce seeds (*Lactuca sativa* L. var. Great Lakes). The results are shown in Table 2. 3,3′-Biplumbagin (**11**), chitranone (**12**), 2,3-epoxyplumbagin (**14**), 3,8′-biplumbagin (**15**), and 6-(1-ethoxyethyl)plumbagin (**16**) showed strong ichthyotoxic activity, and quinone **14** had slight germination inhibitory activity.

Experimental

General Procedures Melting points were measured on a Yanagimoto micro melting point apparatus MP-S3 and are uncorrected. Specific rotations were recorded using a JASCO DIP-1000 digital polarimeter. Spectral data were obtained using the following instruments: IR on a Shimadzu FTIR-8200A; UV on a Hitachi 100-50; EI-MS and HR-MS on a Hitachi M-2500 (70 eV, direct inlet system); ^{1}H- and ^{13}C-NMR on a JEOL EX-270 (^{1}H: 270 MHz, ^{13}C: 67.8 MHz) and a JEOL α500 (^{1}H: 500 MHz, ^{13}C: 125 MHz); and two-dimensional NMR on a JEOL α500. Chemical shifts are given on a δ (ppm) scale with tetramethylsilane as an internal standard. The symbols s, d, t, q, dd, dq, m, and br denote singlet, doublet, triplet, quartet, double doublet, double quartet, multiplet, and broad, respectively.

Preparative TLC (PTLC) was performed on a precoated Kieselgel 60 F_{254} plate (Merck). Column chromatography (CC) and flash-column chromatography (FC) were carried out with Wakogel C-300 (Wako Pure Chemical) and Kieselgel 60 H (Merck), respectively. HPLC was performed with a Shimadzu LC-8A (column, Waters μBondasphere 5 μ C_{18} 100Å [19×150 mm] and 5 μ Silica 100Å [19×150 mm]; flow rate, 10 ml/min; detection, 430 nm).

Extraction and Isolation The fresh fruits (15.6 kg) of *D. maritima*, collected at Chinen, Okinawa, in March 1996, were soaked in 95% EtOH (25 l) for 6 d. The extract was evaporated to dryness, and the residue was partitioned between $CHCl_3$ and H_2O. The $CHCl_3$ layer was evaporated and the residue was divided into C_6H_6-soluble (152.8 g) and C_6H_6-insoluble portions (32.3 g). The C_6H_6-soluble portion was subjected to CC on silica gel with a gradient of C_6H_6–EtOAc to give seven fractions I—VII. Fraction I (44.99 g) was purified by FC on a silica gel (hexane–C_6H_6 gradient) to yield 3-bromoplumbagin (**1**: 7 mg), 3-chloroplumbagin (**2**: 257 mg), 3-methylplumbagin (**3**: 35 mg), plumbagin (**4**: 31.85 g), **14** (300 mg), and friedelin. Fraction II (6.33 g) was purified by FC on silica gel (C_6H_6), PLC on silica gel (hexane–C_6H_6 [1 : 1]), and HPLC on silica gel (hexane–C_6H_6 [1 : 1] containing 0.2% AcOH) and on ODS (MeOH–H_2O (9 : 1)) to yield **16** (51 mg), **18** (168 mg), **17** (32 mg), **11** (80 mg), **13** (7 mg), ethylidene-6,6′-biplumbagin (**8**: 32 mg), **10** (2 mg), **12** (340 mg), and **15** (11 mg). Fraction III (5.99 g) was purified by FC on silica gel (C_6H_6–EtOAc gradient) to yield elliptinone (**6**: 242 mg), droserone (**5**: 82 mg), β-amyrin, lupeol, and maritinone (**7**: 94 mg).

Compounds **1**—**8** were identified by direct comparison with authentic samples.[1]

Isozeylanone (**10**): A red powder. MS *m/z* (%): 374 $[M]^+$ (100), 359 (39), 245 (11), 149 (9), 121 (8), 92 (8), 57 (10). ^{1}H-NMR ($CDCl_3$, 500 MHz) δ: 2.23 (3H, s, CH_3), 3.94 (2H, br d, J=1.7 Hz, –CH_2–), 6.59 (1H, t, J=1.7 Hz, H-3′), 7.26 (1H, dd, J=7.5, 1.0 Hz, H-6 or 6′), 7.28 (1H, dd, J=7.5, 1.0 Hz, H-6 or 6′), 7.62 (1H, t, J=7.5 Hz, H-7 or 7′), 7.64 (1H, t, J=7.5 Hz, H-7 or 7′), 7.68 (1H, dd, J=7.5, 1.0 Hz, H-8 or 8′), 7.69 (1H, dd, J=7.5, 1.0 Hz, H-8 or 8′), 11.85 (1H, s, OH-5 or 5′), 11.95 (1H, s, OH-5 or 5′).

3,3′-Biplumbagin (**11**): Orange plates (C_6H_6), mp 214—217 °C (lit.[3] 214—216 °C). MS *m/z* (rel. int. %): 374 $[M]^+$ (100), 359 (60), 345 (5), 331 (11), 317 (4), 301 (7), 120 (7), 92 (12), 63 (4). The IR and ^{1}H-NMR spectral data were identical with those in ref. 3.

Chitranone (**12**): Orange plates (MeOH), mp 174—177 °C (lit.[5] 116—118 °C). ^{13}C-NMR ($CDCl_3$, 125 MHz) δ: 184.11 (C-1), 184.40 (C-1′), 147.72 (C-2), 149.92 (C-2′), 141.31 (C-3), 135.43 (C-3′), 190.36 (C-4 or C-4′), 188.31 (C-4 or C-4′), 161.51 (C-5), 158.43 (C-5′), 124.35 (C-6), 128.67 (C-6′), 136.92 (C-7 or C-7′), 136.32 (C-7 or C-7′), 119.34 (C-8), 118.65 (C-8′), 132.09 (C-9), 132.44 (C-9′), 114.92 (C-10), 115.29 (C-10′), 16.53 (CH_3-2), 14.67 (CH_3-2′). The IR, UV, MS, and ^{1}H-NMR spectral data were identical with those in refs. 4 and 5.

Methylene-3,3′-biplumbagin (**13**): Orange needles (C_6H_6), mp 230—233 °C (lit.[5] 208—210 °C). The IR, MS, and ^{1}H-NMR spectral data were

identical with those in ref. 5.

2,3-Epoxyplumbagin (**14**): Pale yellow needles (hexane), mp 92—93 °C (lit.[6] 95—96 °C). $[\alpha]_D^{30}$ −4.51° (c=2.41, $CHCl_3$). UV λ_{max} ($CHCl_3$) nm (log ε): 242 (4.04), 282 (3.83), 364 (3.69). ^{13}C-NMR ($CDCl_3$, 67.8 MHz) δ: 190.80 (C-1), 61.23 (C-2), 61.34 (C-3), 196.66 (C-4), 161.42 (C-5), 124.19 (C-6), 137.18 (C-7), 119.82 (C-8), 132.18 (C-9), 114.43 (C-10), 14.61 (CH_3-2). The IR, MS, and ^{1}H-NMR spectral data were identical with those in ref. 6.

3,8′-Biplumbagin (**15**): Orange plates (hexane–C_6H_6), mp 204—205 °C (lit.[7] 200—201 °C). IR ν_{max} (KBr) cm^{-1}: 1655, 1635, 1614, 1577. UV λ_{max} ($CHCl_3$) nm (log ε): 254 (4.41), 283 (4.23), 420 (3.93). MS m/z (rel. int. %): 374 $[M]^+$ (100), 359 (39), 346 (25), 345 (22), 331 (28), 317 (16), 301 (11), 187 (6), 121 (3), 120 (3), 92 (5), 44 (6). ^{1}H-NMR ($CDCl_3$, 500 MHz) δ: 1.94 (3H, s, CH_3-2), 2.08 (3H, d, J=1.5 Hz, CH_3-2′), 6.85 (1H, q, J=1.5 Hz, H-3′), 7.26 (1H, dd, J=8.1, 1.1 Hz, H-6), 7.38 (1H, d, J=8.5 Hz, H-6′), 7.64 (1H, t, J=8.1 Hz, H-7), 7.34 (1H, d, J=8.5 Hz, H-7′), 7.73 (1H, dd, J=8.1, 1.1 Hz, H-8), 11.88 (1H, s, OH-5), 12.49 (1H, s, OH-5′). The ^{13}C-NMR spectral data were identical with those in ref. 8.

6-(1-Ethoxyethyl)plumbagin (**16**): Orange needles (hexane), mp 73 °C. $[\alpha]_D^{30}$ −0.06° (c=0.36, $CHCl_3$). HR-MS m/z: 260.1049 (Calcd for $C_{15}H_{16}O_4$: 260.1037). IR ν_{max} (KBr) cm^{-1}: 1670, 1641, 1607. UV λ_{max} ($CHCl_3$) nm (log ε): 266 (4.05), 415 sh (3.62), 434 (3.64). MS m/z (rel. int. %): 260 $[M]^+$ (2), 245 (41), 231 (12), 218 (14), 217 (100), 216 (92), 215 (28), 214 (16), 213 (10), 201 (7), 189 (7), 171 (8), 147 (5), 128 (5), 121 (3), 115 (12), 91 (4), 77 (4), 43 (7). ^{1}H-NMR: Table 1. ^{13}C-NMR: Table 3.

Ethylidene-3,3′-biplumbagin (**17**): Orange-red plates (hexane–C_6H_6), mp 200—201 °C. HR-MS m/z: 402.1113 (Calcd for $C_{24}H_{18}O_6$: 402.1103). IR ν_{max} (KBr) cm^{-1}: 1663, 1634, 1615, 1577. UV λ_{max} ($CHCl_3$) nm (log ε): 248 (4.20), 275 (4.27), 421 (3.85). MS m/z (rel. int. %): 402 $[M]^+$ (100), 387 (26), 360 (15), 345 (8), 227 (35), 121 (8), 120 (4), 92 (6). ^{1}H-NMR: Table 1. ^{13}C-NMR: Table 3.

Ethylidene-3,6′-biplumbagin (**18**): Orange-red plates (hexane–C_6H_6), mp 185—186 °C. $[\alpha]_D^{28}$ −1.50° (c=1.28, $CHCl_3$). HR-MS m/z: 402.1089 (Calcd for $C_{24}H_{18}O_6$: 402.1103). IR ν_{max} (KBr) cm^{-1}: 1666, 1638, 1609, 1577. UV λ_{max} ($CHCl_3$) nm (log ε): 257 sh (4.29), 273 (4.33), 427 (3.93). MS m/z (rel. int. %): 402 $[M]^+$ (100), 387 (42), 359 (13), 227 (18), 190 (8), 121 (6), 92 (6), 77 (4). ^{1}H-NMR: Table 1. ^{13}C-NMR: Table 3.

Bioassays See the previous paper.[1]

Acknowledgments The authors thank Dr. Tatsuo Higa, University of the Ryukyus, for the use of the NMR spectrometer and Dr. Kaori Ando, University of the Ryukyus, for the use of the polarimeter.

References

1) Higa M., Ogihara K., Yogi S., *Chem. Pharm. Bull.*, **46**, 1189—1193 (1998).
2) Sankaram A. V. B., Rao A. S., Shoolery J. N., *Tetrahedron*, **35**, 1777—1782 (1979).
3) Sidhu G. S., Sankaram A. V. B., *Tetrahedron Lett.*, **1971**, 2385—2388 (1971).
4) Sankaram A. V. B., Rao A. S., Sidhu G. S., *Phytochemistry*, **15**, 237—238 (1976).
5) Gunaherath G. M. K. B., Gunatilaka A. A. L., *J. Chem. Soc. Perkin Trans. 1*, **1988**, 407—410 (1988).
6) Ogihara K., Yamashiro R., Higa M., Yogi S., *Chem. Pharm. Bull.*, **45**, 437—445 (1997).
7) Sankaram A. V. B., Rao A. S., Sidhu G. S., *Tetrahedron Lett.*, **1975**, 3627—3630 (1975).
8) Sankaram A. V. B., Reddy V. V. N., Marthandamurthi M., *Phytochemistry*, **25**, 2867—2871 (1986).
9) Marking L. L., *Trans. Amer. Fish. Soc.*, **99**, 510—514 (1970).
10) Ohta A., Sivalingam P. M., Lin S., Ikekawa N., Yaginuma N., Inada Y., *Toxicon*, **11**, 235—241 (1973).