Dimeric Guaianolides and a Fulvenoguaianolide from *Artemisia myriantha*

Ho-Fai Wong and Geoffrey D. Brown*

The Department of Chemistry, The University of Hong Kong, Pokfulam Road, Hong Kong

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The aerial parts of *Artemisia myriantha* have afforded one new fulvenoguaianolide and four dimeric guaianolides in addition to seven known guaianolides. The structures of all the compounds were elucidated by 2D NMR. It is speculated that the dimeric guianolides are formed via Diels−Alder type reactions of fulvenoguaianolide derivatives.

Artemisia myriantha Wall. ex Bess. (Compositae) is known in traditional Chinese medicine as a treatment for menorrhagia and inflammatory diseases.[1] A single previous phytochemical investigation of this species has revealed that the major constituent is the guaianolide, arglabin (**1**).[2] We now report the isolation and structure elucidation of one new fulvenoguaianolide, four novel dimeric guaianolides, and seven known guaianolides (including arglabin) from this species.

Results and Discussion

Purification of the dichloromethane extract of *A. myriantha* by gradient column chromatography and HPLC has afforded seven known guaianolide derivatives (**1**−**7**), one new fulvenoguaianolide (**8**), and four novel dimeric guaianolides (**10**−**13**). Structure elucidation of all compounds was performed by 2D NMR (HSQC, HMBC, ^{1}H−^{1}H COSY, and NOESY), resulting in unambiguous full NMR assignments for the known compounds. Fully assigned ^{13}C NMR data given in Table 1 for the known guaianolide natural products have either not been reported previously or it has been found that some chemical shifts and/or assignments in the literature were in error.

There has been considerable confusion in the literature concerning the stereochemistry of the epoxide group in compounds **1**−**4**. Thus, the first report of **1** from a *Pentzia* species[3] assigned its structure as 1*β*,10*β*-epoxyguaia-3,11-(13)-dien-12,6α-olide, while a subsequent report from *A. myriantha*[2] reversed the assignment of the epoxide configuration to 1α,10α- (even though this would lead to an identical structure with mesatlantine C, reported by Ilidrissi et al.[4] at about the same time, which clearly had a substantially different ^{1}H NMR spectrum). The more recent publication of an X-ray structure[5] for arglabin from *A. glabella* has confirmed the original stereochemistry proposed for the epoxide group (i.e., it is a 1*β*,10*β*-epoxyguaianolide), and we have "reassigned" the stereochemistry of the epoxide group in **1** from *A. myriantha* on the basis of the X-ray structure of arglabin from *A. glabella*.[5] ^{1}H NMR data for **2** agreed well with that for 8α-acetoxyarglabin,[3] which is also reported to contain a 1*β*,10*β*-epoxy group (i.e., compound **2** is 8α-acetoxy-1*β*,10*β*-epoxyguaia-3,11(13)-dien-12,6α-olide). 8α-Hydroxyarborescin (**3**) was reported as a natural product from a closely related *Artemisia* species (*A. adamsii)* by Bohlmann et al.,[6] who assigned the stereochemistry of the epoxide group in this compound and its parent, arborescin, as 1α,10α-. However, previous synthetic work by Ando et al.[7,8] appeared to indicate a 1*β*,-10*β*-epoxide stereochemistry for arborescin. de Gutierrez et al.[9] have also subsequently assigned this same stereochemistry to natural arborescin and have suggested a method for determinining the stereochemistry of the epoxide group at the 1,10-position of arborescin derivatives based on the ^{1}H chemical shifts observed at H-5 and H-6.[9] Our NMR data for compound **3** gave a better agreement with ^{1}H NMR data reported for arborescin and its derivatives as identified by both Ando and by Gutierrez (i.e., a 1*β*,10*β*-epoxide) than for their 1α,10α-epimers, and the stereochemistry of the epoxide group in 8α-hydroxyarborescin from *A. myriantha* has been assigned as 1*β*,10*β*-accordingly (i.e., compound **3** is 8α-hydroxy-1*β*,10*β*-epoxyguaia-3-en-12,6α-olide). 1*β*,10*β*-Epoxydehydroleucodin (**4**),[10] dehydroleucodin (**5**) (mesatlantine E, which is reported as having the same structure as **5**, has a quite different ^{1}H NMR spectrum[4]),[8,11] and desacetylmatricarin (**6**)[12−14] have all also been isolated previously from related species. Endoperoxide **7** was originally reported from *Tanacetum parthenium*[15] as "tanparthin-*β*-peroxide", although its structure has now been revised to tanparthin-α-peroxide on the basis of an X-ray crystallographic analysis.[16] In view of the discussion of the biogenesis of compounds **10**−**13** later in this paper, it is interesting to note that it was proposed that tanparthin-α-peroxide was formed by a Diels−Alder reaction with molecular oxygen of a cyclopentadiene system contained in the five-membered ring of the guaianolide skeleton.[16]

The mass spectrum of novel compound **8** contained a peak for the molecular ion at *m*/*z* 228, which was identified in the HREIMS as corresponding to the molecular formula $C_{15}H_{16}O_2$. The structure of compound **8** was determined as that of a fulvenoguaianolide[3,17,18] by 2D NMR as previously (full ^{13}C and ^{1}H NMR assignments are given in Tables 2 and 3; ^{13}C−^{1}H connections through 2- and 3-bonds observed in HMBC and ^{1}H−^{1}H correlations observed in COSY spectra of **8** are shown in Figure 2). Downfield signals from the two methyl groups in the ^{1}H NMR spectrum of **8** (δ_H 2.19 (3H, s, H-14) ppm and δ_H 2.11 (3H, s, H-15) ppm) strongly suggested that they were bonded to sp^2-hybridized carbons, and the value of the vicinal coupling constant (J = 5.3 Hz) between H-2 and H-3 confirmed the presence of a *cis*-olefin in the five-membered guaianolide ring. Further to this, ^{13}C chemical shifts for three of the four carbon−carbon double bonds in **8** were located at C-2/C-3, C-4/C-5, and C-1/C-10 by 2D NMR, indicating a fulvene arrangement for this conjugated triene in the five-membered ring of the guaianolide skeleton. The fourth double bond was associated with the α,*β*-unsaturated lactone ring, and the value of the coupling constant between H-6 and H-7 (J = 7.4 Hz) in the ^{1}H NMR spectrum of **8** was observed to be

* To whom correspondence should be addressed. Tel: +852-2859-7915. Fax: +852-2857-1586. E-mail: gdbrown@hkucc.hku.hk.

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Table 1. ^{13}C NMR Assignments of Known Compounds **1**−**7**

position[a,b]	1	2	3	4	5	6	7
1 (C)	72.6	71.8	72.6	65.3	131.9	133.1	99.7
2 (CH_2)	39.6	39.0	39.3	200.9 (C)	195.8 (C)	195.0 (C)	134.0 (CH)
3 (CH)	124.9	125.4	124.8	133.3	135.6	135.7	137.3
4 (C)	140.4	140.2	140.7	176.2	169.6	170.0	93.5
5 (CH)	52.7	51.6	51.8	49.7	53.0	51.7	69.6
6 (CH)	82.9	79.3	79.1	80.5	84.4	81.0	79.6
7 (CH)	50.9	53.4	59.9	52.8	52.9	61.5	42.9
8 (CH_2)	21.4	69.8 (CH)	68.9 (CH)	20.6	24.4	69.7 (CH)	22.9
9 (CH_2)	33.4	40.0	44.7	34.5	37.3	49.1	33.2
10 (C)	62.8	60.3	60.8	67.2	152.0	145.4	71.2
11 (C)	139.0	136.5	40.9 (CH)	138.2	138.5	41.3 (CH)	140.0
12 (C)	170.6	169.8	179.1	169.6	169.2	177.2	170.0
13 (CH_2)	118.4	121.9	16.1 (CH_3)	118.9	118.9	15.5 (CH_3)	119.0
14 (CH_3)	22.7	22.4	22.6	19.0	21.8	21.7	27.7
15 (CH_3)	18.2	18.4	18.4	20.9	19.8	19.9	13.7
CH_3CO		169.6					
CH_3CO		21.1					

[a] ^{13}C directly attached to ^{1}H determined by HSQC. [b] Multiplicity determined by DEPT, indicated in parentheses.

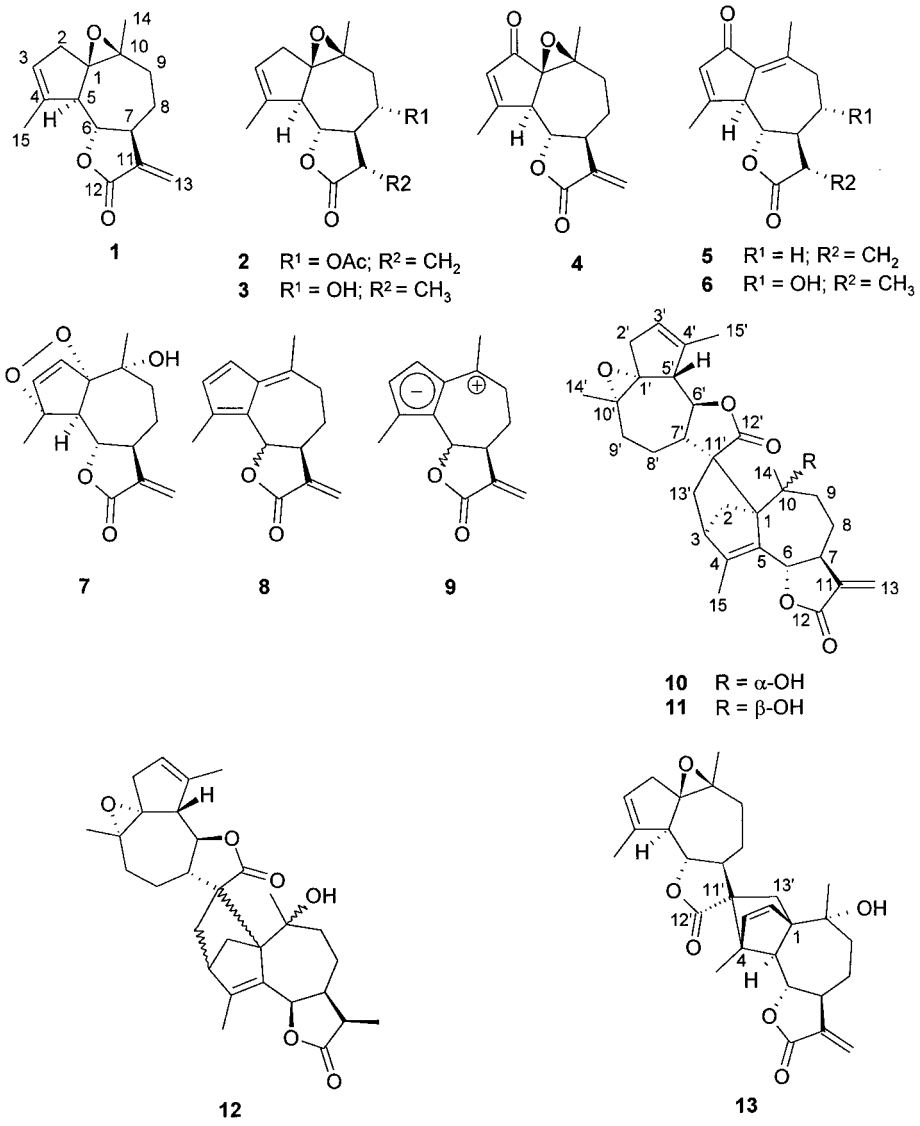


Figure 1. Guaianolide derivatives isolated from *A. myriantha*.

slightly smaller than that for compounds **1**−**7** (typically around 10 Hz), all of which contain a *trans*-lactone ring, but also larger than that expected for a *cis*-lactone (e.g., the 12,6β-lactone ring of **12**, see below). In consequence the stereochemistry at the 6-position of **8** has not been defined in Figure 1, although it seems quite likely that **8** is also a *trans*-lactone in which the conformation of the lactone ring is slightly distorted by the necessity of accommodating a conjugated triene in the adjoining guaianolide system, which in turn results in a somewhat smaller coupling constant for $J_{6,7}$ than is normal (this stereochemistry for the lactone ring would certainly be consistent with the role of **8** as a precursor to *trans*-lactone-ring-containing dimeric guaianoldes **10**, **11**, and **13**, which is proposed below).

Table 2. ^{13}C NMR Assignments for Compounds **8** and **10**−**13**

position[a,b]	8	10	11	12	13
1 (C)	140.7	71.5	70.8	72.0	62.8
2 (CH_2)	123.7 (CH)	47.1	45.7	47.1	135.8 (CH)
3 (CH)	132.2	45.3	46.4	44.9	138.3
4 (C)	146.9	143.0	142.6	152.7	61.2
5 (C)	121.8	134.3	135.7	134.9	66.6 (CH)
6 (CH)	77.0	82.7	82.9	79.8	79.4
7 (CH)	42.0	51.2	50.9	41.8	43.2
8 (CH_2)	34.4	23.9	22.7	21.9	23.7
9 (CH_2)	32.8	41.0	42.6	39.0	34.7
10 (C)	154.2	73.9	78.3	72.3	72.7
11 (C)	141.0	138.9	139.7	42.7 (CH)	141.0
12 (C)	170.8	169.7	170.3	179.9	170.6
13 (CH_2)	123.1	120.0	119.3	9.5 (CH_3)	118.6
14 (CH_3)	24.4	28.5	32.4	30.0	29.8
15 (CH_3)	13.7	14.3	14.1	13.5	16.5
1′ (C)		72.5	72.9	74.6	72.1
2′ (CH_2)		39.4	39.6	39.3	39.3
3′ (CH)		125.3	124.6	124.9	125.0
4′ (C)		140.4	141.1	141.4	141.0
5′ (CH)		54.0	54.2	53.1	53.4
6′ (CH)		82.9	82.4	80.1	81.2
7′ (CH)		52.9	50.2	53.6	57.5
8′ (CH_2)		21.0	22.8	21.7	21.5
9′ (CH_2)		34.2	34.6	33.3	34.4
10′ (C)		62.7	63.2	62.5	62.1
11′ (C)		55.9	56.6	55.7	56.5
12′ (C)		185.6	183.4	181.5	181.2
13′ (CH_2)		35.1	36.2	35.4	41.4
14′ (CH_3)		22.3	22.6	22.6	22.6
15′ (CH_3)		18.5	18.6	18.6	18.6

[a] ^{13}C directly attached to ^1H determined by HSQC. [b] Multiplicity determined by DEPT, indicated in parentheses.

The strongly downfield value for the resonance at C-10 of **8** (δ_C 154.2 ppm) was consistent with the zwitterionic resonance structure **9**, which is known to be a significant contributor to the π-electronic distribution for fulvenes.[17] Owing to the fulvene character of this conjugated triene, all the carbon atoms in the five-membered guaianolide ring (C-1 to C-5) are thought to be comparatively electron-rich. By contrast, the fourth double bond (at C-11 and C-13) of compound **8** is electron-deficient because it is conjugated with a carbonyl functional group. These observations are relevant since it was observed that compound **8** appeared to undergo polymerization on standing in $CDCl_3$ at room temperature. We believe that such self-condensation may proceed via repeated intermolecular Diels−Alder reactions between the electron-rich fulvene component and the electron-deficient alkene component (C-11/13) of compound **8**. This hypothesis has received some support from the further isolation from *A. myriantha* of natural products **10**−**13**, which are all dimeric guaianolides with skeletons that might readily be accounted for by such Diels−Alder type reactions.

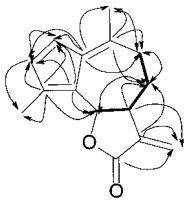


Figure 2. Correlations seen in HMBC (indicated by arrows from ^{13}C to ^1H) and $^1H-^1H$ COSY (indicated by bold lines) used in determining the structure of **8**.

None of the molecular weights for artemyriantholides A−D (**10**−**13**) could be determined directly by mass spectroscopy, as all these compounds appeared to undergo spontaneous retro Diels−Alder reactions in the mass spectrometer under a variety of ionization techniques. The daughter ion(s) formed by such fragmentation generally had half the mass of the parent dimer. Thus, in artemyriantholide A (**10**) the highest mass ion observed by CIMS was at *m*/*z* 247, corresponding to half the molecular weight plus one. The dimeric guaianolide structures of each of

Table 3. ^1H NMR Assignments for Compounds **8** and **10**−**13**

position[a,b]	8	10	11	12	13
2α	6.55 (d 5.3)	1.64	1.22	1.80[c]	5.93 (d 5.5)
2β		2.31 (dd 9.5, 1.1)	2.40 (d 8.5)	1.63[c]	
3	6.30 (d 5.3)	2.62 (br s)	2.58 (br s)	2.62	5.82 (d 5.5)
5					3.15 (d 9.9)
6	5.70 (d 7.4)	4.29 (d 10.5)	4.75 (d 10.4)	5.25 (d 2.9)	4.03 (dd 9.9, 9.9)
7	3.42	2.71	2.62	2.87	3.33
8α	2.11	2.13	1.92	1.64[c]	2.26
8β	1.97	1.51	1.85	1.39[c]	1.43
9α	2.55	1.94	1.77	1.66[c]	1.88
9β	2.28	1.77	1.88	1.99[c]	1.83
11				2.85	
13a	5.69 (d 1.9)	5.52 (d 3.1)	5.49 (d, 3.0)	1.12 (3H d 6.8)	5.34 (d 3.2)
13b	6.38 (d 1.9)	6.23 (d 3.4)	6.20 (d, 3.3)		6.08 (d 3.6)
14	2.19 (3H s)	1.44 (3H s)	1.47 (3H, s)	1.32 (3H s)	1.30 (3H s)
15	2.11 (3H s)	1.94 (3H d 0.8)	1.94 (3H, s)	1.80 (3H, s)	1.51 (3H s)
2α′		2.71	2.68 (d 17.6)	2.74 (d 15.1)	2.14
2β′		2.12	2.09	2.12	2.73 (d 16.7)
3′		5.59 (br s)	5.55 (br s)	5.56 (br s)	5.56 (br s)
5′		2.82 (d 10.3)	2.86 (d 10.3)	2.83 (d 10.3)	2.64 (d 10.4)
6′		4.01 (dd 10.3,10.3)	3.81 (dd 10.3, 10.1)	3.89 (dd 10.3, 10.3)	4.36 (dd 10.4, 10.4)
7′		2.09	2.83 (dd 10.1, 10.1)	2.66 (dd 10.3, 10.3)	1.68
8α′		1.28	1.16	1.53[c]	1.57
8β′		1.49	1.36	1.60[c]	1.27
9α′		2.20	2.15	2.06[c]	1.72
9β′		1.73	1.75	1.95[c]	2.11
13α′		1.85 (dd 12.1, 3.8)	1.85	2.24 (dd 11.9, 3.7)[c]	2.58 (d 11.8)
13β′		1.78	1.65	1.23[c]	1.18 (d 11.8)
14′		1.29 (3H s)	1.28 (3H s)	1.32 (3H s)	1.31 (3H s)
15′		1.95 (3H d 1.3)	1.96 (3H d 1.3)	1.94 (3H d 1.3)	1.96 (3H s)
10-OH		4.82			

[a] ^{13}C directly attached to ^1H determined by HSQC. [b] Integral (if not [1H]), multiplicity and coupling constant(s) (in Hz), when resolved in 1D NMR, indicated in parentheses. [c] Assignments as α or β uncertain. 13b-proton *cis* with carbonyl group.

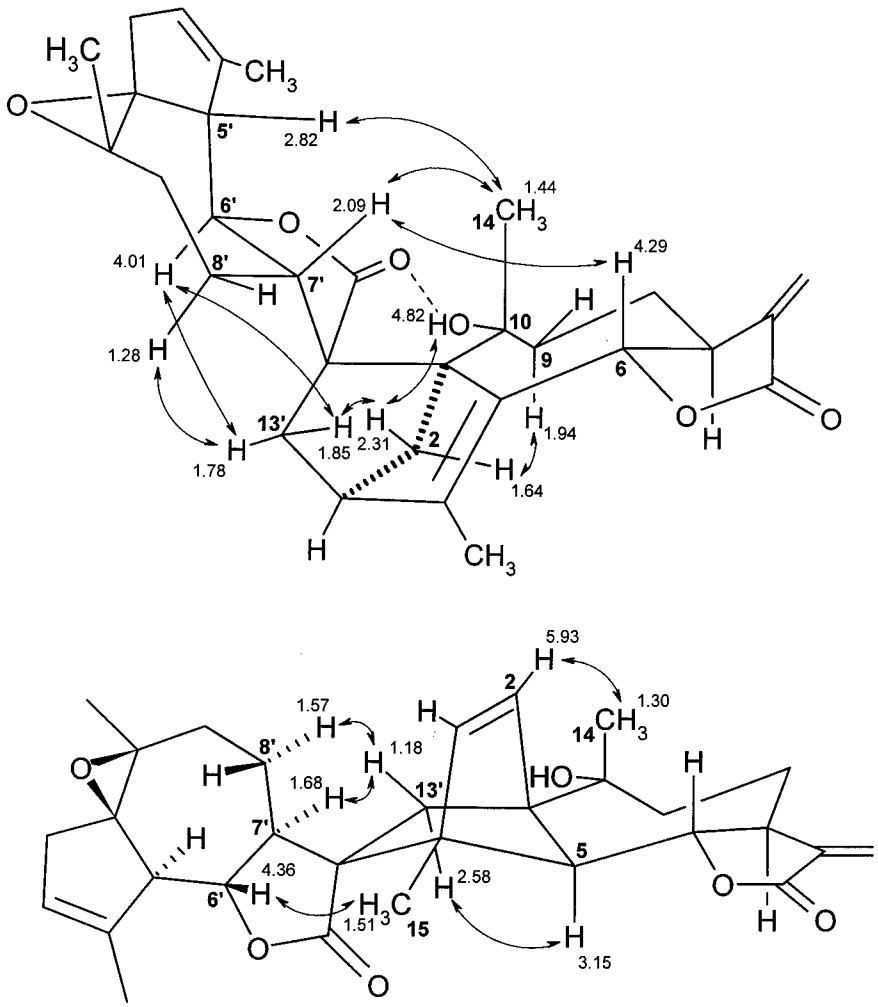


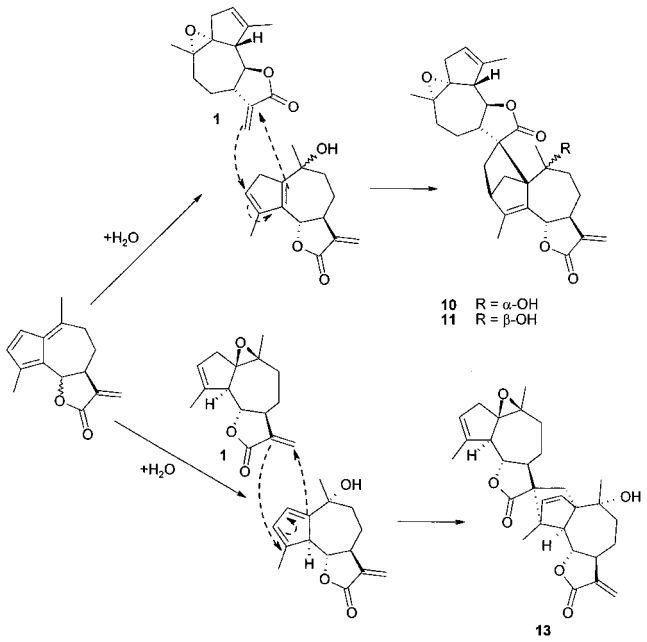
Figure 3. Critical NOESY correlations used in establishing the conformations of **10** (top) and **13** (bottom), indicated by double-headed arrows.

compounds **10**−**13** were more easily established by counting the number of resonances in their ^{1}H and ^{13}C NMR spectra and then ascertaining the nature of the linkage for each dimer by 2D NMR (full ^{13}C and ^{1}H NMR assignments for **10**−**13** are given in Tables 2 and 3). Two- and three-bond heteronuclear correlations which were observed between C-3/H-13′, C-4/H-13′, and C-11′/H-3 in the HMBC spectrum of **10** and homonuclear correlations observed in the ^{1}H−^{1}H COSY between H-3 and H-13′ provided strong evidence for the connection of two monomers via new carbon−carbon bonds formed between C-1/C-11′ and C-3/C-13′, thereby requiring the planar dimeric structure of artemyriantholide A, as shown in Figure 1. Unusually, it was possible to see correlations in the HMBC spectrum from both C-9 and C-10 to the hydroxyl proton at the 10-position, which appeared as a sharp singlet (δ_H 4.82 ppm) in one-dimensional ^{1}H NMR. These observations suggested that this hydroxyl proton is not undergoing exchange to any appreciable extent on the NMR time scale, and we propose that this is due to strong intramolecular hydrogen bonding with the 12′-carbonyl group. In addition, the 10-hydroxyl proton also showed a nuclear Overhauser enhancement with one of the protons at the 2-position (δ_H 2.31 ppm), indicating that the hydroxyl group must be on the same face of the molecule as the bridging unit at C-2 (the other proton at the 2-position correlated with H-9α in the NOESY spectrum) and *anti* to the newly formed carbon−carbon bonds at C-1 and C-3. The stereochemistry shown for the dimeric linkage in Figure 3 is consistent both with these NOEs, with the requirement for intramolecular hydrogen bonding of the 10-hydroxyl group, and with additional NOEs seen from H-14 to H-5′ and H-7′ on the top face of the molecule and H-13α′/H-13β′ to H-6′ on the lower face.

The relative sterochemistry established about the newly formed carbon−carbon bonds in **10** would then be consistent with a formation from the Diels−Alder reaction of a guaianolide containing a cyclopentadiene functionality in the five-membered ring (possibly derived from a fulvenoguaianolide such as **8**) with the electron-deficient carbon−carbon double bond of the α,β-unsaturated lactone of a molecule of arglabin (**1**) via an *exo* transition state (Figure 3 and Scheme 1). This orientation of approach is unusual for Diels−Alder additions, which normally adopt an *endo* transition state, in which the possibility of secondary orbital overlap between frontier orbitals of the diene and dienophile reactants is maximized. This unusual orientation may be the result of steric avoidance and of favorable hydrogen bonding in the transition state between the lactone carbonyl of the dienophile (arglabin (**1**)) and the hydroxyl group adjacent to the diene, which determine both the regio- and stereoselectivity of the reaction. Two dimeric guaianolides, artesieversin[19] and biennin,[20] are known which are linked in the same way as for artemyriantholide A and may therefore be formed via the same *exo* transition state as that proposed for **10**.

The mass spectrum of artemyriantholide B (**11**) showed a fragmentation pattern nearly identical to that of **10** in CIMS and ^{1}H, ^{13}C, and 2D NMR data for **11** indicated the same planar structure, with critical NOEs confirming that

Scheme 1. Proposed Mechanisms for the Formation of Both 1,3-Linked Dimeric Guaianolides (**10**/**11**) and a 1,4-Linked Dimeric Guaianolide (**13**) by Diels−Alder Type Reactions with Dienophile **1** of Isomeric Dienes Which May Be Derived from a Single Fulvenoguaianolide Precursor, Such as **8**[a]



[a] The reactants are shown approaching one another in an *exo* Diels−Alder transition state in both cases, and this is consistent with the observed stereochemistry of the products.

dimerization had occurred from the same *exo* transition state as for **10**. The most significant differences in the NOESY spectrum of **11** were the presence of correlations between H-14 and H-2β/H-13α', indicating that the methyl group at C-10 was now in the α-configuration. The proposal that artemyriantholide B was epimeric with compound **10** at C-10 (for which the methyl group was assigned to the β-orientation) was confirmed by making a comparison of chemical shifts between compounds **10** and **11** (Tables 2 and 3). Although most positions had very similar values (within 1−2 ppm for ^{13}C; and 0.1−0.2 ppm for ^{1}H), there was a marked downfield shift in the ^{13}C NMR spectrum for the C-14 resonance in **11** (δ_C 32.4 ppm) as compared with **10** (δ_C 28.5 ppm), which was consistent with an equatorial orientation for the 14-methyl group in **11** instead of an axial orientation in **10** (there was also a large change in the chemical shift at C-10). Strong downfield shifts in the ^{1}H resonances at H-6 (δ_H 4.75 and 4.29 ppm for **11** and **10**, respectively) and H-7′ (δ_H 2.83 and 2.09 ppm for **11** and **10**, respectively) were also consistent with the 10-hydroxyl group adopting an axial orientation in compound **11**, for which there is expected to be a significant interaction with these two protons (cf. de Gutierrez's method for distinguishing the stereochemistry of the 1,10-epoxide group in arborescin derivatives, discussed earlier).[9] No correlations were seen to the 10-hydroxyl group in **11** in any 2D NMR experiments, and this is reasonable given the steric impossibility of forming a seven-membered hydrogen-bonded ring to the lactone carbonyl of the arglabin-derived guaianolide moiety (as found in **10**), when the 10-hydroxyl group is axial (hence the 10-hydroxyl proton undergoes rapid exchange, as is normal for −OH groups, and does not appear in the 2D NMR). ^{13}C and ^{1}H NMR data reported for artesieversin, which also incorporates a 10β-hydroxyl group,[19] were very similar to that of artemyriantholide B (**11**), leaving little doubt regarding the overall structure and stereochemistry of this dimer.

Dimeric guaianolide artemyriantholide C (**12**) also shared the same skeleton as compounds **10**/**11**, although the presence of a doublet at δ_H 1.12 ppm in the ^{1}H NMR spectrum of **12** indicated a methyl group at C-13, replacing the olefin of the α,β-unsaturated lactone system in compounds **10/11**. The CI mass spectrum of **12** contained two daughter ions at *m*/*z* 249 and 247 both due to a retro Diels−Alder reaction and corresponding to fragments derived from both the 11,13-dihydro-guaianolide moiety (C-1−C-15) and the arglabin moiety (C-1′−C-15′), respectively. The small coupling constant (J = 2.9 Hz) between H-6 and H-7 indicated that artemyriantholide C contained a 12,6β-lactone ring. Correlations seen in the NOESY spectrum of compound **12** were ambiguous in helping to define the stereochemistry of the hydroxyl group at the 10-position and of the new carbon−carbon bonds at C-1/C-11′ and C-3/C-13′.

Artemyriantholide D (**13**) is a dimeric guaianolide formed apparently from an alternative Diels−Alder reaction, in which new carbon−carbon bond formation has taken place between C-1/C-13′ and C-4/C-11′ (as shown by correlations observed in the HMBC spectrum between C-1/H-13′, C-2/H-13′, and C-11′/H-15), instead of between C-1/C-11′ and C-3/C-13′, as for compounds **10**−**12**. Several guaianolide dimers incorporating this kind of linkage are now known,[21−25] and it has often been speculated that their biogenesis involves Diels−Alder reactions.[23−25] The stereochemistry of the dimeric linkage in compound **13** was deduced as follows. The large coupling constant for H-5 (J = 9.9 Hz) in the 1D ^{1}H NMR spectrum of **13** indicated an axial conformation for this proton, which was accordingly assigned as H-5α. Observation of an NOE from H-5α to H-13α' in the NOESY spectrum of **13** therefore required that the 13′-bridging carbon also be on the α-face of the molecule. The stereochemistry at the 11′-spiro carbon was then defined by correlations observed from the other proton at the 13′-position (H-13β') to both H-7′ and H-8α' and was confirmed by an NOE between the two guaianolide halves (H-15 with H-6′). An *exo* Diels−Alder transition state is once again required in order to account for this stereochemistry of the dimeric linkage in compound **13**.

To address the concern that some of the dimeric guaianolides isolated from *Artemisia myriantha* might be artifacts of the isolation procedure, solutions of arglabin were left in $CDCl_3$ solution for several weeks, in an attempt to mimic the extraction process in which plant material is repeatedly extracted with organic solvent. Arglabin (**1**) was chosen for this study since it is the most abundant guaianolide from this species and is the presumed monomeric precursor involved in formation of most of these dimers. Under these conditions, no observable dimerization occurred; thus, it appears that dimers **10**−**13** are not artifacts of the extraction process. In addition to compounds **1**−**8** and **9**−**13**, the well-known flavanoid chrysosplenetin[26] and the sesquiterpene caryophyllene were also isolated from *A. myriantha* in substantial amounts.

Experimental Section

General Experimental Procedures. Chemical shifts are expressed in ppm (δ) relative to TMS as an internal standard. All NMR experiments were run on a Bruker DRX 500 instrument in $CDCl_3$ solution. Two-dimensional spectra were recorded with 1024 data points in F_2 and 256 data points in F_1. HREIMS were recorded at 70 eV on a Finnigan-MAT 95 MS spectrometer. IR spectra were recorded in $CHCl_3$ on a Shimadzu FTIR-8201 PC spectrometer. TLC plates were developed using *p*-anisaldehyde. Column chromatography was performed using silica gel 60−200 μm (Merck). HPLC separa-

tions were preformed using a Varian chromatograph equipped with RI star 9040 and UV 9050 detectors and an Intersil PREP-SIL 20 mm × 25 cm column, operating isocratically with EtOAc/*n*-hexane mixtures at a flow rate 8 mL/min.

Plant Material. *A. myriantha* was collected from Yunnan Province, China, in August 1999. Taxonomic identification was made by Prof. Ling Yeou-Ruenn of the South China Botanical Garden, Guangzhou, PRC, and a voucher specimen is kept at the University of Hong Kong Herbarium (D. Q. Zhou s.n., 19 Aug 1999 HKU).

Extraction and Isolation. The aerial parts of *A. myriantha* (650 g) were pulverized to a fine powder under liquid N_2, repeatedly extracted with CH_2Cl_2, and dried, and the solvent was removed under reduced pressure to yield a dark brown gum (20.5 g; 3.2% w/w), which was subjected to gradient CC (developing solvents 100% *n*-hexane → 100% EtOAc → 100% MeOH). Fractions from CC were further purified by HPLC. **1** (243 mg) (CC: 50% EtOAc/*n*-hexane; HPLC: R_t 12.9 min in 45% EtOAc/*n*-hexane); **2** (7.1 mg) (CC: 65% EtOAc/*n*-hexane; HPLC: R_t 43.4 min in 42% EtOAc/*n*-hexane/1% CH_3COOH), **3** (7.7 mg) (CC: 65% EtOAc/*n*-hexane; HPLC: R_t 16.6 min in 42% EtOAc/*n*-hexane/1% CH_3COOH), **4** (8.9 mg) (CC: 65% EtOAc/*n*-hexane; HPLC: R_t 23.8 min in 45% EtOAc/*n*-hexane), **5** (50.3 mg) (CC: 65% EtOAc/*n*-hexane; HPLC: R_t 24.5 min in 45% EtOAc/*n*-hexane), **6** (2.5 mg) (CC: 80% EtOAc/*n*-hexane; HPLC: R_t 45.5 min in 50% EtOAc/*n*-hexane/5% CH_3COOH), **7** (3.9 mg) (CC: 70% EtOAc/*n*-hexane; HPLC: R_t 31.5 min in 42% EtOAc/*n*-hexane/1% CH_3COOH), **8** (40.6 mg) (CC: 55% EtOAc/*n*-hexane; HPLC: R_t 13.6 min in 45% EtOAc/*n*-hexane), **10** (20.3 mg) (CC: 55% EtOAc/*n*-hexane; HPLC: R_t 23.1 min in 45% EtOAc/*n*-hexane), **11** (3.9 mg) (CC: 65% EtOAc/*n*-hexane; HPLC: R_t 14.0 min in 42% EtOAc/*n*-hexane/1% CH_3COOH), **12** (3.2 mg) (CC: 65% EtOAc/*n*-hexane; HPLC: R_t 27.5 min in 42% EtOAc/*n*-hexane/1% CH_3COOH), **13** (6.4 mg) (CC: 80% EtOAc/*n*-hexane; HPLC: R_t 25.5 min in 50% EtOAc/*n*-hexane/5% CH_3COOH).

Arglabin (1): see refs 2, 3, and 5 for physical properties; ^{13}C NMR, see Table 1.

8α-Acetoxyarglabin (2): see ref 3 for physical properties; ^{13}C NMR, see Table 1.

8α-Hydroxyarborescin (3): see ref 6 for physical properties; ^{13}C NMR, see Table 1.

1*β*,10*β*-Epoxydehydroleucodin (4): see ref 10 for physical properties; ^{13}C chemical shifts for C-1 and C-4 were incorrectly reported and C-5 was wrongly assigned as C-7 (and vice versa) in this reference; see Table 1 for revised description of ^{13}C NMR of this compound.

Dehydroleucodin (5): see refs 8 and 11 for physical properties; ^{13}C data (reported in ref 8 only) was unassigned; see Table 1 for fully assigned ^{13}C NMR of this compound.

Desacetylmatricarin (6): see ref 12 for physical properties; ^{13}C chemical shift for C-9 was incorrectly reported in this reference; see Table 1 for revised description of ^{13}C NMR of this compound.

Tanparthin-α-peroxide (7): see refs 15 and 16 for physical properties; in ^1H NMR, H-2 was wrongly assigned as H-3 (and vice versa) in both references; for clarification of ambiguous ^{13}C NMR assignments of C-1/C-4 and C-2/C-3 given in ref 16 for this compound, see Table 1.

Guaia-1(10),2,4,11(13)-tetraen-12,6*ξ*-olide (8): gum; $[\alpha]_D$ −34.2° (*c* 0.12, $CHCl_3$); IR ($CHCl_3$) ν_{max} 3024, 2932, 2856, 1759, 1637, 1446 cm^{-1}; ^1H NMR and ^{13}C NMR, see Tables 2 and 3; CIMS *m/z* 229 ($M^+ + 1$) (100), 183 (8), 156 (4); HREIMS *m/z* 228.1146 (20) (M^+, calcd for $C_{15}H_{16}O_2$ 228.1150).

Artemyriantholide A (10): gum; $[\alpha]_D$ +37.2° (*c* 1.0, $CHCl_3$); UV (EtOH) λ_{max} (log ϵ) 205 (4.5), 337 (2.8); IR ($CHCl_3$) ν_{max} 3420 (br), 3026, 3011, 2934, 1767, 1732, 1670, 1624, 1603 cm^{-1}; ^1H NMR and ^{13}C NMR, see Tables 2 and 3; CIMS *m/z* 247 ($M^+/2 + 1$) (49), 229 (100), 205 (18), 201 (19), 187 (82).

Artemyriantholide B (11): gum; $[\alpha]_D$ +51.0 (*c* 0.4, $CHCl_3$); UV (EtOH) λ_{max} (log ϵ) 206 (4.6), 287 (3.0), 330 (2.4); IR ($CHCl_3$) ν_{max} 3600, 3460 (br), 3022, 2928, 2851, 1759, 1730 (sh), 1604 cm^{-1}; ^1H NMR and ^{13}C NMR, see Tables 2 and 3; CIMS *m/z* 247 ($M^+/2 + 1$) (13), 229 (100), 205 (5), 203 (5), 201 (7), 187 (38); HREIMS *m/z* 246.1250 ($M^+/2$, calcd for $C_{15}H_{18}O_3$ 246.1256) (15), 228 (70), 213 (65), 149 (42), 135 (100).

Artemyriantholide C (12): gum; $[\alpha]_D$ +34.5 (*c* 0.3, $CHCl_3$); λ_{max} (log ϵ): 205 (4.5), 268 (3.5); IR ($CHCl_3$) ν_{max} 3410 (br), 3024, 2930, 2853, 1757 cm^{-1}; ^1H NMR and ^{13}C NMR, see Tables 2 and 3; CIMS *m/z* 249 (9), 247 (17), 231 (100), 229 (29), 205 (15), 203 (16), 201 (11), 187 (48).

Artemyriantholide D (13): gum; $[\alpha]_D$ +17.2 (*c* 0.6, $CHCl_3$); λ_{max} (log ϵ) 206 (4.5), 280 (3.0), 346 (2.7); IR ($CHCl_3$) ν_{max} 3600, 3510 (br), 3015, 2936, 2856, 1759, 1730 cm^{-1}; ^1H NMR and ^{13}C NMR, see Tables 2 and 3; CIMS *m/z* 247 ($M^+/2 + 1$) (24), 229 (100), 205 (4), 201 (5), 187 (55).

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