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A GUAIANOLIDE AND OTHER CONSTITUENTS FROM *LYCHNOPHORA* SPECIES*

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Key Word Index—*Lychnophora passerina*; *L. uniflora*; *L. salicifolia*; Compositae; Vernonieae; sesquiterpene lactones; guaianolide; caryophyllene derivative; lupeol derivative.

Abstract—A new guaianolide, 11β,13-dihydroeremanthine, together with a caryophyllene derivative and pentacyclic triterpenes, has been isolated from *Lychnophora* species.

So far six species of the Brazilian genus *Lynchnophora* (Vernonieae) [1] have been investigated [2]. We have now studied the constituents of two further species and re-examined more material of *L. salicifolia* Mart. The aerial parts of the latter afforded, in addition to the compounds isolated previously, lupeyl acetate, β-amyrin and its acetate as well as a further caryophyllene derivative, the epoxy alcohol **1**. The structure of **1** followed from the ^{1}H NMR data (Table 1), especially when they are compared with those of the other derivatives, which were present in the same plant [2]. Spin decoupling allowed the assignment of nearly all the signals. The presence of a caryophyllene derivative was obviously from several typical signals. A broadened three-fold doublet occurred at δ 2.65 (H-1), broadened singlets at 4.98 and 4.83 (H-12) and singlets at 1.00 and 1.02 (H-13 and -14), while the typical signal of the olefinic methyl was replaced by two doublets at 3.84 and 3.41 (J = 12.5 Hz, 15-H) and the olefinic signal by a double doublet at 3.07 (J = 13 and 4 Hz). The last signal was that of an epoxide proton, which was coupled with signals at 1.42 (H-4, *ddd*, J = 11, 4, 3 Hz) and 2.30 (H-4′, *m*). The latter was overlapped with one of the signals of H-3 even at 400 MHz. Irradiation at 2.65 (H-1) allowed the assignment of the H-9 and H-10 signals (1.82, *brdd*, 1.68 *dd* and 1.59 *dd*) Though the stereochemistry at C-5 and C-6 could not be established, the one given was in good agreement with a model and with the assumption that **1** was formed in the plant by oxidation of caryophyllene. β-Amyrin acetate, taraxasteryl acetate and **3** were isolated from the roots in addition to the compounds reported previously.

Table 1. ^{1}H NMR spectral data of compound **1** (400 MHz, TMS as int. standard, $CDCl_3$)

H-1	2.65 *brddd*
H-3α	2.30 *m*
H-3β	2.14 *m*
H-4α	2.30 *m*
H-4β	1.42 *dddd*
H-5α	3.07 *dd*
H-7α	1.68 *m*
H-7β	2.52 *ddd*
H-8	1.45 *m*
H-9	1.82 *brdd*
H-10α	1.68 *dd*
H-10β	1.59 *dd*
H-12	4.83 *brs*
H-12′	4.98 *brs*
H-13	1.02 *s*
H-14	1.00 *s*
H-15	3.84 *d*
H-15′	3.41 *brd*

J (Hz): 1,9 = 9; 1,10α = 8.5; 1,10β = 11; 3α,4β = 11; 4α,4β = 14; 4α,5 = 4; 4β,5 = 11; 7α,7β = 13; 7β,8α = 3; 7β,8β = 4; 8α,9 = 10; 10α,10β = 11.

Table 2. ^{1}H NMR spectral data of compound **6**

H-1	2.37 *m*
H-2	1.54 *m*
H-3	2.55 *m*
H-3′	2.13 *m*
H-5	2.55 *m*
H-6	3.95 *dd*
H-7	1.78 *ddd*
H-8α	2.38 *ddd*
H-8β	1.94 *brddd*
H-9	5.51 *brd*
H-11	2.27 *dq*
H-13	1.24 *d*
H-14	5.18 *brs*
H-14′	5.00 *brs*
H-15	1.82 *brs*

J (Hz): 5,6 = 6,7 = 10; 7,8α = 3; 7,8β = 12; 7,11 = 12; 8α,8β = 16; 8,9 = 8; 11,13 = 7.

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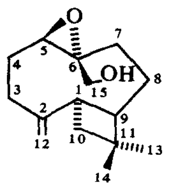
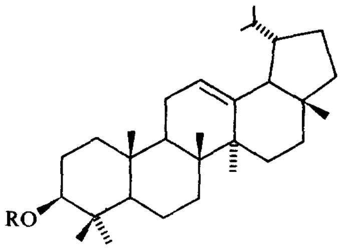
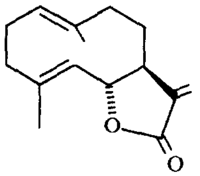
*Part 328 in the series "Naturally Occurring Terpene Derivatives". For Part 327 see Bohlmann, F., Ziesche, J., Robinson, H. and King, R. M. (1981) *Phytochemistry* **20**, 1146.



1



2 R = H
3 R = Ac



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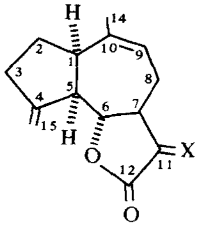
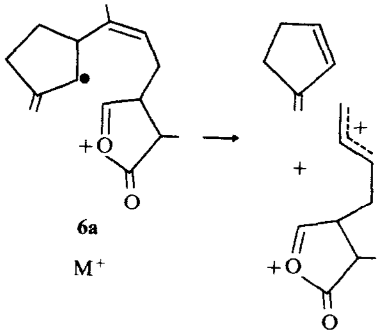
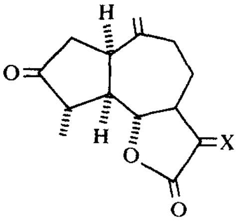


5 X = CH_2
6 X = αMe, H



6a
M^+

6b
m/z 152



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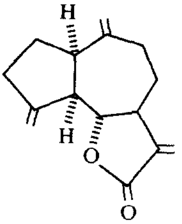
8 X = αMe, H



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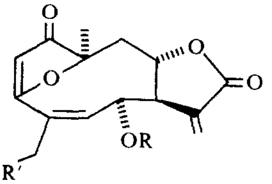
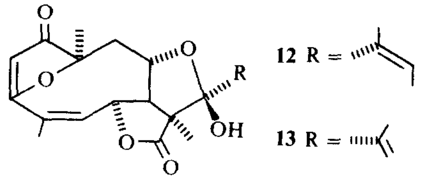
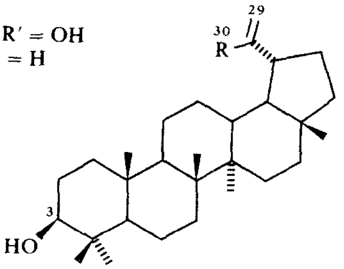


10 R = Meacr, R' = OH
11 R = Ang, R' = H



12 R =
13 R =



14 R = CHO
15 R = CH_2OH

The roots of *L. passerina* Gardn. afforded taraxasterol and its acetate, β-amyrin and its acetate, lupeol and its acetate, stigmasterol, costunolide (**4**), eremanthine (**5**) [3], the ketones **7** [4, 5] and **8** [4, 5], dehydrocostuslactone (**9**) [6] and 11β,13-dihydroeremanthine (**6**), which seemed to be new. Separation of **6** from **5** was only possible after transformation of **5** into the corresponding pyrazoline derivative. The ^1H NMR data for **6** (Table 2) were similar to those of eremanthine. The stereochemistry at C-11 followed from the observed large coupling $J_{7,11}$. In the mass spectrum the base peak was at *m/z* 152 ($C_9H_{12}O_2$) (**6b**), which probably was formed from **6a** as shown. The structure of **6** was further established by its formation from **5** by treatment with sodium boranate. The aerial parts gave β-amyrin and its acetate, taraxasterol, stigmasterol, lupeol and its acetate, the isomers **2** and **3**, α-humulene, eremanthine (**5**), the ketones **7** and **8** and goyazensolide (**10**) [7].

The roots of *L. uniflora* Sch. Bip. afforded lupeol and its acetate, taraxasteryl acetate, eremanthine (**5**) and the angelate **11** [8], while the aerial parts gave β-amyrin and its acetate, taraxasteryl acetate, stigmasterol, lupenone, lupeol and its acetate, the isomers **2** and **3**, caryophyllene epoxide **11**, the eremantholides **12** [2] and **13** [9] and the lupeol derivative **14**, which on reduction afforded the known diol **15** [10].

The chemotaxonomic situation of the genus *Lychnophora* is still diverse; one section can be characterized by the occurrence of caryophyllene derivatives, while a second part contains sesquiterpene lactones which are also present in the genus *Eremanthus* and related genera.

EXPERIMENTAL

The air-dried plant material was extracted with Et_2O–petrol (1:2). The extracts obtained were separated first by repeated TLC (Si gel). Known compounds were identified by comparing the IR and ^1H NMR spectra with those of authentic material.

Lychnophora salicifolia (voucher RMK 8344). The roots (330 g) afforded in addition to compounds previously reported 10 mg β-amyrin acetate, 10 mg taraxasteryl acetate and 10 mg **3**, while the aerial parts (1.1 kg) gave in addition 300 mg lupeyl acetate, 100 mg β-amyrin and 10 mg β-amyrin acetate as well as 200 mg **1** (Et_2O–petrol, 1:1).

Lychnophora passerina (voucher RMK 8335). The roots (100 g) afforded 5 mg taraxasterol, 60 mg taraxasteryl acetate, 2 mg β-amyrin, 20 mg β-amyrin acetate, 10 mg lupeol, 40 mg lupeyl acetate, 5 mg stigmasterol, 5 mg **4**, 60 mg **5**, 10 mg **6** (Et_2O–petrol, 1:3, after addition of CH_2N_2 to the mixture of **5** and **6**), 5 mg **7**, 5 mg **8** and 5 mg **9**, while the aerial parts (650 g) gave 75 mg taraxasteryl acetate, 30 mg β-amyrin, 30 mg β-amyrin acetate, 100 mg stigmasterol, 800 mg lupeol, 170 mg lupeyl acetate, 50 mg α-humulene, 100 mg **2**, 20 mg **3**, 350 mg **5**, 10 mg **7**, 5 mg **8** and 5 mg **10**.

Lychnophora uniflora (voucher RMK 8340). The aerial parts (340 g) afforded 20 mg β-amyrin, 2 mg β-amyrin acetate, 10 mg taraxasteryl acetate, 15 mg stigmasterol, 10 mg lupenone, 550 mg lupeol, 170 mg lupeyl acetate, 20 mg **2**, 5 mg **3**, 2 mg caryophyllene epoxide, 20 mg **11**, 20 mg **12**, 10 mg **13** and 20 mg **14** (Et_2O–petrol, 1:1), while the roots gave 30 mg taraxasteryl acetate, 10 mg lupenone, 10 mg lupeol, 120 mg lupeyl acetate, 5 mg **5** and 10 mg **11**.

15-Hydroxy-5β,6α-epoxy-5,6-dihydrocaryophyllene (**1**). Colourless oil, IR $\nu_{max}^{CCl_4}$ cm^{-1}: 3610 (OH), 1635 (C=C); MS *m/z* (rel. int.): 236 (M^+, 2), 218.167 ($M - H_2O$, 6) ($C_{15}H_{22}O$), 203 (218 − Me, 4), 57 ($C_4H_9^+$, 100). $[\alpha]_D = -31.7$ ($c = 0.3$, $CHCl_3$).

11β,13-Dihydroeremantholide (**6**). Colourless oil, IR $\nu_{max}^{CCl_4}$ cm^{-1}: 1782 (γ-lactone), 903 ($C{=}CH_2$); MS *m/z* (rel. int.): 232.146 (M^+, 25) ($C_{15}H_{20}O_2$), 217 (M − Me, 5), 214 ($M - H_2O$, 5), 152 ($M - C_6H_8$, 100).

$[\alpha]_{24°}^{\lambda}$ =	589	578	546	436	365 nm
	−26.3	−26.3	−29.7	−53.4	−84.6

($c = 0.35$, $CHCl_3$).

Compound **5** (10 mg) in 1 ml MeOH after addition of 20 mg $NaBH_4$ afforded 7 mg **6**, identical with the natural compound.

30-Oxo-lupeol (**14**). Colourless gum, IR $\nu_{max}^{CCl_4}$ cm^{-1}: 3640 (OH), 1700 (C=CCHO); MS *m/z* (rel. int.): 440.365 (M^+, 11) ($C_{30}H_{48}O_2$), 422 ($M - H_2O$, 8), 407 (422 − Me, 6), 57 (C_4H_9, 100); ^1H NMR ($CDCl_3$): δ 9.52 (*brs*, H-30), 6.28 (*brs*, H-29), 5.90 (*brs*, H-29′), 3.19 (*dd*, H-3, $J = 10$, 5.5 Hz), 1.02, 0.97, 0.93, 0.86, 0.82, 0.76 (*s*, Me). To 8 mg **14** in 1 ml MeOH 10 mg $NaBH_4$ were added. TLC afforded 6 mg **15**, identical with authentic material.

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