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SECO-EREMOPHILANOLIDES FROM *SENECIO MACROTIS*[*]

FERDINAND BOHLMANN,† RAJINDER K. GUPTA,† JASMIN JAKUPOVIC,†
ROBERT M. KING‡ and HAROLD ROBINSON‡

†Institute for Organic Chemistry, Technical University of Berlin, Strasse des 17. Juni 135, D-1000 Berlin 12, West Germany;
‡Smithsonian Institution, Washington, DC 20560, U.S.A.

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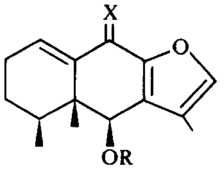
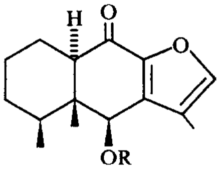
Key Word Index—*Senecio macrotis*; Compositae; furanoeremophilanes; *seco*-eremophilanolides.

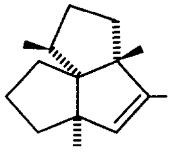
In continuation of our investigations of representatives of the tribe Senecioneae we have studied the constituents of *Senecio macrotis* Baker, collected in north-eastern Brazil. The roots afforded the furanoeremophilanes **3**–**5** [1, 2], **6** [3], **7** [4] and **8** [3], isocomene (**9**) [5] and a complex mixture of lactones which could be separated by HPLC only after acetylation. The ^{1}H NMR data of the three pairs of lactones indicated that all the compounds were aldehydes, which differed in the ester residues: two were angelates, two tiglates and two *iso*-valerates. The ^{1}H NMR data of the pairs differed in the chemical shifts of an olefinic methyl signal and of that of the acetate methyl signal. A triplet at δ 6.96 present in the spectra of all compounds indicated an olefinic proton in a β-position to the aldehyde group, while a second down-field shifted, broadened singlet around δ 6.7 must be assigned to the hydrogen at the acetate bearing carbon, as this signal was at much higher field as in the spectrum of the natural compounds. It was coupled with the protons of the olefinic methyl. A third down-field signal could be



	1	2	3	4	5
R	Ang	Sen	Ang	Tigl	*i* Val
X	H_2	H_2	O	O	O



6 R = Ang
7 R = Tigl
8 R = *i* Val



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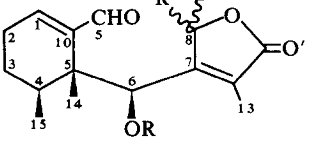

	10	11	12	13	14	15	16	17	18	19	20	21
R	Ang	Ang	Tigl	Tigl	*i* Val	*i* Val	Ang	Ang	Tigl	Tigl	*i* Val	*i* Val
R'	OH	H	OH	H	OH	H	OAc	H	OAc	H	OAc	H
R''	H	OH	H	OH	H	OH	H	OAc	H	OAc	H	OAc

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[*] Part 315 in the series "Naturally Occurring Terpene Derivatives". For Part 314 see Bohlmann, F., Zdero, C., Robinson, H. and King, R. M. (1981) *Phytochemistry* **20**, 731.

Table 1. ^{1}H NMR spectral data of compounds **16**–**21** (270 MHz, $CDCl_3$, TMS as internal standard)

	16	**17**	**18**	**19**	**20**	**21**
1-H	6.96 *dd*		6.96 *dd*		6.96 *dd*	
2-H	2.42 *m*		2.42 *m*		2.42 *m*	
6-H	6.05 *br. s*	6.07 *br. s*	6.01 *br. s*	6.04 *br. s*	5.98 *br. s*	5.99 *br. s*
8-H	6.69 *br. s*	6.72 *br. s*	6.67 *br. s*	6.70 *br. s*	6.69 *br. s*	6.71 *br. s*
9-H	9.33 *s*	9.31 *s*	9.32 *s*	9.29 *s*	9.32 *s*	9.30 *s*
13-H	2.11 *br. s*	2.15 *br. s*	2.08 *br. s*	2.12 *br. s*	2.10 *br. s*	2.14 *br. s*
14-H	1.33 *s*		1.33 *s*		1.28 *s*	
15-H	0.88 *d*		0.86 *d*	0.87 *d*	0.86 *d*	
OCOR	6.12 *qq*		6.90 *br. q*	6.90 *br. q*	2.18 *m*	
	2.00 *dq*		1.81 *br. d*		2.10 *m*	
	1.92 *dq*		1.82 *br. s*		0.93 *d*	0.93 *d*
					0.92 *d*	0.92 *d*
OAc	2.20 *s*	2.17 *s*	2.19 *s*	2.16 *s*	2.14 *s*	2.16 *s*

J (Hz): 1, 2 = 3.5; 4, 15 = 7; *O*-Ang: 3′, 4′ = 7; 3′, 5′ = 4′, 5′ = 1.5; *O*-Tigl: 3′, 4′ = 7; *O*-*i*-Val: 3′, 4′ = 3′, 5′ = 7.

assigned only to the proton at the carbon with the different ester groups. Comparing the ^{1}H NMR data with those of known eremophilanolides [6, 7] led to the structures **16**–**21** for the acetates and consequently the natural products were **10**–**15**. The stereochemistry at C-8 (normal numbering of eremophilanes), however, could not be determined, while that at C-6 was assigned by analogy only, as all eremophilanes had this configuration. We have named the compound without an ester group at C-6 secomacrotolide and the epimer 8-epi-secomacrotolide. Compounds **10**–**15** obviously were formed by oxidative degradation of precursors such as compound **1**. The aerial parts also afforded compounds **6**–**8** as well as **1** [8], **2** [8] and germacrene D.

EXPERIMENTAL

The air-dried plant material (voucher RMK 8394) was extracted with Et_2O–petrol (1:2) and the resulting extracts were separated first by CC (Si gel) and further by repeated TLC (Si gel). The roots (100 g) afforded 5 mg **3**, 5 mg **4**, 10 mg **5**, 5 mg **6**, 5 mg **7**, 10 mg **8**, 5 mg **9** and *ca* 15 mg of a mixture of **10**–**15** (Et_2O–petrol, 3:1), which could be only partially separated. Acetylation (Ac_2O, 70°, 1 hr) afforded the acetates **16**–**21**, which were separated by HPLC (MeOH–H_2O, 7:3, reversed-phase) yielding 3 mg **16**, 1 mg **17**, 2 mg **18**, 1 mg **19**, 1 mg **20** and 1 mg **21**. The aerial parts (800 g) yielded 100 mg germacrene D, 15 mg **1**, 15 mg **2**, 50 mg **6**, 50 mg **7** and 50 mg **8**.

6β-Angeloyloxy-secomacrolide acetate (**16**). Colourless gum, IR $\nu_{max}^{CCl_4}$ cm^{-1}: 2730, 1695, 1635 (C=CCHO), 1795 (γ-lactone), 1770, 1220 (OAc), 1730, 1655 (C=CCO_2R); MS *m/z* (rel. int.): 244.110 (M − AngOH, HOAc, 1) ($C_{15}H_{16}O_3$), 83 ($C_4H_7CO^+$, 100); CI (isobutane): 405 (M + 1, 1), 345 (405 − HOAc, 8), 305 (405 − AngOH, 100), 277 (305 − CO, 22), 245 (305 − HOAc, 10).

$$[\alpha]_{24^\circ}^{\lambda} = \frac{589 \quad 578 \quad 546 \quad 436\,\text{nm}}{+110.6 \quad +116.6 \quad +134.0 \quad +249.0} \; (c = 0.3).$$

8-epi-*6β-Angeloyloxy-secomacrotolide acetate* (**17**). Colourless gum, IR $\nu_{max}^{CCl_4}$ cm^{-1}: 2730, 1695, 1635 (C=CCHO), 1795 (γ-lactone), 1770, 1220 (OAc), 1725, 1655 (C=CCO_2R); MS identical with that of **16**.

6β-Tiglinoyloxy-secomacrotolide acetate (**18**). Colourless gum, IR $\nu_{max}^{CCl_4}$ cm^{-1}: 2720, 1700, 1640 (C=CCHO), 1790 (γ-lactone), 1770, 1220 (OAc), 1725, 1655 (C=CCO_2R); MS *m/z* (rel. int.): 304 (M − TiglOH, 0.3), 244.110 (304 − HOAc, 2) ($C_{15}H_{16}O_3$), 83 ($C_4H_7CO^+$, 100); CI (isobutane): 405 (M + 1), 345 (405 − HOAc, 22), 305 (405 − TiglOH, 100), 245 (305 − HOAc, 11).

$$[\alpha]_{24^\circ}^{\lambda} = \frac{589 \quad 578 \quad 546 \quad 436\,\text{nm}}{+130 \quad +131 \quad +160 \quad +312.5} \; (c = 0.2).$$

8-epi-*6β-Tiglinoyloxy-secomacrotolide acetate* (**19**). Colourless gum, IR $\nu_{max}^{CCl_4}$ cm^{-1}: 2730, 1700 (CHO), 1790 (γ-lactone), 1725 (C=CCO_2R); MS identical with that of **18**.

6β-Iso-*valeryloxy-secomacrotolide acetate* (**20**). Not completely pure, colourless gum, IR $\nu_{max}^{CCl_4}$ cm^{-1}: 2730, 1700, 1635 (C=CCHO), 1790 (γ-lactone), 1750 (CO_2R); MS *m/z* (rel. int.): 244.110 (M − *i*-ValOH, HOAc, 2) ($C_{15}H_{16}O_3$), 85 ($C_4H_9CO^+$, 100), 57 (85 − CO, 41); CI (*iso*-butane): 407 (M + 1, 0.5), 347 (407 − HOAc, 10), 305 (407 − *i*-ValOH, 100), 247 (307 − AcOH, 31).

$$[\alpha]_{24^\circ}^{\lambda} = \frac{589 \quad 578 \quad 546 \quad 436\,\text{nm}}{+46 \quad +52 \quad +62 \quad +118} \; (c = 0.1).$$

The 8-epimer **21** was a colourless gum which still contained **17**.

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A PETASOL DERIVATIVE FROM *HOEHNEPHYTUM IMBRICATUM**

Ferdinand Bohlmann,† Maniruddin Ahmed,† Harold Robinson‡ and Robert M. King‡

‡ Smithsonian Institution, Washington, DC 20560, U.S.A.

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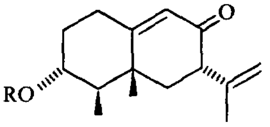
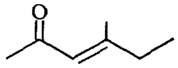
Key Word Index—*Hoehnephytum imbricatum*; Compositae; Senecioneae; eremophilane; petasol ester.

There have been no reports on the chemistry of the small Brazilian genus *Hoehnephytum*. We have now investigated *H. imbricatum* (Gardn.) Cabrera. The roots afforded lupenone, cycloartenone and the petasol esters **1** [1] and **2** [1]. The aerial parts contained a mixture of the olefins **4a**–**4c**, germacrene D, bicyclogermacrene, α-humulene, squalene, lupenone and a further petasol ester, the 3-ethyl crotonate **3**. The structure of **3** followed from the ^{1}H NMR data (Table 1), especially if compared with those of the corresponding angelate. Its structure was established unambiguously by X-ray analysis [1]. Therefore the isopropenyl group in **1**–**3** has the α-configuration. Consequently in the corresponding petasol esters previously reported [2, 3] the stereochemistry at C-7 has to be changed. The compounds isolated from the *Hoehnephytum* species indicate that this genus is not very closely related to the South American *Senecio* species, but certainly is a typical member of the tribe Senecioneae.



1 R = Ang
2 R = Sen

3 R =



$Me(CH_2)_nCH=CH_2$

4a $n = 8$
4b $n = 9$
4c $n = 10$

Table 1. ^{1}H NMR spectral data of compound **3**

1α-H	2.35 *ddd*	12-H	4.99 *dq*
1β-H	2.53 *dddd*	12′-H	4.83 *br. s*
2α-H	1.49 *m*	13-H	1.75 *br. s*
2β-H	1.62 *m*	14-H	1.25 *s*
3β-H	4.92 *ddd*	15-H	0.97 *d*
4α-H	1.69 *m*	OCOR	5.66 *dq*
6α-H	1.90 *dd*		2.19 *br. q*
6β-H	2.04 *dd*		1.09 *t*
7β-H	3.12 *dd*		2.18 *d*
9-H	5.79 *d*		

J (Hz): 1α, 1β = 14; 1α, 2α = 4; 1α, 2β = 2; 1β, 2α = 14; 1β, 2β = 4; 1β, 9 = 1.5; 2α, 2β = 14; 2α, 3β = 3β, 4α = 11; 2β, 3β = 4; 4, 15 = 6.5; 6α, 6β = 13; 6α, 7β = 14; 7β, 12 = 1; 2′, 4′ = 2′, 6′ = 1; 4′, 5 = 7.5.

EXPERIMENTAL

The air-dried plant material (voucher RMK 8390) was extracted with Et_2O–petrol (1:2). The extracts obtained were first separated by CC on Si gel and further by repeated TLC (Si gel). The hydrocarbons were identified by their ^{1}H NMR spectra and by GC/MS and the other known compounds by comparing their IR and ^{1}H NMR spectra with those of authentic material. The roots (160 g) afforded 20 mg lupenone, 12 mg cycloartenone,

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*Part 317 in the series "Naturally Occurring Terpene Derivatives". For Part 316 see Bohlmann, F., Jakupovic, J., Dhar, A. K., Robinson, H. and King, R. M. (1981) *Phytochemistry* **20**, 843.