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FURTHER GUAIANOLIDES FROM *HYMENOPAPPUS* SPECIES

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Key Word Index—*Hymenopappus scabiosaeus*, *H. tenuifolius*; Compositae; sesquiterpene lactones; germacranolides; guaianolides.

Abstract—The aerial parts of *Hymenopappus scabiosaeus* afforded three known germacranolides, and a known and three new guaianolides. The structures were elucidated by high field ^{1}H NMR spectroscopy. The chemotaxonomic relevance of the lactones is discussed briefly.

INTRODUCTION

The genus *Hymenopappus* with 10 species distributed over Western U.S.A. and Mexico can be placed in a group of helenioid genera centering about the subtribe Bahiinae [1]. However, the genus has also been placed in the tribe Anthemideae [2]. The chemistry of one species clearly indicated that the latter possibility can be excluded [3]. As there is still a problem of relationship among the helenioid group we have studied two further species of this genus. The results of this study are discussed in this paper.

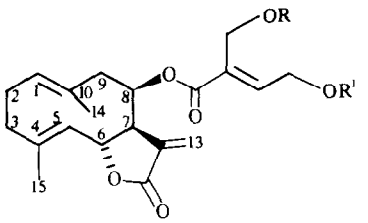
RESULTS AND DISCUSSION

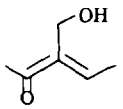
The aerial parts of *H. scabiosaeus* L'Her. var. *scabiosaeus* afforded the germacranolides **1** [4, 5], **3** [6], **4** [7] and the guaianolides **5** [8] and **6–8**. Furthermore the thymol derivatives **10** and **11** and some widespread constituents were present. The structure of **1** followed from its ^{1}H NMR spectrum and from that of its acetate **2** [5]. The ^{1}H NMR spectra of **3**, **4** and **5** were identical with those of authentic material. The ^{1}H NMR spectrum of **7** was in part close to that of **5** (Table 1). However, a low field singlet at δ7.84 indicated the presence of a hydroperoxide and a new double doublet at δ5.78 was attributed to an olefinic proton. Spin decoupling indicated that a Δ^9-derivative was present. Accordingly, all data agreed with the structure of the hydroperoxide **7**, which is formed biogenetically by reaction of **5** with oxygen. The stereochemistry at C-1 followed from the chemical shift of H-5 which showed a pronounced downfield shift if compared with the shift of lactones like **8**.

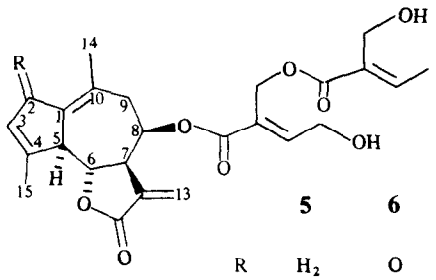
The ^{1}H NMR spectrum of **6** (Table 1) was close to that of guaianolides like dehydroleucodin [9]. The nature of the 8-acyloxy group followed from the characteristic NMR signals which were identical with those of **5**. The relative position of the hydroxy group in the ester group was established by NOEs between H-4′ and H-5′ as well as between H-4″ and H-5″.

The ^{1}H NMR spectrum of **8** and its acetate **9** (Table 1) were close to that of rupicolin B [10]. However, the presence of an ester group at C-8 caused a downfield shift of H-8. The nature of the unusual ester side chain was deduced from the ^{1}H NMR signals.

The aerial parts of *H. tenuifolius* Pursh. also afforded **10** and **11** as well as the guaianolide **5** as the main constituent. Obviously, all the sesquiterpenes are biogenetically closely related. Most likely the germacranolide **1** is the common precursor. Even the different ester groups are almost certainly derived from the 4-hydroxy-sarracinate



	1	**2**	**3**	**4**
R	H	Ac		
R′	H	Ac	H	H
				4*Z*, 3β OAc



	5	**6**	**7**
R	H_2	O	H_2
			Δ^9,1α OOH

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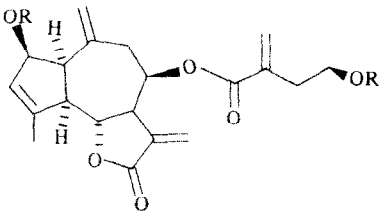
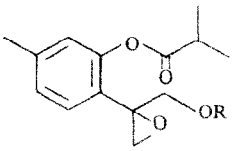


8 R = H **9** R = Ac



10 R = *i*Bu **11** R = MeBu

Table 1. ^{1}H NMR spectral data of compounds **6**–**9** (400 MHz, $CDCl_3$)

H	6	7	8*	9‡
2		2.66 *br d*	4.73 *br d*	4.89 *br d*
2′		2.55 br d		
3	6.25 *dq*	5.48 *br s*	5.74 *br s*	5.72 *br s*
5	3.55 *br d*	3.35 *br d*	2.67 *br dd*	2.74 *br dd*
6	4.13 *t*	4.48 *t*	4.65 *dd*	4.63 *dd*
7	3.17 *dddd*	3.29 *dddd*	3.20 *m*	3.22 *dddd*
8	5.78 *br d*	5.98 *br d*	5.56 *ddd*	5.57 *ddd*
9	2.91 *dd*	5.78 *dq*	2.96 *dd*	2.80 *dd*
9′	2.77 *br d*		2.78 *dd*	2.58 *dd*
13	6.22 *d*	6.29 *d*	6.30 *d*	6.32 *d*
13′	5.72 *d*	5.58 *d*	5.55 *d*	5.55 *d*
14	2.37 *br s*	1.98 *br s*	5.12 *br s*	5.12 *br s*
14′			5.14 *br s*	5.05 *br s*
15	2.32 *br s*	1.94 *br s*	2.00 *br s*	2.02 *br s*
OCOR	6.97 *t*	7.00 *t*	6.13 *br s*	6.13 *br s*
	4.49 *br d*	4.48 *br d*	5.66 *br s*	5.63 *br s*
	4.97 *d*	4.95 *s*	2.52 *t*	2.52 *t*
	4.87 *d*	6.91 *q*	3.71 *t*	4.17 *t*
	6.85 *q*	1.93 *d*		
	1.92 *d*	4.31 *br s*		
	4.30 *br s*			

*H-1 3.20 m

‡H-1 3.40 *dd*.

J [Hz]: Compound **6**: 3, 15 = 5, 15 = 1; 5, 6 = 6, 7 = 10; 7, 8 = 7, 13 ~ 3; 8, 9 = 6; 9, 9′ = 15; compound **7**: 2, 2′ = 18; 5, 6 = 6, 7 = 10; 7, 8 = 7, 13 ~ 3; 8, 9 = 7; 9, 14 = 1; OCOR in compounds **6** and **7**: 3, 4 = 7; 3′, 4′ = 6; compounds **8** and **9**: 1, 2 = 6; 1, 5 = 9; 5, 6 = 11; 6, 7 = 9; 7, 8 = 3; 7, 13 = 3.5; 7, 13′ = 3; 8, 9 = 8, 9′ = 7; 9, 9′ = 13; OCOR: 4, 5 = 6.

residue present in **1**. In the case of **8** an allylic rearrangement accompanied with reduction can be proposed.

The chemistry, especially that of the sesquiterpene lactones, of these two *Hymenopappus* species again show close relationships to *Schkuhria*, *Villanova* and *Picradeniopsis* as discussed previously [3] while again no similarity to the chemistry of the genus *Loxothysanus* could be visualized [11].

EXPERIMENTAL

The air-dried, aerial parts were extracted and worked-up as reported previously [12]. The extract of *H. scabiosaeus* (280 g, collected in Oklahoma and the voucher (LW 616) deposited in the Bebb Herbarium of the University of Oklahoma) afforded by CC (silica gel) three fractions (1: Et_2O–petrol, 1:9, 2: Et_2O–petrol, 1:3 and 3: Et_2O and Et_2O–MeOH, 19:1). TLC (Et_2O–petrol, 1:9) of fraction 1 gave 20 mg germacrene D, 40 mg taraxasterol, 20 mg of its acetate, 25 mg stigmasterol and 15 mg sitosterol. TLC of fraction 2 (Et_2O–petrol, 1:5) gave 100 mg **10** and 70 mg **11**. HPLC of fraction 3 (RP 8, *ca* 100 bar, MeOH–H_2O, 7:3) gave four fractions (3/1–3/4). TLC of 3/1 (MeOH–$CHCl_3$, 1:9) gave 1.5 mg **6** (R_f 0.5) and 7 mg **3**. TLC of 3/2 (same solvent, two developments) afforded 3 mg **8** (R_f 0.3), 50 mg **5** (R_f 0.4) and 6 mg **4** (R_f 0.2). Repeated HPLC of 3/3 (MeOH–H_2O, 7:3) gave 1 mg **7**. TLC of 3/4 (MeOH–$CHCl_3$, 1:9) gave 100 mg **1** which was converted (Ac_2O, 1 hr, 70°) to the acetate **2**. The extract from 70 g of air-dried aerial parts of *H. tenuifolius* (voucher LW 615) afforded by CC and TLC 200 mg **5**, 50 mg **11**, 70 mg **12**, 30 mg

lupeol and 47 mg of its acetate. Known compounds were identified by comparing the 400 MHz ^{1}H NMR spectra with those of authentic material.

8β-[4-Hydroxy-5-O-sarracinoyl-sarracinoyloxy]-dehydroleucodin (**6**). Colourless gum; IR $\nu_{max}^{CCl_4}$, cm^{-1}: 3600 (OH), 1770 (γ-lactone), 1715 (C=CCO$_2$R); MS *m/z* (rel. int.): 472.173 [M]$^+$ (4) (calc. for $C_{25}H_{28}O_9$: 472.173), 454 [M − H$_2$O]$^+$ (2), 356 [454 − $C_5H_6O_2$]$^+$ (7), 243 [M − OCOR]$^+$ (26), 115 [(HO)$_2$C$_4$H$_5$CO]$^+$ (28), 98 [$C_5H_6O_2$]$^+$ (63), 97 [115 − H$_2$O]$^+$ (61), 69 [97 − CO]$^+$ (100); $[\alpha]_D$ − 35 ($CHCl_3$; *c* 0.23).

1α-Hydroperoxyligustrin-8-O-[4-hydroxy-5-O-sarracinoyl]-sarracinate (**7**). Colourless gum; IR $\nu_{max}^{CCl_4}$ cm^{-1}: 3620 (OH), 1770 (γ-lactone); MS *m/z* (rel. int.): 340 [M − H$_2$O, RCO$_2$H]$^+$ (1), 244 (4), 226 (4), 98 [$C_5H_6O_2$]$^+$ (100), 97 [RCO − H$_2$O]$^+$ (42), 69 [97 − CO]$^+$ (98).

3β-Hydroxyligustrin-8-O-[2-(2-hydroxyethyl)-acrylate] (**8**). Colourless gum; IR $\nu_{max}^{CCl_4}$ cm^{-1}: 3600 (OH), 1765 (γ-lactone), 1710 (C=CCO$_2$R); MS *m/z* (rel. int.): 360.157 [M]$^+$ (2) (calc. for $C_{20}H_{24}O_6$: 360.157), 244 [M − RCO$_2$H]$^+$ (22), 226 [244 − H$_2$O]$^+$ (30), 98 (100); $[\alpha]_D^{24°}$ − 22 ($CHCl_3$; *c* 0.18). Acetylation (1 hr, Ac$_2$O, 75°) afforded **9**; colourless gum; MS *m/z* (rel. int.): 444.178 [M]$^+$ (2) (calc. for $C_{24}H_{28}O_8$: 444.178), 384 [M − HOAc]$^+$ (16), 226 [384 − RCO$_2$H]$^+$ (100).

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