1,8E-*Hexadecadien*-10,12,14-*triin*-7-*ol* **4**. Colourless oil eluted with *n*-hexane–AcOEt 8:2. IR ν_{max} cm^{-1}: 3500, 3440, 3080, 2935, 2860, 2220, 2180, 1640, 1590, 1380, 1070, 995, 915. UV λ_{max} nm (ε): 330 (4800), 308 (6200), 290 (5100), 273 (4000), 258 (4100), 242 (17900), 232 (17200). ^{1}H NMR δ ppm (*J* Hz): 1.4 (6H, *m*, H-4, 5 and 6), 1.98 (3H, *s*, H-16), 2.01 (2H, *m*, H-3), 4.18 (1H, *dt*, *J* = 5.5, H-7), 4.97 (2H, *m*, H-1), 5.78 (1H, *m*, H-2), 5.82 (1H, *d*, *J* = 15.8, H-9) and 6.35 (1H, *dd*, J_1 = 15.8, J_2 = 5.5, H-8). ^{13}C NMR: see Table 1.

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SEQUITERPENES FROM *AGERATINA TOMENTELLA*

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Key Word Index—*Ageratina tomentella*; Compositae; Eupatorieae; sesquiterpene lactones; heliangolides; guaianolides; elemanoic acid.

Abstract—An investigation of *Ageratina tomentella* yielded, besides the two known sesquiterpene lactones hiyodorilactone C acetate and 5″-desoxy-3-*epi*-4″-hydroxyprovincialin, two new sesquiterpenes, 11,13-dehydro-8β-tigloyloxy-eleman-12-oic acid and 8-*epi*-8-[5′-(4″-hydroxytigloyloxy)-tigloyloxy]-rupicolin A. The structures of the new compounds were elucidated by spectroscopic methods.

INTRODUCTION

As a part of our chemosystematic survey of the tribe Eupatorieae [1–7], we investigated the sesquiterpenes of *Ageratina tomentella* (Schrad.) R. M. King & H. Robinson. The results are discussed in this paper.

RESULTS AND DISCUSSION

The dichloromethane extract of leaves of *A. tomentella* afforded the known heliangolide hiyodorilactone C acetate (**1**) [8, 9] as the major constituent. The structure of **1** was easily deduced from its ^{1}H NMR spectrum. We also include previously unreported ^{13}C NMR data for **1** in Table 1. Most of the signals of the second compound (**2**) were nearly identical with those of **1**. One difference between the two compounds appeared to be in the nature of their side chains at C-8. In place of a simple acetate ester at C-8, compound **2** contained a complex C_{10} diester at C-8. Also, the configuration of the acetate function at C-3 differed in **2** from that of **1**. ^{13}C and ^{1}H NMR data showed that **2** is the known compound 5″-desoxy-3-*epi*-4″-hydroxyprovincialin which was previously isolated from *Piptothrix pubens* [10] and from *P. areolare* [11].

The ^{1}H NMR spectrum of the new compound **3**, $C_{25}H_{30}O_9$, showed signals characteristic for the C_{10} diester 5′-[4″-hydroxytigloyloxy]-tiglate group is a triplet at δ7.07 (H-3′), a doublet of triplets at 6.64 (H-3″), an AB pair at δ4.90 and 4.85 (H-5′a and 5′b), a broadened two proton doublet at 4.30 (H-4″a and 4″b) and another doublet of doublets at 4.46 (H-4′a and H-4′b). Inspection of the other signals in the ^{1}H NMR spectrum, together with the ^{13}C NMR and IR data, indicated that **3** was obviously an α,β-unsaturated lactone (IR band at 1760, 1650 cm^{-1}, ^{13}C NMR: δ124.0 (C-13) and 169.5 (C-12); ^{1}H NMR; δ6.29 (1H, *d*, *J* = 3.6 Hz, H-13a) and 5.62 (1H, *d*, *J* = 3.2 Hz, H-13b). Moreover, the ^{1}H NMR spectrum of **3**, in conjunction with systematic spin decoupling, suggested that **3** was a derivative of rupicolin A (Table 2) [12]. Comparison of the ^{1}H NMR spectrum of **3** (Table 2) with those of two other derivatives of rupicolin A, 8-*epi*-8-isobutyrylrupicolin A (**4**) [13] and 8-*epi*-8-tiglylrupicolin A (**5**) [14], showed significant differences among **3**, **4** and **5**, only for the signals due to the side chains at C-8. All other spectral data (see Experimental) supported the assignment of **3** as the new compound, 8-*epi*-8-[5′-(4″-hydroxy-tigloyloxy)-tigloyloxy]-rupicolin A.

The CIMS of **6** exhibited a $[M+1]^+$ at *m/z* 333 (6%), suggesting a molecular formula of $C_{20}H_{28}O_4$. The base peak at *m/z* 233 (232 + 1) ($C_{15}H_{20}O_2$) was formed by loss of the side chain ester + H. This was identified as a tiglate

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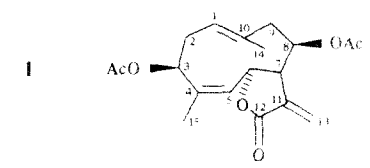

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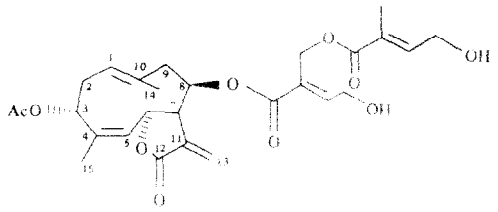

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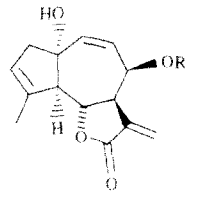

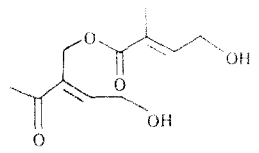

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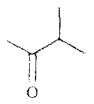

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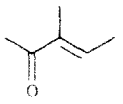

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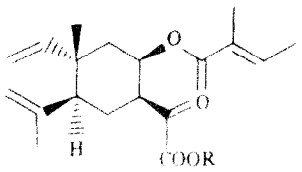

6 R = H
7 R = Me

group on the basis of the characteristic ^{1}H NMR signals [a one-proton broad quartet at δ6.79 (H-3′), a three-proton vinyl methyl broad doublet at 1.78 (H-4′) and a three-proton vinyl methyl broad singlet at 1.80 (H-5′)]. The ^{1}H NMR signals of the skeleton of compound **6** were clearly interpretable in terms of an elemane-type sesquiterpene: a doublet of doublets at δ5.79 (H-1), a doublet at 4.92 (H-2a), a doublet at 4.90 (H-2b), a broad singlet at 4.88 (H-3a), a broad singlet at 4.69 (H-3b), a three-proton singlet at 1.11 (H-14), and a broad singlet at 1.76 (H-15). A broad singlet at δ5.35 supported the presence of the side chain at C-8. All spectral findings (^{13}C NMR, ^{1}H NMR, EIMS, CIMS and IR) established **6** to be 11,13-dehydro-8β-tigloyloxy-eleman-12-oic acid. The final confirmation of the structure and configuration of **6** was provided by comparison of the ^{1}H NMR spectra of **6** and known compound 7 [15] (Table 2).

Table 1. ^{13}C NMR spectral data of compounds **1**, **3** and **6** (90.8 MHz, $CDCl_3$)

C	1	3	6*
1	125.0	83.3	136.8‡
2	29.4	47.0[a]	112.7†
3	78.0	119.2	110.8†
4	137.4	141.7	140.7†
5	126.6	47.6[a]	42.0‡
6	75.3	65.5[b]	27.4†
7	48.4	66.9[b]	52.8‡
8	75.3	76.8	70.0‡
9	43.4	123.0	39.5†
10	136.0	144.5	42.6†
11	135.2	134.2	146.7†
12	169.5	169.7	171.2†
13	124.0	122.6	127.2†
14	19.4	24.3	14.2‡
15	23.0	17.5	24.7‡
1′	169.5	165.2	167.3†
2′	21.0	126.6	128.8†
3′		148.2	149.6†
4′		59.4	19.1‡
5′		58.0	12.1‡
1″	169.1	167.3	
2″	20.7	127.3	
3″		141.7	
4″		59.0	
5″		12.2	

[a,b] Assignments interchangeable.
*In attached proton test experiment.
†Carbons are quarternary or methylene carbons.
‡Carbons are methyl or methine carbons.

EXPERIMENTAL

Plant material. Leaves, flower and heads of *Ageratina tomentella* (1.6 kg dry wt) were collected on 6 October 1984, in the state of Oaxaca, Mexico, 6.9 miles south of the border with Puebla along highway 190 from Huajuapan to Izucar, from a limestone hillside where it occurred with *Acacia*. A voucher specimen (Sundberg and Lavin no. 3035) is deposited in the Plant Resources Center at the University of Texas at Austin.

Extraction and isolation. Ground, dried plant material was extracted with CH_2Cl_2. The extract was concd to a syrup (126.8 g), then taken up in MeOH–Me_2CO (3:2) and kept in a refrigerator overnight. After filtering to remove the ppt., the resulting soln was then evapd to yield a brown syrup. The syrup was loaded onto a silica gel column, which was eluted with a hexane–EtOAc gradient solvent system. Fractions were further purified by CC over Sephadex LH-20 eluted by hexane–CH_2Cl_2–MeOH (7:4:1) and prep. TLC (silica gel) developed with hexane–EtOAc (4:1, 7:3 or 3:2).

8-epi-8-[5-(4-*Hydroxytigloyloxy*)-*tigloyloxy*]-*rupicolin A* (**3**). IR ν_{max}^{KBr} cm^{-1}: 3420 (OH, broad), 1760 (γ-lactone), 1700 (unsaturated ester), 1650 (double bonds), 1140 (tertiary alcohol); EIMS (probe) *m/z* (rel. int.): 244 (19) [M − (side chain + H)]$^+$,

Table 2. 1HNMR spectral data of compounds 3 and **6** (360 MHz, CDCI3)

H	3	6
1		5.79 *dd* (*J* = 10,8, 17.2)
2a	2.65 m (2H)	4.92 d (J = 10.8
2b		4.90 d (J = 17.2)
3a	5.51-5.57 m	4.88 *br s*
3b		4.69 *br s*
5	2.79 *brd* (d = 11)	2.18 m
6a	4.42 *dd* (J = 11, 9)	2.10m
6b		**1.44 m**
7	3.45 *dddd* {J = 9,3.6,3.2, 2.8)	2.91 *br* d (J = 8.9)
8	5.97 *dd* (J = 6.4, 2.8)	5.35 *br s*
9a, b	5.57 *dd* (1H, J = 6.4, 1.5)	1.77 m
13a	6.29 d (J = 3.6)	6.39 *br s*
13b	5.62 d (J = 3.2)	5.69 *br s*
14	1.97 *br s* (3H)	1.11 **s (3H)**
15	1.97 br s (3H)	1.76 *br s* (3H)
3'	7.07 t (a = 5.8)	6.79 br q (J = 6.3)
4'a, b	4.46 *dd* (J = 5.8, 15)	1.78 *br d* (3H, J = 6.3)
5'a	4.90 d (J = 13)	1.80br s (3H)
5'b	4.85 d (J = 13)	
3"	6.64 *dt* (J = 1.5, 6,0)	
4"a, b	4.30 *br* d (J = 6.0)	
5"	1.76 d (3H, d = 1.5)	

226 (33) [M-(side chain+H)-H20] +, 201 (11) [M-(side chain + H) - Me - CO] +, 198 (7) [M - (side chain + H) - H20 -CO] +.

ll,13-Dehydro-8-~-tigloyloxy-eleman-12-oic acid (6). IR $\tilde{\nu}_{max}^{CaCl_3}$ cm-1. 3300-2800, 2650, 1720 (CO2R), 1690 (C=CCO2H), 1640 (C=C), 1620 (C=C); CIMS (methane, 0.5 torr, probe) *m/z* (rel. int.): 333 (6) [M + 1] +, 233 (100) [M + 1-(side chain + H)] +, 83 (33) [C4H7CO, tiglate acylium ion] +.

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