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NEW ALICYCLIC DITERPENES AND ENT-LABDANES FROM GUTIERREZIA SOLBRIGII

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Abstract – The investigation of the aerial parts of Gutierrezia solbrigii afforded in addition to known compounds nine new ent-labdane derivatives, an aromatic ester and five alicyclic diterpenes. The structures were elucidated by highfield ^{1}H NMR spectroscopy.

Gutierrezia (Compositae, tribe Astereae) is a genus with about 20 species distributed over North and South America [1]. So far seven species have been studied chemically. In addition to acetylenes, diterpenes are widespread [2]. We now have studied a species from Argentina. The aerial parts afforded in addition to bisabol-2,10-dien-1-one [3], the corresponding 6-hydroxy derivative [4], spathulenol, dehydrofalcarinol, aesculetin, baccharisoxide (16) [5] and 8-oxo-β-cyperone (17) [6], nine new ent-labdane derivatives (1 - 9), five alicyclic diterpenes (10 - 14) and the aromatic ester 15. The unusual structure of the latter followed from the ^{1}H NMR (s. Experimental). The substitution pattern was deduced from the chemical shifts of the aromatic protons.

Compound 1 was transformed to the methylester 1a. The structure followed from the molecular formula ($C_{21}H_{34}O_4$) and the ^{1}H NMR data (Table I), which were close to those of similar labdanes [2]. The stereochemistry at C-3 followed from the couplings of H-3. The ^{1}H NMR spectrum of 2a (Table I) showed that this compound was the angelate of 1a. Accordingly, the H-3 signal was shifted downfield and the typical signals of an angelate were visible. The ^{1}H NMR spectrum of 3 (Table I) indicated that this diterpene had hydroxy groups at C-2, C-15 and C-16. The configuration at C-2 and C-3 followed from the couplings and the relative position of the angeloyloxy group could be deduced from the chemical shifts of H-2 and H-3. The ^{1}H NMR spectra of 5 and 7 (Table I) were close to those of 2 and 3. The presence of a butenolide followed from the typical signals at δ = 5.86 and 4.72 (2H). The spectrum of 4 showed that this lactone only differed from 7 by the absence of the 3-angeloyloxy group while the data of 6 (Table I) indicated the presence of the glucoside of 5. Acetylation gave the corresponding tetra-acetate, its ^{1}H NMR spectrum (Table I) clearly showed that a β-glucopyranoside tetra-acetate was present. The spectral data of 8 were close to those of 5 (Table I). Typical furan signals, however, showed that the butenolide was replaced by a β-substituted furan .

The position of the hydroxy group at C-18 in compounds 1 - 8 was established by NOE difference spectroscopy. Clear NOE's were obtained between H-19 and H-20 and in the case of 7 clear effects between H-19 and H-20 and H-2 as well as between H-18 and H-3 were observed. The latter effect established the position of an oxygen function at C-3 instead of C-1.

The ^{1}H NMR spectrum of 9 (Table I) differed more pronounced from those of 1 - 8. The data, however, were close to those of ent-labd-13-en-8,15-diol [7]. The presence of an additional 2-hydroxy group followed from the triplet of tripletsat δ = 3.91. The presence of ent-labdanes was proposed as other Gutierrezia species also contain these enantiomeres [2].

The structures of 10 - 14 followed from the spectral data of the methyl esters 10a - 14a. Spin decoupling allowed the assignment of all ^{1}H NMR signals (Table II). Starting with the typical narrowly splitted triplet of triplets at δ = 5.84 and 7.10 respectively (H-2) the signals of H-4, H-1 and H-20 respectively could be determined. The configurations of the double bonds followed from the chemical shifts of H-6, H-9, H-10, H-14, H-16, H-17 and H-19 which typically differ in E- and Z-isomers as has been established by NOE difference spectroscopy with 10a - 14a. Thus a clear NOE was observed between H-16 and H-14 as well as between H-17 and H-13. The position of the carbomethoxy group directly followed from the results of spin decoupling as the olefinic β-proton easily could be assigned from its chemical shift. Furthermore in the mass spectra of 10a - 14a the fragment m/z 165 ($C_{10}H_{13}O_2$), most likely was formed by splitting the 8,9-bond. In the spectra of 13a and 14a the changed position of the lactone carbonyl clearly followed from the chemical shift of H-2. Lactone 13 we have named 17-hydroxyisogutiesolbriolide.

10 - 14 belong to a new class of rapidly growing alicyclic diterpenes which seem to be fairly common in Compositae. Already now we have isolated more than 60 of these compounds. Acid 10 we have named 17-hydroxygutiesolbriolide. The acids 10 - 14 are closely related to centipedic acid, a diterpene where the butenolide part is replaced by a furan moiety and the 17-oxygen function is missing. This acid was reported from a Centipeda (=Grangea) and Plagiocheilus spe-

Table I. ^{1}H NMR spectral data of 1a - 2a, 3 - 9, 5a and 6a (400 MHz, $CDCl_3$, TMS as internal standard)

	1a+	2a+	3	4	5	5a	6a	6	7	8	9
H-2	o	o	3.97 ddd	3.95 dddd	o	o	o	o	4.05 ddd	o	3.92 dddd
H-3	3.69 dd	5.01 dd	4.83 d	1.67 m 2.10 m	5.01 dd	4.91 dd	4.87 dd	5.05 dd	4.83 d	4.99 dd	o
H-7	2.39 br d 2.09 m	2.40 br d 2.10 m	2.39 br d 2.09 ddd	2.42 br d 2.01 ddd	2.42 br d 2.08 ddd	2.43 br d 2.10 m	2.38 br d 2.07 m	2.41 br d 2.13 m	2.43 br d 2.09 ddd	2.41 br s 2.07 m	o
H-12	2.29 m	2.30 m	2.29 m 1.80 m	2.55 m 2.28 m	2.55 m 2.23 m	2.55 m 2.23 m	2.55 m 2.24 m	2.54 m 2.23 m	2.57 m 2.25 m	2.78 m 2.26 m	o
H-14	5.63 br s	5.65 br s	5.57 br t	5.85 tt	5.85 tt	5.86 tt	5.84 tt	5.86 tt	5.86 tt	6.26 br s	5.45 br t
H-15	-	-	-	-	-	-	-	-	-	7.35 t	4.16 br d
H-16	2.16 d	2.17 d	4.16 d 4.11 d	4.72 br s	4.72 t	4.72 t	4.71 t	4.73 t	4.72 t	7.19 br s	1.71 br s
H-17	4.86 br s 4.51 br s	4.87 br s 4.52 br s	4.88 br s 4.58 br s	4.92 br s 4.50 br s	4.90 br s 4.47 br s	4.92 br s 4.49 br s	4.87 br s 4.45 br s	4.91 br s 4.48 br s	4.94 br s 4.50 br s	4.89 br s 4.59 br s	1.14 s
H-18	3.70 d 3.43 d	3.33 br d 2.92 br d	3.29 d 2.90 d	3.43 d 3.14 d	3.35 d 2.93 d	3.83 d 3.73 d	3.48 d 3.22 d	3.51 d 3.32 d	3.32 d 2.91 d	3.35 d 2.92 d	0.94 s
H-19	0.72 s	0.96 s	0.69 s	0.80 s	0.69 s	0.78 s	0.83 s	0.76 s	0.71 s	0.68 s	0.85 s
H-20	0.86 s	0.76 s	0.80 s	0.78 s	0.78 s	0.87 s	0.88 s	0.78 s	0.83 s	0.76 s	0.84 s
OCOR	-	6.11 qq 1.99 dq 1.89 dq	6.16 qq 2.01 dq 1.91 dq	-	6.12 qq 1.99 dq 1.88 dq	6.05 qq 1.97 dq 1.87 dq 2.09 s	6.01 qq 1.95 dq 1.84 dq	6.11 qq 1.99 dq 1.88 dq	6.20 qq 2.03 dq 1.93 dq	6.11 qq 1.99 dq 1.88 dq	-

+) OCH_3 3.69; H-1' - H-6': 4.42 d, 5.03 t, 5.08 t, 5.16 t, 3.62 ddd, 4.14 dd, 4.04 dd, 2.05 s, 2.00 s, 1.99 s (6 H) (J [Hz]: 1',2' = 8; 2',3' = 3',4' = 4',5' ~ 10; $5',6_1'$ = 4; $5',6_2'$ = 2; $6_1',6_2'$ = 12); o) Obscured multiplets;

J [Hz]: $2\alpha,3$ = 12; $2\beta,3$ = 4; $6\alpha,7\alpha$ = $6\beta,7\alpha$ = 2; $6\beta,7\beta$ = 4; $6\beta,7\beta$ = 7,7' = 12; 14,15 = 7; 14,16 = 1.5; 16,16' = 11; 18,18' = 12; compounds 4 and 9: $1\alpha,2\alpha$ = $2\alpha,3\alpha$ = 4; $1\beta,2\alpha$ = $2\alpha,3\beta$ = 11; compounds 3 and 7: $1\alpha,2\alpha$ = 4; $1\beta,2\alpha$ = $2\alpha,3\beta$ = 11; compounds 5 - 7: 12,14 = 14,16 ~ 1; OAng: 3',4' = 7; 3',5' = 4',5' = 1.5.

Table II. ^{1}H NMR spectral data of 10a - 14a (400 MHz, $CDCl_3$, TMS as internal standard)

	10a	11a	12a	13a	14a
H-1	-	-	-	4.76 dt	4.77 dt
H-2	5.84 tt	5.84 tt	5.85 tt	7.10 tt	7.10 tt
H-4	2.47 br t	2.46 br t	2.46 br t	2.33 br t	2.33 br t
H-5	2.30 br dt	2.28 br dt	2.30 br dt	2.28 br dt	2.28 br dt
H-6	5.10 br t	5.12 br t	5.11 br t	5.13 br t	5.13 br t
H-8	2.08 br t	2.13 br t	2.09 br t	2.07 br t	2.07 br t
H-9	2.49 br dt	2.30 br dt	2.61 br dt	2.49 br dt	2.52 br dt
H-10	5.80 t	6.69 t	5.84 t	5.82 t	5.85 t
H-12	2.30 br t	2.34 br t	2.30 br t	2.28 br t	2.28 br t
H-13	2.16 br dt	2.15 br dt	2.23 br dt	2.16 br dt	2.17 br dt
H-14	5.24 br t	5.30 br t	5.37 br t	5.24 br t	5.37 br t
H-16	1.78 d	1.78 d	1.74 br s	1.78 d	1.74 d
H-17	4.05 s	4.06 s	4.55 s	4.06 s	4.55 s
H-19	1.62 br s	1.64 br s	1.63 br s	1.60 br s	1.60 br s
H-20	4.73 d	4.73 d	4.73 d	-	-
OMe	3.74 s	3.74 s	3.74 s	3.74 s	3.74 s
OAc	-	-	2.06 s	-	2.07 s

J [Hz]: 2,4 = 2,20 = 1; 4,5 = 5,6 = 8,9 = 9,10 = 12,13 = 13,14 ~ 7; (compounds 13a and 14a: 1,2 = 1,4 = 1.5).

cies [8,9]. Similar alicyclic diterpenes with a furan or butenolide ring have been isolated from Solidago species [10]. All these genera are placed in the tribe Astereae. The ent-labdane derivatives are closely related to those of Gutierrezia sarothrae [2] and in part to those of further species belonging to this genus [11,12], but baccharis oxide, first isolated from Baccharis species [5] also seems to be common.

EXPERIMENTAL

^{1}H NMR spectra were recorded on a Bruker WM 400 and IR spectra in $CHCl_3$ on a Beckman IR 4230. EIMS were obtained at 70 eV with a Varian MAT 711. TLC were performed on Sigel PF 254. Plant material was collected in Argentina, January 1985 (voucher RMK 9361, deposited in the US National Herbarium, Washington) and extracted with Et_2O/MeOH/petrol, 1 : 1 : 1. CC (Si gel) of the extract of the aerial parts (300 g) gave four fractions (1: petrol, 2: Et_2O/petrol, 1 : 1, 3: Et_2O and 4: Et_2O/MeOH, 9 : 1). TLC of fraction 1 gave 20 mg squalene and TLC of fraction 2 (Et_2O/petrol, 1 : 4) afforded 2 mg bisabol-2,10-dien-1-one, 2 mg of the corresponding 6-hydroxy derivative, 2 mg spathulenol, 2 mg dehydrofalcarinol and 2.5 mg 8 (R_f 0.54, Et_2O/petrol, 1 : 1). TLC of fraction 3 (Et_2O/C_6H_6/CH_2Cl_2, 1 : 1 : 1) gave 5 mg 6 (R_f 0.50, Et_2O/petrol, 1 : 1) and repeated TLC of fraction 4 (C_6H_6/

Et_2O/CH_2Cl_2/MeOH, 8 : 8 : 8 : 1) gave 1.5 mg 2 (R_f 0.62, Et_2O/MeOH, 19 : 1), 5 mg 7 (R_f 0.60, all same solvents), 1.5 mg 14 (R_f 0.58), 1.6 mg 12 (R_f 0.57), 1.5 mg 9 (R_f 0.55), 25 mg 3 (R_f 0.52), 1.5 mg 13 (R_f 0.51), 1.6 mg 11 (R_f 0.50), 1.5 mg 1 (R_f 0.42), 2 mg 4 (R_f 0.40) and 4 mg 6 (R_f 0.10). The roots (150 g) gave by CC and TLC 2 mg squalene, 3 mg baccharis oxide, 2 mg dehydrofalcarinol, 2.5 mg 16, 2 mg aesculetin, 2 mg 5, 1.5 mg 7 and 3 mg 15 (R_f 0.33, Et_2O/petrol, 1 : 9). Knwon compounds were identified by comparing the 400 MHz ^1H NMR spectra with those of authentic material.

3α,18-Dihydroxy-ent-labd-8(17),13E-dien-15-oic acid (1). Colourless gum which was transformed to the methyl ester by adding CH_2N_2 (5 min., 20°); IR λ_{max} cm^{-1}: 3600 (OH), 1715, 1650 (C=CCO_2R). EIMS m/z 350.246 M^+ (7) ($C_{21}H_{34}O_4$), 335 M - Me (9), 332 M - H_2O (4), 317 335 - H_2O (6), 301 332 - OMe (7), 55 (100).

3α-Angeloyloxy-18-hydroxy-ent-labd-8(17), 13E-dien-15-oic acid (2). Colourless gum which was transformed to 2a (CH_2N_2); IR λ_{max} cm^{-1}: 3600 (OH), 1720 (C=CCO_2R); EIMS m/z 432.288 M^+ (1.7) ($C_{26}H_{40}O_5$), 400 M - MeOH (0.5), 332 M - RCO_2H (7), 317 332 - Me (8), 302 332 - CH_2O (18), 301 332 - OMe (12), 287 302 - Me (16), 83 $C_4H_7CO^+$ (100), 55 83 - CO (97).

2β,15,16,18-Tetrahydroxy-3α-angeloyloxy-ent-labd-8(17),13Z-diene (3). colourless gum; IR λ_{max} cm^{-1}: 3600 (OH), 1710, 1650 (C=C CO_2R); EIMS m/z 418.272 M^+ (1) ($C_{25}H_{38}O_5$), 400 M - H_2O (1), 300 400 - RCO_2H (7), 269 300 - CH_2OH (10), 83 $C_4H_7CO^+$ (100), 55 83 - CO (71).

2β,18-Dihydroxy-ent-labd-8(17),13-dien-15,16-olide (4). Colourless gum; IR λ_{max} cm^{-1}: 3600 (OH), 1755 (lactone); EIMS m/z 334 M^+ (0.5), 316.204 M - H_2O (2) ($C_{20}H_{28}O_3$), 286 316 - CH_2O (18), 121 (100), 98 $C_5H_6O_2$ (90).

3α-Angeloyloxy-18-hydroxy-ent-labd-8(17), 13-dien-15,16-olide (5). Colourless gum, IR λ_{max} cm^{-1}: 3530 (OH), 1755 (lactone), 1705, 1650 (C=CCO_2R); EIMS m/z 416.256 M^+ (2) ($C_{25}H_{36}O_5$), 386 M - CH_2O (4), 316 M - RCO_2H (6.5), 286 316 - CH_2O (100), 271 286 - Me (36), 258 286 - CO (41), 83 $C_4H_7CO^+$ (68), 55 83 - CO (66). Acetylation (1 h, Ac_2O, 70°) gave the 18-O-acetate; EIMS m/z 458.266 M^+ (1.5) ($C_{27}H_{38}O_6$), 398 M - AcOH (1), 358 M - RCO_2H (11), 298 358 - AcOH (21), 201 298 - $C_5H_5O_2$ (22), 83 $C_4H_7CO^+$ (100).

3α-Angeloyloxy-18β-glucopyranosyloxy-ent-labd-8(17),13-dien-15,16-olide (6). Colourless gum which was acetylated by reaction with Ac_2O in $CHCl_3$ in the presence of 4-dimethylaminopyridine [13] affording by TLC a colourless gum; IR λ_{max} cm^{-1}: 1750, 1260 (OAc, lactone); EIMS m/z 746 M^+ (0.2), 686.330 M - AcOH (0.6) ($C_{37}H_{50}O_{12}$), 626

686 - AcOH (0.3), 584 626 - ketene (0.3), 5.24 5.84 - AcOH (0.3), 445 542 - $C_5H_5O_2$ (1.3), 399 M - glucoside residue (1.2), 331 $C_{14}H_{19}O_9$ (64), 271 331 - AcOH (8), 211 271 - AcOH (6), 169 211 - ketene (100), 109 169 - AcOH (31), 83 $C_4H_7CO^+$ (56).

3α-Angeloyloxy-2β,18-dihydroxy-ent-labd-8(17),13-dien-15,16-olide (7). Colourless gum; IR λ_{max} cm^{-1}: 3600 (OH), 1750 (lactone), 1700, 1640 (C=CCO$_2$R); EIMS m/z 432.251 M$^+$ (0.8) ($C_{25}H_{36}O_6$), 414 M - H_2O (0.7), 384 414 - CH_2O (0.9), 332 M - RCO_2H (1), 302 332 - CH_2O (58), 287 302 - Me (12), 284 302 - H_2O (10), 83 $C_4H_7CO^+$ (100).

3α-Angeloyloxy-4-epi-daniellol (8). Colourless gum; IR λ_{max} cm^{-1}: 3600 (OH), 1715, 1650 (C=CCO$_2$R); EIMS m/z 400.261 M$^+$ (29) ($C_{25}H_{36}O_4$), 300 M - RCO_2H (9), 270 300 - CH_2O (22), 83 $C_4H_7CO^+$ (82), 55 83 - CO (100).

2β,8β,15-Trihydroxy-ent-labd-13E-ene (9). Colourless gum; IR λ_{max} cm^{-1}: 3600 (OH); EIMS m/z 306.256 M - H_2O (4) ($C_{20}H_{34}O_2$), 288 306 - H_2O (7), 273 288 - Me (7), 243 273 - CH_2O (9), 190 $C_{14}H_{22}$ (79), 55 (100).

17-Hydroxygutiesolbriolide (10). Purified as its methyl ester 10a; colourless gum; IR λ_{max} cm^{-1}: 3600 (OH), 1750 (lactone), 1715 (C=CCO$_2$R); EIMS m/z 362.209 M$^+$ (1.2) ($C_{21}H_{30}O_5$), 344 M - H_2O (2), 312 344 - MeOH (28), 297 312 - Me (17), 165 $[C_{10}H_{13}O_2]^+$ (24), 98 $C_5H_6O_2$ (100). Acetylation (Ac_2O, 1 h, 70°) gave an acetate which was identical with 12a (^{1}H NMR, TLC).

10E-17-Hydroxygutiesolbriolide (11). Purified as its methylester 11a; colourless gum; IR λ_{max} cm^{-1}: 3600 (OH), 1750 (lactone), 1710 (C=CCO$_2$R); EIMS m/z 362.209 M$^+$ (0.7) ($C_{21}H_{30}O_5$), 344 M - H_2O (1.7), 312 344 - MeOH (22), 165 $[C_{10}H_{13}O_2]^+$ (16), 98 $C_5H_6O_2$ (100).

17-Acetoxygutiesolbriolide (12). Purified as its methyl ester 12a; colourless gum; IR λ_{max} cm^{-1}: 1750 (OAc, lactone), 1715 (C=CCO$_2$R); EIMS m/z 386 M - H_2O (4), 344.199 M - AcOH (6.5) ($C_{21}H_{28}O_4$), 312 344 - MeOH (56), 165 $[C_{10}H_{13}O_2]^+$ (70), 98 $C_5H_6O_2$ (58).

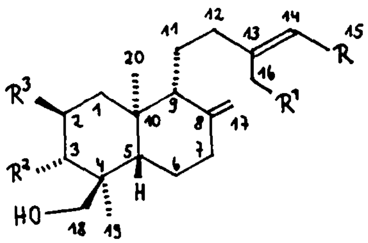
17-Hydroxyisogutiesolbriolide (13). Purified as its methyl ester 13a; colourless gum; IR λ_{max} cm^{-1}: 3600 (OH), 1760 (lactone), 1715 (C=CCO$_2$R); EIMS m/z 344.199 M - H_2O (2.3) ($C_{21}H_{28}O_4$), 312 344 - MeOH (27), 297 312 - Me (30), 119 (100), 165 $[C_{10}H_{13}O_2]^+$ (46), 98 $C_5H_6O_2$ (48).

17-Acetoxyisogutiesolbriolide (14). Purified as its methyl ester 14a; colourless gum; IR λ_{max} cm^{-1}: 1760 (lactone), 1740 (OAc), 1720 (C=CCO$_2$R); EIMS m/z 404.220 M$^+$ (0.3) ($C_{23}H_{32}O_6$), 344 M - AcOH (10), 312 344 - MeOH (48), 297 312 - Me (36), 165 $[C_{10}H_{13}O_2]^+$ (44), 119 (100).

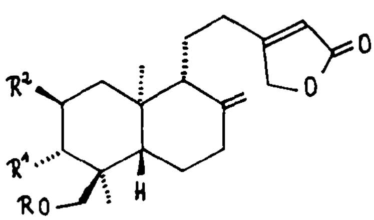
Methyl-3-(2-vinyl-4-methoxyphenyl)-propionate (15). Colourless oil; IR λ_{max} cm^{-1}: 1730 (CO_2R), 1600 (aromate); EIMS m/z 220.109 M^+ (42) ($C_{13}H_{16}O_3$), 205 M - Me (12), 147 M - CH_2CO_2Me (100); ^1H NMR ($CDCl_3$): 7.02 d (H-3), 6.77 dd (H-5), 7.08 d (H-6), 2.96 t (H-7), 2.54 t (H-8), 6.94 dd (H-10), 5.65 dd (H-11t), 5.33 dd (H-11c), 3.81 and 3.67 s (OMe) (J [Hz]: 3,5 = 2.5; 5,6 = 8.5; 7,8 = 8; 10,11t = 17; 10,11c = 11; 11t,11c = 1).

REFERENCES

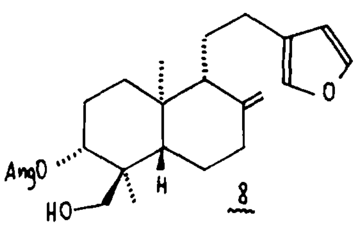
1. O. T. Solbrig (1966) Contrib. Gray Herb. 197, 3.
2. F. Bohlmann, C. Zdero, R.M. King and H. Robinson (1984) Phytochemistry 23, 2007 (in there further lit.).
3. F. Bohlmann, C. Zdero and S. Schöneweiß (1976) Chem. Ber. 109, 3366.
4. S. El-Dahmy, J. Jakupovic, F. Bohlmann and T.M. Sarg (1985) Tetrahedron 41, 309.
5. T. Anthonsen, T. Bruun, E. Hemmer, D. Holme, A. Lamvik, E. Sunde and N.A. Sörensen (1970) Acta Chem. Scand. 24, 2479.
6. F. Bohlmann and C. Zdero (1976) Phytochemistry 15, 1075.
7. C. Asselineau, S. Bory, M. Fetizon and P. Laslo (1961) Bull. Soc. Chim. Fr. 1429.
8. F. Bohlmann and P.K. Mahanta (1979) Phytochemistry 18, 1067.
9. F. Bohlmann, H. Robinson and R.M. King (1980) Phytochemistry 19, 2235.
10. F. Bohlmann, T. Chau-Thi, P. Singh and J. Jakupovic (1985) Planta Med. (in press).
11. F. Bohlmann, M. Grenz, A.K. Dhar and M. Goodman (1981) Phytochemistry 20, 105.
12. F. Bohlmann, C. Zdero, R.M. King and H. Robinson (1979) Phytochemistry 18, 1533.
13. G. Höfle, W. Steglich and H. Vorbrüggen (1978) Angew. Chem. 90, 602.



	1*	2	3
R	CO_2H	CO_2H	CH_2OH
R[1]	H	H	OH
R[2]	OH	OAng	OAng
R[3]	H	H	OH



	4	5+	6	7
R	H	H	Gluc	H
R[1]	H	OAng	OAng	OAng
R[2]	OH	H	H	OH



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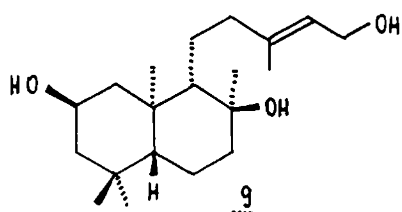
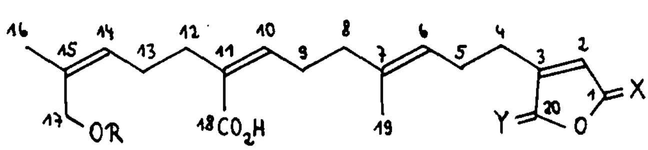
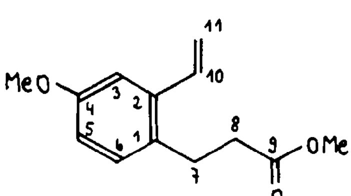


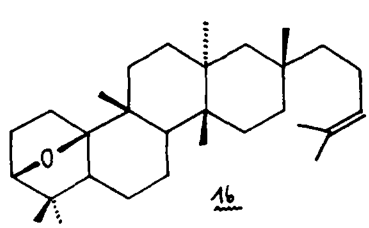
9



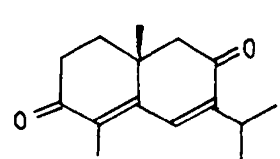
	10	11	12	13	14
X	=O	=O	=O	H_2	H_2
Y	H_2	H_2	H_2	=O	=O
R	H	H 10E	Ac	H	Ac



15



16



17

*) 1a, 2a, 10a - 14a are the corresponding methyl esters

+) 5a and 6a are the corresponding acetates