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CO-OCCURRENCE OF EREMOPHILANES AND EUDESMANES IN *ARTEMISIA PECTINATA*

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Key Word Index—*Artemisia pectinata*, Compositae, sesquiterpenes, eremophilanes, eudesmanes, spiroketal enolether polyine

Abstract—The aerial parts of *Artemisia pectinata* afforded, in addition to a typical spiroketal enol ether and the known eremophil-9,11(13)-dien-12-oic acid, the corresponding 8,12-lactone as well as two eudesmane derivatives, a hydroxy and an acetoxy acid The co-occurrence of eremophilanes and eudesmanes and the absence of the corresponding eudesman-8,12-olide with a *trans*-fused lactone ring is remarkable

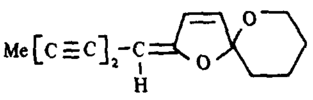
INTRODUCTION

The chemistry of the large genus *Artemisia* is not very uniform In addition to different types of acetylenic compounds [1], coumarins [2], lignans [3] and sesquiterpene lactones [4] are widespread Although eudesmanolides are very common in this genus, other types of sesquiterpene lactones have also been reported We have now studied a species from Mongolia, *Artemisia pectinata* Pall A species collected 300 km SW of Ulan-Bator afforded some sesquiterpenes, including eremophila-9(10),11(13)-dien-12-oic acid [5] Our results on material collected *ca* 600 km NW of Ulan-Bator are discussed in this paper

RESULTS AND DISCUSSION

The aerial parts of *A pectinata* afforded the typical spiroketal **1**, which is present in only some groups of the Anthemideae [1], and as the main constituent the eremophilane derivative **2**, which so far has been isolated only from *Athanasia* [6] and *Baeria* species [7] Furthermore, the corresponding lactone **3** and the eudesmane derivatives **4** and **5** were present

The structure of **3**, molecular formula $C_{15}H_{20}O_2$, followed from the ^1H NMR spectral data (Table 1). Spin decoupling allowed the assignment of all signals Inspection of a model further showed that the couplings observed required the proposed relative stereochemistry



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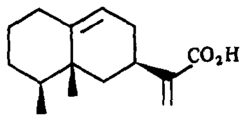

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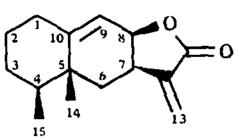

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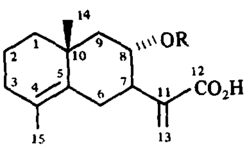

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5 R = Ac

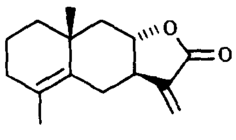

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Table 1 ^{1}H NMR spectral data of **3**–**6** (400 MHz, $CDCl_3$, TMS as internal standard)

	3*	**4**	Me ester of **4**	**5**	**6**
H-6	1 82 *dd*	2 59 *dd*	2 58 *dd*	2 73 *dd*	3 01 *dd*
H-6′	1 77 *dd*	1 99 *dd*	1 98 *dd*	1 89 *dd*	1 89 *dd*
H-7	3 18 *ddddd*	2 40 *ddd*	2 38 *ddd*	2 65 *ddd*	2 29 *ddddd*
H-8	4 87 *br dd*	3 94 *ddd*	3 96 *ddd*	5 30 *ddd*	4 12 *ddd*
H-9	5 46 *dd*	1 88 *m*	1 90 *m*	2 03 *m*	2 10 *m*
H-9′		1 55 *m*	1 55 *m*	1 57 *m*	1 50 *dd*
H-13	6 26 *d*	6 42 *s*	6 29 *s*	6 36 *s*	6 09 *d*
H-13′	5 60 *d*	5 77 *s*	5 70 *s*	5 73 *s*	5 44 *d*
H-14	0 95 *s*	1 02 *s*	1 09 *s*	1 15 *s*	1 09 *s*
H-15	0 87 *d*	1 58 *br s*	1 59 *br s*	1 62 *br s*	1 62 *br s*
OAc	—	—	—	1 96 *s*	—
OMe	—	—	3 77 *s*	—	—

*H-1 2 24 *ddddd*, H-1′ 2 04 *br d*

J (Hz) Compound **3** 1, 1′ = 1, 2′ = 13, 1, 2 = 5, 1, 8 = 1, 9 = 1, 4, 15 = 7, 6, 6′ = 14, 6, 7 = 7, 6′, 7 = 6, 7, 8 = 7, 7, 13 = 3, 7, 13′ = 2 7, 8, 9 = 4, compounds **4** and **5** 6, 6′ = 14, 6, 7 = 3 5, 6′, 7 = 12, 7, 8 = 12, 8, 9 = 11, 8, 9′ = 4, compound **6** 7, 13 = 3 1, 7, 13′ = 2 8

at C-7 and C-8 A corresponding lactone, epimeric at C-7 and C-8, has previously been reported from a *Frullania* species [8] Furthermore, a 6-hydroxy derivative of **3** has been prepared from alantolactone [9] The ^{1}H NMR spectrum is very similar to that of **3**

The ^{1}H NMR spectrum (Table 1) of the methyl ester of **4**, obtained by addition of diazomethane, displayed signals of an α-substituted acrylate which typically showed no allylic coupling A broadened singlet at δ1 59 and the absence of further olefinic signals required a tetrasubstituted double bond, while a second methyl signal at δ1 09 indicated the presence of a eudesmanolide Spin decoupling allowed the assignment of most signals and clearly showed that a hydroxyl group was at C-8 The configuration at this carbon followed from the couplings with H-7 and H-9 The structure was supported further by the ^{13}C NMR spectrum (see Experimental) Finally **4** was transformed to the lactone **6** via the tosylate Again the ^{1}H NMR spectral data clearly supported the structure and the stereochemistry (Table 1) The latter was established further by the positive Cotton effect, which, following the Geissman rule [10], is an indication that an 8,12-*trans*-eudesmanolide was present Thus **6**, which was also isolated as a natural compound, is the 8-epimer of a desoxy derivative of ivangustin [11] In addition to **6**, a 5-hydroperoxide of **6** ($\Delta^{4,15}$) was obtained, which, however, most likely was an artefact as the vinyl proton signals were not present in the starting material The structure followed from the ^{1}H NMR spectrum

The structure of **5** could be deduced from the spectroscopic data While most data were similar to those of the methyl ester of **4**, the ^{1}H NMR signal of H-8 was shifted downfield and a singlet at δ1 96 indicated the presence of an acetate group

The chemistry of this *Artemisia* species is unusual and may support its placement in the new genus *Neopallasia* [12] Further investigation of more species may show whether these constituents are more widespread in this genus

EXPERIMENTAL

The air-dried aerial parts (600 g, collected in Mongolia in summer 1983, voucher deposited at the Academy Institute at Halle, G D R) were extracted with MeOH–Et_2O–petrol (1 1 1) and the extract obtained (22 g) was worked up in the usual way [13] CC (SiO_2) fractions were as follows 1 (Et_2O–petrol, 1.10), 2 (Et_2O–petrol, 1 4), 3 (Et_2O–petrol, 1 3) and 4 (Et_2O–petrol, 1 1, and Et_2O) Repeated CC (Et_2O–petrol, 1 10) of fraction 1 gave 4 mg **1** and 6 5 g **2** (compared with authentic material, 400 MHz ^{1}H NMR and TLC) TLC (SiO_2, PF 254, Et_2O–petrol, 1 4) of fraction 2 afforded crude **3**, which was purified by distillation ($bp_{0\ 1\,\mathrm{Torr}}$ ~ 150°, bath temp, short distil) yielding 300 mg **3** Fraction 3 contained crude **5** TLC (Et_2O–C_6H_6, 1 1) of one tenth of this fraction gave 240 mg **5** (R_f 0 45) One tenth of fraction 4 was purified by TLC (Et_2O, R_f 0 42) affording 440 mg **4** A second investigation afforded, in addition to these compounds, 10 mg **6**, identical with the compound obtained from **4**

*Eremophil-*9,11(13)*-dien-*8β,12*-olide* (**3**) Colourless oil, $bp_{0\ 1\,\mathrm{Torr}}$ ~ 150°, IR $\nu_{\max}^{CCl_4}$ cm^{-1} 1770 (γ-lactone), MS m/z (rel int) 232 146 $[M]^+$ (58) (calc for $C_{15}H_{20}O_2$ 232 146), 217 $[M-Me]^+$ (9), 204 $[M-CO]^+$ (6), 136 (59), 121 $[136-Me]^+$ (76), 91 (100)

$$[\alpha]^{\lambda}_{24^\circ} = \frac{589 \quad 578 \quad 546 \quad 436\,\mathrm{nm}}{+47\ 9 \quad +54\ 3 \quad +59\ 4 \quad +73\ 6} \ (CHCl_3,\ c\ 0\ 3)$$

8α*-Hydroxyeudesma-*4,11(13)*-dien-*12*-oic acid* (**4**) Viscous, colourless oil, ^{13}C NMR ($CDCl_3$) (C-1–C-15) 39 7, 18 7, 32 8*, 126 1, 142 0, 30 5*, 48 3, 70 6, 50 3, 35 8, 132 4, 171 9, 126 5, 25 4, 19 4 (Signals labelled with an * may be interchangeable) To 40 mg **4**, CH_2N_2 in Et_2O was added After evapn, TLC (Et_2O–petrol, 1 1, 3 developments, R_f 0 34) gave 40 mg Me ester of **4**, colourless oil, IR $\nu_{\max}^{CCl_4}$ cm^{-1} 3620 (OH), 1730, 1635 ($C{=}CCO_2R$), MS m/z (rel int) 264 173 $[M]^+$ (11) (calc for $C_{16}H_{24}O_3$ 264 173), 246 $[M-H_2O]^+$ (58), 232 $[M-MeOH]^+$ (24), 231 $[246-Me]^+$ (100), 217 $[232-Me]^+$ (41), 199 $[217-H_2O]^+$ (20), 171 $[199-CO]^+$ (58), 91 (56)

To 50 mg **4** in 0 1 ml pyridine, 50 mg *p*-tosyl chloride was added After standing at 20° for 24 hr, usual work-up afforded by

TLC (Et_2O–petrol, 1 3, 3 developments, R_f 0 30) 30 mg **6**, colourless oil, IR $\nu_{\max}^{CCl_4}$ cm^{-1} 1780 (γ-lactone), MS *m/z* (rel int) 232 146 $[M]^+$ (24) (calc for $C_{15}H_{20}O_2$ 232 146), 217 $[M-Me]^+$ (100), 123 (51), 91 (44), CD (MeCN) $\Delta\varepsilon_{304} = -0\ 05$, $\Delta\varepsilon_{261} = +0\ 18$

A second fraction (10 mg, R_f 0 20) contained the corresponding hydroperoxide (5-OOH of **6**) ($\Delta^{4\ 15}$), colourless oil, IR $\nu_{\max}^{CCl_4}$ cm^{-1} 3520 (OOH), 1780 (γ-lactone), MS *m/z* (rel int) 231 $[M-OOH]^+$ (29), 149 (53), 95 (77), 53 (100)

8α-*Acetoxyeudesma*-4,11(13)-*dien*-12-*oic acid* (**5**) Colourless oil, IR $\nu_{\max}^{CCl_4}$ cm^{-1} 3500–2700, 1715, 1640 (C=CCO_2H), 1750, 1260 (OAc), MS *m/z* (rel int) 292 167 $[M]^+$ (4) (calc for $C_{17}H_{24}O_4$ 292 167), 232 $[M-HOAc]^+$ (63), 217 $[232-Me]^+$ (100), 171 (24), 91 (37)

$$[\alpha]^{\lambda}_{24^\circ} = \frac{589 \quad 578 \quad 546 \quad 436\,\text{nm}}{+42 \quad +43 \quad +51 \quad +88} \ (\text{CHCl}_3,\ c\ 0\ 9)$$

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