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A HARDWICKIIC ACID DERIVATIVE FROM *PULICARIA GNAPHALODES**

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Key Word Index—*Pulicaria gnaphalodes*; Compositae; Inuleae; diterpene lactone; clerodane derivative.

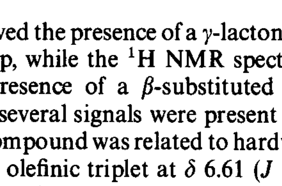
Abstract—The aerial parts of *Pulicaria gnaphalodes* afforded a new clerodane lactone closely related to hardwickiic acid.

Table 1. ^1H NMR spectral data of compound **1** ($CDCl_3$, 400 MHz, TMS as internal standard)

		Δ*			Δ*
H-1α	1.64 *dddd*	0	H-12	2.47 *dd* (*br*)	0
H-1β	1.82 *m*	0	H-14	6.27 *s* (*br*)	0
H-2α	2.55 *ddd*	0.03	H-15	7.37 *dd*	0
H-2β	2.36 *dddd*	0.01	H-16	7.24 *s* (*br*)	0
H-3	6.61 *dd*	0.04	H-17	1.10 *d*	0.03
H-6	4.50 *d*	0.06	H-19	0.96 *s*	0.06
H-8	2.61 *dq* (*br*)	0.02	H-20	0.94 *s*	0.03
H-10	2.07 *dd*	0.02			
H-11	1.70 *ddd*	0			
H-11′	1.80 *ddd*	0.01			

* Δ-values after addition of $Eu(fod)_3$.

J(Hz): 1α,1β = 15; 1α,2α = 6.5; 1α,2β = 10; 1α,10 = 13; 1β,10 = 2.5; 1β,2α = 10; 1β,2β = 7; 2α,2β = 20; 2,3 = 3.5; 6,8 = 1.3; 8,17 = 7; 11,11′ = 13; 11,12 = 8; 14,15 = 1.5; 14,16 = 1.5.



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Only a few species from the genus *Pulicaria* (subtribe Inulinae) have been investigated chemically. In addition to widespread acetylenes [1], from one species sesquiterpene lactones [2] were isolated, while from another species thymol derivatives [3] and flavones [4] were obtained. From the aerial parts of *P. gnaphalodes* (Vent.) Boiss., we have isolated a crystalline compound (**1**), mp 161°, molecular formula $C_{20}H_{24}O_4$. The IR spectrum showed the presence of a γ-lactone and a second carbonyl group, while the ^1H NMR spectrum (Table 1) showed the presence of a β-substituted furan moiety. Furthermore, several signals were present which showed that the new compound was related to hardwickiic acid. In particular, the olefinic triplet at δ 6.61 (J = 3.5 Hz), two methyl singlets and a methyl doublet as well as the chemical shifts of the furan protons were similar. However, the presence of additional oxygen functions led to some differences. Decoupling experiments allowed the assignment of most of the remaining signals. Irradiation of the doublet collapsed the broadened quartet at δ 2.41 to a broadened singlet, while irradiation at δ 4.50 sharpened the quartet. This allowed the assignment of the signals of H-6 and H-8, as obviously the small coupling of the H-6 signal was a long-range coupling with H-8. By irradiation of the olefinic signal the H-2 signals could be assigned. A broadened double doublet at δ 2.47 was obviously that of H-12, which was coupled with two overlapping signals at δ 1.80 and 1.70. Further decouplings allowed the assignment of H-1 and H-10. The couplings observed clearly showed that a *trans*-decalin system was present, while the optical rotation indicated that the diterpene was an *ent*-clerodane derivative. Somewhat surprising was the magnitude of the coupling $J_{6,8}$ as both hydrogens are axial and a *W*-coupling should be present only if the cyclohexanone ring was in a half-chair form. The $Eu(fod)_3$-induced shifts, however, supported the proposed stereochemistry. Both methyl signals (H-19 and H-20) were shifted downfield, while the signal of H-8 was affected much less. Furthermore as the H-3 signal was shifted, a preferred complexing of the lactone could be assumed. This, however, required the proposed

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* Part 368 in the series 'Naturally Occurring Terpene-Derivatives'. For Part 367, see Bohlmann, F., Zdero, C., King, R. M. and Robinson, H. (1981) *Phytochemistry* **20**, 2425.

configuration, as the other possibility, H-6 and H-8 α-orientated, did not explain the observed shifts. Consequently, the new diterpene was 7-oxo-6α-hydroxy-hardwickiic acid lactone (**1**). Obviously, further species of *Pulicaria* will have to be investigated to clarify the chemotaxonomy of this genus. So far relationships to *Inula* can be stated though this genus does not appear very uniform with regard to its chemistry.

EXPERIMENTAL

The air-dried plant material (250 g), collected near Teheran (voucher A. R. 115) was extracted with Et_2O–petrol (1:2). CC (Si gel) and TLC (Si gel) of the polar fractions (Et_2O–CH_2Cl_2, 2:1) gave 30 mg colourless crystals (**1**), mp 161°. IR $\nu_{max}^{CHCl_3}$ cm^{-1}: 1785, 1750, 1690, 1605, 1515, 885; MS m/z (rel. int.): 328.167 $[M]^+$ (42), 313 $[M - Me]^+$ (8), 233 $[M - CH_2CH_2 \text{ furane}]^+$ (19), 205 $[233 - CO]^+$ (20), 95 $[^+CH_2CH_2 \text{ furane}]^+$ (91), 81 $[\text{pyrilium}]^+$ (100);

$$[\alpha]^{\lambda}_{24^\circ} = \frac{589 \quad 578 \quad 546\,\text{nm}}{-62.3 \quad -65.0 \quad -74.9} (c = 2.39, CHCl_3).$$

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GUAIANOLIDES FROM *CENTAUREA CANARIENSIS**

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Key Word Index—*Centaurea canariensis*; Compositae; sesquiterpene lactones; guaianolides; costic acid derivative.

Abstract—The aerial parts of *Centaurea canariensis* afforded four new guaianolides, all closely related to dehydrocostus lactone, and a derivative of costic acid. The structures were elucidated by spectroscopic methods.

INTRODUCTION

Many species from the large genus *Centaurea* (tribe Cynareae) have been investigated chemically. In addition to polyacetylenes [1] several sesquiterpene lactones [2] have been isolated. *C. canariensis* Brouss. var. *subexpinnata* Burch. also contains acetylenes and several sesquiterpene lactones, all closely related to dehydrocostus lactone.

RESULTS AND DISCUSSION

The roots of *C. canariensis* afforded the tetrayne **1** and aplotaxene (**2**), while the aerial parts gave capillol acetate (**3**) [1], germacrene D, bicyclogermacrene, γ- and δ-cadinene and five new compounds, the costic acid derivative **4** and four guaianolides (**7**–**10**). **4** after addition of diazomethane afforded on oxidation the ketone **6**. The ^1H NMR data of **4** and **6** (Table 1) clearly showed that **4** was a derivative of costic acid. Spin decoupling allowed the assignment of all signals. The position of the hydroxy group followed from the ^1H NMR data of the corresponding ketone **6**. The downfield shift of the broadened singlets of H-15 agreed only with a keto group at C-3. The small coupling $J_{2,3}$ required a 3β-hydroxy group. The stereochemistry at C-5 and C-7 followed from the couplings observed for H-5 and H-7. Consequently, the ^1H NMR data were in part very similar to those of costic acid. The ^1H NMR data of **7**, **9** and **10** were close to those of 8α-senecioyloxy dehydrocostus lactone [3]. (Table 1). Spin decoupling allowed the assignment of all

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*Part 372 in the series 'Naturally Occurring Terpene Derivatives'. For Part 371, see Bohlmann, F. and Zdero, C. (1981) *Phytochemistry* **20** 2529.