Hygrophiloside tetra-acetate (**1a**). Prepared by acetylation of **1** (Ac_2O, pyridine, room temp., 2 hr). Crystallization from EtOH gave pure **1a**, mp 148–148.5°; $[\alpha]_D^{20} -69°$ ($CHCl_3$; *c* 0.9); ^1H NMR (90 MHz, $CDCl_3$): δ9.60 (*s*, CHO-10), 6.78 (*m*, H-7), 6.23 (*d*, $J = 2$ Hz, H-1), 6.12 (*d*, $J = 6.5$ Hz, H-3), 4.92 (*d*, $J = 6.5$ Hz, H-4), 3.39 (*m*, H-9), 3.12 (*s*, OH), 2.91 and 2.68 (*br* AB-system, $J = 19$ Hz, CH_2-6), 2.11, 2.03, 2.00 and 1.98 (4 × OAc); ^{13}C NMR (22.6 MHz, $CDCl_3$): δ189.3 (C-10), 152.3 (C-7), 142.9 (C-8), 139.4 (C-3), 110.0 (C-4), 91.4 (C-1),73.1 (C-5), 52.7 (C-9), 46.0 (C-6), 96.0, 71.0, 71.8, 68.2, 71.8, 61.5 (C-1–C-6 in the β-glucopyranosyl moiety). (Found: C, 52.7; H, 5.5. $C_{23}H_{28}O_{13} \cdot 1/2\ H_2O$ requires: C, 53.0; H, 5.6%.)

Conversion to isoaucubin penta-acetate (**2a**). To a stirred soln of **1** (90 mg) in MeOH (5 ml) was added $NaBH_4$ (60 mg). After 45 min the mixture was taken to dryness and the residue acetylated as above. Work-up gave, after prep. TLC, **2a** (78 mg) as crystals from EtOH, mp and mmp 121–122°; $[\alpha]_D^{20} -91°$ ($CHCl_3$; *c* 0.7), lit. [5] mp 125°; $[\alpha]_D^{28} -46°$ (EtOH; *c* 0.95); an authentic sample, kindly supplied by Dr. Endo, exhibited the rotation $[\alpha]_D^{20} -90°$ ($CHCl_3$; *c* 0.2).

The ^1H and ^{13}C NMR spectra were as reported [5].

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A NOR-SESQUITERPENE-γ-LACTONE FOUND IN *CREPIS PYGMAEA*

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Key Word Index—*Crepis pygmaea*; Compositae; sesquiterpenoid lactones; 1,2–4,5-tetrahydro-11-nor-11-hydroxy-$\Delta^{7,11}$-santonin.

Abstract—The isolation and structural elucidation of a novel nor-sesquiterpene-γ-lactone are reported.

INTRODUCTION

We have recently reported the isolation and structural elucidation of an unusual nor-sesquiterpene-γ-lactone (**1**) found in *Crepis pygmaea* L.‡ [1], whose structure has been definitively confirmed through synthesis [2]. During the isolation of **1** from the chloroform extract of the whole plant, a number of minor by-products were observed.

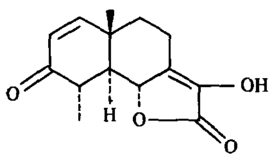
The present report describes the characterization of one of these products as the novel nor-sesquiterpenoid, 1,2–4,5-tetrahydro-11-nor-11-hydroxy-$\Delta^{7,11}$-santonin (**2**) (or its mirror image).

‡Plant material was collected in July–August on Vettore mountain, Umbria, Italy. A specimen (voucher Nos. 2115/01) has been deposited at The University of Perugia, Perugia, Italy.

RESULTS AND DISCUSSION

Compound **2** was obtained by chromatographic fractionation of the chloroform extract of *C. pygmaea* as previously described [1]. In particular, repeated fractionation on silica gel (Kieselgel 60 Merck) columns of the crude fraction containing **1** [1] yielded, besides **1**, chromatographically pure **2** (80 mg), which crystallized from ether as white cubes.

Compound **2**, mp 177–179°; R_f (TLC) 0.39 (pre-coated Merck plates, *n*-hexane–CH_2Cl_2–*i*-PrOH, 34:6:10), $[\alpha]_D + 25.7°$ ($CHCl_3$; *c* 2.9); MS *m/z* 250 $[M]^+$; UV λ_{max}^{EtOH} nm (ε): 237 (8420); molecular formula $C_{14}H_{18}O_4$ (Found: C, 66.92; H, 7.32. $C_{14}H_{18}O_4$ requires: C, 67.18; H, 7.25%). The IR spectrum ($\nu_{max}^{CHCl_3}$ cm^{-1}: 3520, 1755 and 1710) suggested the presence of an α,β-unsaturated γ-lactone containing a cyclohexanone ring and an additional alcoholic function. The ^1H NMR spectrum



1

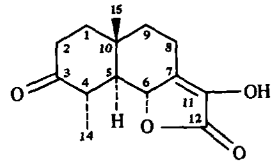


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Table 1. ^{1}H NMR spectral data of compound **2** (500 MHz, $CHCl_3$, TMS as internal standard)

H	δ	H	δ
1 ax	1.57 *ddd*	8 ax	2.35 *dddd*
1 eq	1.77 *ddd*	8 eq	2.89 *ddd*
2 eq	2.40 *ddd*	9 ax	1.28 *ddd*
2 ax	2.54 *ddd*	9 eq	1.71 *ddd*
4	2.60 *ddq*	14	1.22 *d*
5	1.27 *dd*	15	1.24 *s*
6	4.71 *ddd*		

J (Hz): 1ax, 1eq = 14.0; 1ax, 2eq = 5.2; 1ax, 2ax = 14.0; 1eq, 2ax = 6.6; 1eq, 2eq = 2.2; 2ax, 2eq = 14.0; 4, 5 = 11.6; 4, 6 = 0.6; 4, 14 = 6.8; 5, 6 = 10.3; 6, 8ax = 1.5; 8ax, 8eq = 14.0; 8ax, 9eq = 5.4; 8ax, 9ax = 13.6; 8eq, 9eq = 1.6; 8eq, 9ax = 5.0; 9ax, 9eq = 13.6.

Table 2. ^{13}C NMR chemical shifts of compound **2** (67.88 MHz, $CDCl_3$, TMS as internal standard)

C	δ	C	δ
1*	37.11 *t*†	8*	19.91 *t*
2*	19.91 *t*	9*	39.76 *t*
3	211.19 *s*	10	35.45 *s*
4	45.55 *d*	11	135.34 *s*
5	56.22 *d*	12	170.11 *s*
6	80.69 *d*	14*	13.60 *q*
7	133.63 *s*	15*	16.85 *q*

*Assignments made by comparison with available reference compounds [1, 5].
†SFORD multiplicity.

(90 MHz, $CDCl_3$, TMS as internal standard) revealed the presence of signals centred at δ: 4.73 (1H, *dd*, $J = 12$ and 0.5 Hz, collapsing to a *d* on irradiation at δ2.63 and to an *s* (*br*) on irradiation at δ1.30) consistent with the sequence HC–CH–C$\underline{H}$–O–; 2.63 (1H, *m*, partially obscured by other signals); 1.24 (3H, *d*, $J = 6$ Hz collapsing to a *s* on irradiation at δ2.63) accounting for O=C–CH(C$\underline{H}_3$)–CH–CHOR and 1.24 (3H, *s*) for a tertiary methyl group.

All the above data showed a close similarity between compounds **1** and **2** with the lack in the latter of the –CH=CH– system.

Detailed examination of the ^{1}H NMR spectra obtained with a 500 MHz instrument ($CDCl_3$) led to the conclusion that the remaining hydroxyl group (see IR spectral data) had to be on the lactone ring as in the case of compound **1**. The fact that in these spectra the signals were resolved into an approximately first-order pattern permitted selective decoupling experiments which confirmed, besides the complete assignment of every proton (see Table 1), the C-11 position of the hydroxyl group. Moreover, the particular coupling constants found for H-4, H-5 and H-6 led to the stereochemistry shown at C-4, C-5 and C-6.

The *trans*-A/B ring junction was proved by the ORD spectrum (0.002 M MeOH, 28°) which showed a positive Cotton effect ($[\alpha]_{320}$ +450°, $[\alpha]_{240}$ +980°) as reported in the literature [3, 4] for similar model compounds.

Finally, the ^{13}C NMR ($CDCl_3$) spectrum of **2** (see Table 2) showed 14 carbon atoms possessing complexity and chemical shifts in perfect agreement with the proposed structure.

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