treated with (±)-α-phenylbutyric anhydride (freshly crystallized, excess) at 40° for 1 5 hr (*R*)-α-Phenylethylamine (12 μl) was added and after 15 min the mixture was diluted with dry EtOAc (800 μl) and checked by GLC on a 25 m glass capillary column coated with OV-101 at 210°, following the procedure described in ref [7] A peak decrement of 4 for the (*R*)-acid indicated the *R*-configuration at C-4

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A DITERPENOID OF THE ATIS-16-ENE CLASS FROM *ELAEOSELINUM FOETIDUM*

Mariano Pinar, Manuel Rico†, Benjamín Rodriguez and Belén Fernández

Instituto de Química Orgánica General, CSIC, Juan de la Cierva 3, Madrid-6, † Instituto de Estructura de la Materia, CSIC, Serrano 119, Madrid-6, Spain

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Key Word Index—*Elaeoselinum foetidum*, Umbelliferae, diterpenoid, *ent*-atis-16-ene derivative

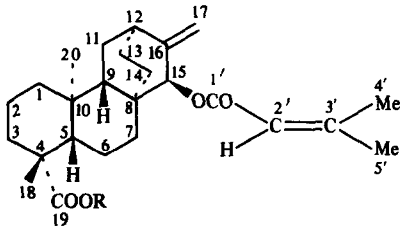
Abstract—A new diterpenoid has been isolated from the root of *Elaeoselinum foetidum* Its structure was established as *ent*-15α-senecioxy-atis-16-en-19-oic acid mainly by ^{1}H NMR and ^{13}C NMR spectroscopic studies of its methyl ester derivative

INTRODUCTION

In a previous communication [1], we reported *ent*-kaur-16-en-19-oic acid and the new methyl *ent*-8,9-seco-9,16-diketo-17-nor-kaur-8(15)-en-19-oate (foetidin) as the major diterpenic constituents of the aerial parts of *Elaeoselinum foetidum* (L) Boiss, an umbelliferous plant endemic at the Iberian Peninsula A study of the root of this plant, has now allowed the isolation of large amounts of the previously known *ent*-kaur-16-en-19-oic acid [2] together with a minor new diterpenic acid (**1**), which was purified as the methyl ester derivative (**2**), and whose structure was established by spectroscopic means

RESULTS AND DISCUSSION

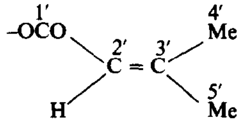
The methyl ester (**2**) of the new diterpenoid had a molecular formula $C_{26}H_{38}O_4$ and its IR spectrum showed strong and broad ester (1718 cm^{-1}) and exocyclic methylene (3080, 1653 and 910 cm^{-1}) absorptions and no hydroxyl bands The ^{1}H NMR spectrum of **2** showed characteristic signals for a senecic ester [δ5 79 (1H, *qq*, J_{allylic} = 1 17 Hz, $J_{\text{allylic}'}$ = 0 95 Hz), 2 22 (3H, *d*, $J_{\text{allylic}'}$ = 0 95 Hz) and 1 94 (3H, *d*, J_{allylic} = 1 17 Hz)] attached to a carbocyclic secondary carbon atom This carbon is between an *sp*^{3} tetrasubstituted carbon atom and an exocyclic methylene group, as the signal of its geminal proton showed a triplet at δ5 12 (J_{allylic} = 2 0 Hz) and the signals assigned to the exocyclic methylene group appeared as two triplets (J_{gem} = J_{allylic} = 2 0 Hz) at δ4 97 and 4 88 Double resonance experiments confirmed all the above assignments, because on irradiation at δ5 79 (olefinic proton of the senecic ester group) the signals at δ2 22



	R
1	H
2	Me

Table 1 ^{13}C NMR chemical shifts* of compound **2**

Carbon No		Carbon No	
1	39 8 *t*†	11	26 2 *t*
2	18 8 *t*	12	36 4 *d*
3	38 1 *t*	13	26 9 *t*
4	43 8 *s*	14	28 7 *t*
5	56 6 *d*	15	76 0 *d*
6	19 7 *t*	16	152 3 *s*
7	33 3 *t*	17	110 1 *t*
8	37 2 *s*	18	28 7 *q*
9	43 5 *d*	19	178 0 *s*
10	38 0 *s*	20	12 4 *q*
–OMe	51 2 *q*		
		1′	167 0 *s*
		2′	116 5 *d*
		3′	156 8 *s*
		4′	27 5 *q*
		5′	20 4 *q*



*In ppm relative to TMS Taken at 90 55 MHz. in CDCl$_3$ solution

†SFORD multiplicity

and 1 94 collapsed into singlets, and irradiating the geminal proton of the ester group (δ5 12) the triplet signals of the two protons of the exocyclic methylene group (δ4 97 and 4 88) were transformed into doublets (J_{gem} = 2 Hz) In addition, compound **2** possessed two methyl groups attached to fully substituted carbon atoms (two singlets at δ1 17 and 0 80) and a carbomethoxyl group (a 3H singlet at δ3 65) The UV absorption of **2** (λ_{max} 221 nm, log ε 4 04) was also indicative of the presence of the senecioate moiety in the molecule of the diterpenoid

All the above data may be accommodated most readily, albeit not exclusively, in tetracarbocyclic, monoolefinic, diterpenic structures of *ent*-kaur-16-ene or *ent*-atis-16-ene types with a carbomethoxyl group on C-19 and a senecic ester group on C-15 [3, 4] However, the ^{13}C NMR spectrum of **2** (Table 1) provided conclusive proofs for the *ent*-atis-16-ene hydrocarbon skeleton and for the presence of a C-19 carbomethoxyl group and an *ent*-15α-senecic ester group in the molecule of this new diterpenoid Effectively, C-1 to C-6, C-10, and C-18 to C-20 carbon atom resonances of compound **2** (Table 1) were in complete agreement with those reported for methyl *ent*-atis-16-en-19-oate [5], whereas C-11 to C-17 carbon atom resonances were almost identical to those found in some *ent*-15α-esterified *ent*-atis-16-ene alkaloids [6], but very different to the previously reported values for *ent*-15α- or *ent*-15β-acetoxy-kaur-16-enes [7] Moreover, all the carbon atom resonances of compound **2** are also in agreement with the expected values obtained from methyl *ent*-atis-16-en-19-oate [5], taking into account the introduction of an ester function on the *ent*-15α position [4, 7] In particular, the diamagnetic shifts ($\Delta\delta = -6\ 3$ and $-8\ 5$ ppm) experienced by the C-7 and C-9 carbon atoms in compound **2** with respect to methyl *ent*-atis-16-en-19-oate clearly pointed to *ent*-α as the configuration of the C-15 ester function

The absolute configuration of this new diterpenoid was not ascertained However, compound **2** is believed to belong to the *enantio* series like *ent*-kaur-16-en-19-oic acid, co-occurring in the same species Moreover, the variation of the optical rotations of compound **2** (see Experimental) and gummiferolic acid [3] is similar, and the *enantio* absolute configuration of this last compound is well-known [3]

The new diterpenic acid is thus the 15-senecioate of *ent*-15α-hydroxy-atis-16-en-19-oic acid (**1**) and belongs to the very small group of nitrogen-free natural substances with this hydrocarbon skeleton ([3] and refs therein)

EXPERIMENTAL

For general details on Experimental see ref [1] Plant materials were collected in June 1974 between Arcos de la Frontera and Tabernas de la Rivera (Cádiz, Spain) and voucher specimens (No 177215) were deposited in the Herbarium of the Royal Botanical Garden of Madrid

Extraction and isolation of the diterpenoids Dried and finely powdered *Elaeoselinum foetidum* (L) Boiss roots (400 g) were extracted overnight with *n*-hexane–Et$_2$O (2 1) in a Soxhlet The extract (23 g) was chromatographed on a silica gel column (Merck No 7734, deactivated with 15% H$_2$O) Elution with *n*-hexane–EtOAc (25 1) yielded in order of elution *ent*-kaur-16-en-19-oic acid (4 g) and a complex mixture (7 g) of diterpenic acids This mixture was treated with ethereal CH$_2$N$_2$ and the mixture of the methyl esters was repeatedly and carefully subjected to column and PLC chromatography, but, unfortunately, only one of the constituents was isolated as a pure substance (**2**, 30 mg) *ent*-Kaur-16-en-19-oic acid was identified by its physical (mp, $[\alpha]_D$) and spectroscopic (IR, ^{1}H NMR, MS) data and by comparison with an authentic sample

Compound **2** A syrup, IR $\nu_{max}^{CHCl_3}$ cm^{-1} 3080, 3000, 2950, 2880, 1718 (br), 1653, 1605, 1470, 1465, 1448, 1380, 1360, 1280, 1150, 1095, 1075, 1015, 990, 970, 910, 853, UV λ_{max}^{EtOH} nm (log ε) 221 (4 04), ^{1}H NMR (360 MHz, CDCl$_3$) see Results and Discussion, ^{13}C NMR (90 55 MHz, CDCl$_3$) see Table 1, EIMS (direct inlet, 75 eV) *m/z* (rel int) 414 $[M]^+$ (1), 399 (0 6), 355 (0 6), 332 (8), 314 $[M - \text{senecic acid}]^+$ (6), 299 (3), 286 (2), 279 (3), 271 (2), 255 (5), 239 (3), 211 (2), 199 (1), 185 (2), 181 (2), 173 (2), 167 (8), 149 (30), 121 (6), 105 (6), 91 (7), 83 (100), 71 (9), 57 (15), 55 (18) C$_{26}$H$_{38}$O$_4$ MW 414

$$[\alpha]^{20} = \frac{589 \quad 578 \quad 546 \quad 436 \quad 365\ \text{nm}}{-66^\circ \quad -69^\circ \quad -79^\circ \quad -139^\circ \quad -227^\circ}\ (\text{CHCl}_3,\ c\ 1\ 15)$$

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