Nuclear Magnetic Resonance Signals of Methyl Groups in Structural Determination of Triterpenes. 2α,3α- and 2β,3β-Dihydroxyolean-12-en-28-oic Acids

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Summary Structures previously assigned to the two *cis*-diols from osmium tetroxide oxidation of methyl olean-2,12-dien-28-oate should be interchanged; 2α,3α-dihydroxyolean-12-en-28-oic acid occurs in *Shorea acuminata* resin.

SEVERAL triterpene acids occur in the resin of *Shorea acuminata* (Dipterocarpaceae) one of which we show to be 2α,3α-dihydroxyolean-12-en-28-oic acid. Its methyl ester (Ia) ($C_{31}H_{50}O_4$, m.p. 296—299°, $[\alpha]_D + 58°$) readily forms an acetonide (Ic), m.p. 235—239°. In the mass spectrum of the acetonide are found peaks at *m/e* 511, 468, 453, and 409, due to loss from the molecular ion (526) of CH_3, acetone,[1] CO_2CH_3, or a combination of these. The most abundant ions are at *m/e* 262 and 203; these ions and others at *m/e* 189 and 133 are found also in the spectrum of the methyl ester (Ia). Such fragments are diagnostic[2] of a methyl olean-12-en-28-oate (II) or its ursane analogue, and result from a retro-Diels–Alder cleavage of ring C.[2] The oleanane skeleton is favoured since n.m.r. signals due to secondary methyl groups are not found.[3]

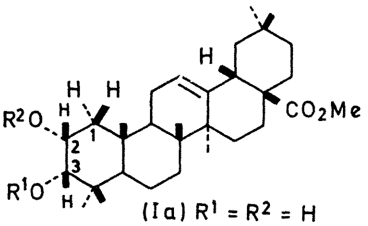
The diol methyl ester is in fact identical to one of two *cis*-2,3-diols[4,5] resulting from osmium tetroxide oxidation of methyl olean-2,12-dien-28-oate (III). We have repeated the oxidation and show below that the structures (Ia) and (IVa) given earlier[4,5] to these diols, m.p. 258—261° and 296—299° (lit.[5] 278—282°), should be reversed.

N.m.r. frequencies of angular methyl groups in a triterpene skeleton are influenced by changes in substitution pattern, and the effects are normally additive.[3] Applications of the generalization to structural determination have been demonstrated.[3] The Table shows that the predicted methyl resonances for the 2α,3α-diol (Ia) and for the 2β,3β-diol (IVa) are in excellent agreement with those measured for diols m.p. 296—299° and m.p. 258—261°, respectively.

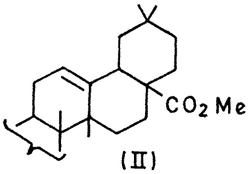
	C-23	C-24	(*Effect on*) *resonance* C-25	*frequencies*[a] C-26	C-27	C-29/30
Parent[9] (methyl olean-12-en-28-oate) ..	52·5	50	55·5	43·5	69	55·5/56
Effect[3] of 2α-OH	+2	+1·5	+1·5	−0·5	−0·5	−1
Effect[8] of 3α-OH	+6	+2	+0·5	*ca.* 0	*ca.* 0	*ca.* 0
Calc. for (Ia)	60·5	53·5	57·5	43	68·5	54·5/55
Found for diol m.p. 296–299°	60·5	51	56·5	42	68	54/55
Effect[3] of 2α-OAc	+2·5	+2·5	+7·5	−0·5	−0·5	−1
Effect[8] of 3α-OAc	−1	+4	+0·5	*ca.* 0	*ca.* 0	*ca.* 0
Calc. for (Ib)	54	56·5	63·5	43	68·5	54·5/55
Found for diacetate of diol m.p. 296—299°	52	58·5	62	43	69·5	54/55
Effect[3] of 2β-OH	+1·5	+13	+19	+1	0	+0·5
Effect[9] of 3β-OH	+7	−2	+0·5	+1	0	0
Calc. for (IVa)	61	61	75	45·5	69	56/56·5
Found for diol m.p. 258—261°	60	60	73	44·5	67	53·5/55
Effect[3] of 2β-OAc	+2[b]	+10·5	+15·5	+1·5	0	0
Effect[9] of 3β-OAc	0	+3	+1	0	0	+0·5
Calc. for (IVb)	54·5	63·5	72	45	69	56/56·5
Found for diacetate (m.p. 227—231°) of diol m.p. 258—260°	54	63	71	45	67	54/54

[a] In Hz from $SiMe_4$ as measured at 60 MHz in $CDCl_3$.
[b] Value taken from ref. 8.

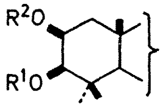
Corroborative results obtained for the corresponding diacetates are also shown. Diol m.p. 296—299° obtainable from *Shorea acuminata* is thus methyl 2α,3α-dihydroxyolean-12-en-28-oate (Ia), and diol m.p. 258—261° is the 2β,3β-analogue (IVa).



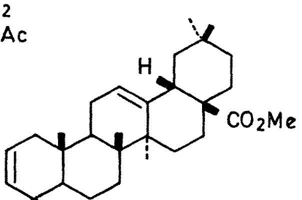
(Ia) R¹ = R² = H
(Ib) R¹ = R² = Ac
(Ic) R¹,R² = CMe₂
(Id) R¹ = H,R² = Ac



(II)



(IVa) R¹ = R² = H
(IVb) R¹ = R² = Ac



(III)

The correctness of the conclusion is established as follows. Firstly the width at half-height ($w_{\frac{1}{2}}$)[6] of signals due to the C-2 hydrogen in the 2α,3α-diol (Ia) (m.p. 296—299°) and its diacetate (Ib), is 21 and *ca.* 18 Hz;† in the 2β,3β-analogues (IVa and IVb) $w_{\frac{1}{2}}$ is 9 and *ca.* 8 Hz.† The C-2 hydrogen is thus axial in the former compounds and equatorial in the latter.[6]

Splitting in the C-3 hydrogen signal indicates that coupling between C-2 and C-3 hydrogens is 2—3 Hz in 2α,3α-compounds and 4—5 Hz in 2β,3β-compounds. Upon decoupling of the C-3 hydrogen in the naturally occurring 2α,3α-diol (Ia), the multiplet near δ 3·9 due to the C-2 hydrogen simplifies to a four-line signal characteristic of the X part of an ABX spectrum (see Ia). $J_{AX} + J_{BM}$ as measured is 15 Hz, which is as expected[7] for *ax–ax* and *ax–eq* coupling of hydrogens at positions 2 and 1.

Finally, controlled acetylation of the isolated 2α,3α-diol yields a monoacetate, m.p. 231—234°, the n.m.r. spectrum of which shows a doublet (*J* 3) at δ 3·5, and a broad multiplet near δ 5·3. Such signals, and those due to methyl groups, are in agreement with a structure (Id) which results from selective acetylation of the equatorial 2α-hydroxy-group.

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† Signal partly buried under 12-H signal, $w_{\frac{1}{2}}$ of which is *ca.* 8 Hz.

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