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TERPENOID RING A α-KETOL SULPHONATE ESTER SOLVOLYSIS: CONVERSION OF ENT-3β-HYDROXYBEYER-15-EN-2,12-DIONE TO THE ISOMERIC ENT-1α-HYDROXYBEYER-15-EN-2,12-DIONE

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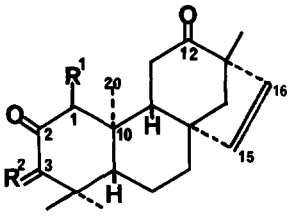
SUMMARY. Acetolysis of tetracyclic diterpenoid 3-equatorial, 3-axial or 1-axial sulphonate-2-ketones results in attack at the 1-axial position. Jones oxidation of the derived 1-hydroxy-2-ketone results in an unexpected ring contraction-decarboxylation giving a 2-nor-1-ketone.

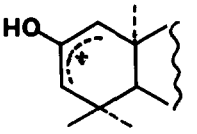
Solvolytic reactions of secondary α-ketol sulphonate esters have been scantily documented,[1] although the S_N2 reactions of α-halogeno-ketones are well known.[2] Recently Satoh and Takahashi[3] reported a new example of the S_N2' reaction where the incoming nucleophile entered trans to the leaving group instead of the normal cis relationship shown by most S_N2' reactions of allylic halides.[4] We would like to report an apparently similar exceptional reaction; however in our case the configuration of the product was always the same irrespective of the initial configuration of the leaving group at the alternate α position.

Tosylation of the tetracyclic diterpene α-ketol, ent-3β-hydroxybeyer-15-en-2, 12-dione (1)[5] with tosyl chloride in pyridine gave the corresponding equatorial tosylate (2), m.p. 202-203°. Acetolysis of (2) at reflux in sodium acetate buffered acetic acid gave as the major product the axial ent-1α-acetoxybeyer-15-en-2,12-dione (3), m.p. 176-178°, τ 5.8 (1H, broad s, $W_{\frac{1}{2}}$ 3 Hz, H-1 equatorial), accompanied by minor amounts of the ent-3β-acetate (4)[5] and ent-3α-acetate (5),[6] (see Table). Similar acetolysis of the axial ent-3α-mesylate (6)[7] gave a comparable result (see Table).

The constitution of the major product (3) was deduced as follows. Compound (3) underwent practically instantaneous hydrolysis with dilute base at room temperature to give the corresponding alcohol (7), m.p. 191-193°. Reacetylation of this α'-ketol (7) regenerated the parent acetate (3) showing that during its hydrolysis base induced epimerisation or isomerisation had not taken place. Furthermore sodium borohydride reduction of the 12-dithioethane ketal of (7) gave the diaxial ent-1α,2β-diol which did not form an acetonide (acetone-$HClO_4$). The recent report by Connolly and Harding[8] that after base equilibration of a 1,2-beyer-15-ene ketol the axial ent-1α-hydroxy-2-ketone was the predominant product of the two possible C-1 epimers, supported our axial ent-1α-acetoxy and hydroxy group assignments to both (3) and (7) respectively.†

The acetolysis of the axial ent-1α-mesylate (8)[7] gave predominantly the ent-1α-acetoxy-2-ketone (3) as before together with minor amounts of the two epimeric 3-acetates (see Table) instead of the expected[9] 20(10→ent-1β)abeobeyerene. This unexpected reaction as well as the product composition suggested the formation of a common intermediate from all three starting sulphonates, possibly the delocalised enol cation (9).





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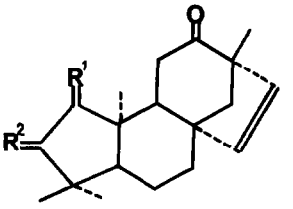


	R^1	R^2 α	R^2 β
(1)	H	OH	H
(2)	H	OTs	H
(3)	OAc	H	H
(4)	H	OAc	H
(5)	H	H	OAc
(6)	H	H	OMs
(7)	OH	H	H
(8)	OMs	H	H

	R^1	R^2
(10)	O	H_2
(11)	H_2	O

† An X-ray diffraction study incorporating the ent-1α-hydroxy-2-one moiety has been recently reported.[10]

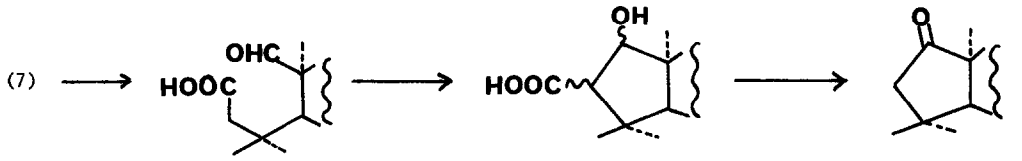
TABLE

Percentages* of Acetolysis Products

SUBSTRATE	AXIAL ent-1α-acetate(3)	AXIAL ent-3α-acetate(5)	EQUATORIAL ent-3β-acetate(4)
EQUATORIAL ent-3β-tosylate (2)	75	7.5	17.5
AXIAL ent-3α-mesylate (6)	71	14.5	14.5
AXIAL ent-1α-mesylate (8)	72	14.5	13.5

*Estimated by n.m.r. of the total crude reaction product - accuracy ± 5%

Jones oxidation with excess reagent at 0° of the 1,2-ketol (7) resulted in the evolution of CO_2 and the isolation of the 2-nor-1-ketone (10), m.p. 144-146°, in 30% yield, which was different from the isomeric 3-nor-2-ketone (11).[6] This unexpected decarboxylation is tentatively postulated to proceed via a β-hydroxy acid as shown in the SCHEME, although to our knowledge there is no precedent of an acid catalysed aldol type condensation of an aldehyde with the α-carbon of a carboxylic acid under such conditions.



SCHEME

Finally it is noteworthy that Connolly and Harding[8] have recently isolated the ent-2α-hydroxybeyer-15-en-1-one and related C-1 oxygenated diterpenes from an Erythroxylon species and the above reaction is a facile synthetic route to these compounds.

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