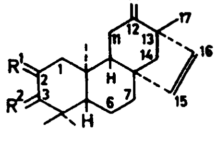
ent-3β-Hydroxybeyer-15(16)-ene-2,12-dione from *Androstachys johnsonii* Prain (Euphorbiaceae)

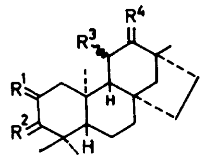
By K. H PEGEL* and L P L PIACENZA
(*Chemistry Department, University of Natal, Durban, South Africa*)
and L PHILLIPS and E S WAIGHT
(*Chemistry Department, Imperial College, London, S W 7*)

Summary The major heartwood diterpene of *Androstachys johnsonii* presents the first instance of a C-12 oxygenated beyerane-type diterpene and the possible existence of a new type of diterpene skeleton is suggested

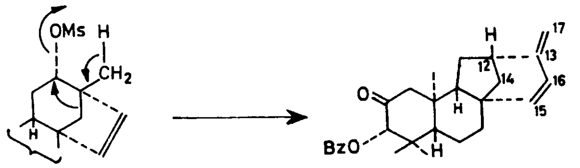
THE major heartwood diterpene of *A johnsonii* Prain is the tetracyclic ketol (Ia),† $C_{20}H_{28}O_3$, m p 163—165·5°, $[\alpha]_D$ − 372° ($CHCl_3$ throughout), ν_{max} (KBr throughout) 3525 (broad), 1710 (broad), and 767 cm^{-1}, λ_{max} (EtOH throughout) 296 nm (ϵ 240), it gives a yellow colour with tetranitromethane and a red colour with alkaline triphenyltetrazolium chloride, but no colour with ferric chloride The ketol forms a monoacetate, $C_{22}H_{30}O_4$, m p 169—170°, $[\alpha]_D$ − 362°, a dioxime $C_{20}H_{30}N_2O_3$, m p 275—277° (dec), and it is catalytically reduced to the 15,16-dihydroketol (IIa), $C_{20}H_{30}O_3$, m p 107—108°, $[\alpha]_D$ − 34°, ν_{max} no band at 767 cm^{-1}, λ_{max} 284 nm (ϵ 71)



(I)	R¹		R²		R³	
	α	β	α	β	α	β
a,	O		OH	H	O	
b,	H	H	OH	H	H	H
c;	OH	H	OH	H	OH	H
d,	H	OH	OH	H	OH	H
e,	H	OAc	O		O	



(II)	R¹		R²		R³	R⁴	
	α	β	α	β	ξ	α	β
a,	O		OH	H	H	O	
b,	OH	H	OH	H	H	OH	H
c,	OAc	H	O		H	O	
d,	O		OAc	H	Br	O	



(IV) (III)

The red colour with triphenyltetrazolium chloride indicates the presence of an α-ketol function in (Ia) The formation of *ent*-beyer-15(16)-en-3β-ol (Ib) as one of its Huang-Minlon reduction products, as well as the presence of a singlet at τ 5·14 in the spectrum of the ketol monoacetate, identifies this function as a 3-hydroxy-2-ketone unit The hydroxy-group configuration at C-3 was established as 3α-equatorial by preparing (i) the two epimeric C-2 triols (Ic) and (Id) and (ii) the triol (IIb) by two different routes

Reduction ($NaBH_4$) of the ketol (Ia) gave the triol (Ic), m p 223—226° (subl) which on catalytic reduction was converted into the dihydro-triol (IIb), m p 224—227° (subl) Anhydrous $AlCl_3$ isomerised the parent ketol acetate to the iso-ketol acetate (Ie), m p 228—231°, τ 4 53 (1H, q, C-2 α-proton, *J* 6 and 13 Hz), which on alkaline $NaBH_4$ reduction yielded the triol (Id), m p 218—221·5°, dissimilar from (Ic) [i r and t l c , (Id) having the lower mobility consistent with a 2,3-diequatorial diol structure] On the other hand, oxidation of the ketol (Ia) with Bi_2O_3 to the corresponding diosphenol followed by acetylation and catalytic reduction from the β-face[1] finally yielded the dihydro-2α-acetoxy-3,12-dione (IIc), m p 156—158°, τ 4 46 (1H, q, C-2 proton, J_{boat} 8 3 and 11 2 Hz) Reduction ($NaBH_4$) of (IIc), followed by alkaline hydrolysis of the product, resulted in the 2α,3α,12α-dihydro-triol, identical in all respects (m p , i r , and t l c) with (IIb) The orientation of the hydroxy-groups in the above products is as indicated since it has been shown[2] that hydride reduction of the C-2 and C-3 *ent*-beyerane carbonyl groups takes place preferentially from the less hindered β face of the molecule and similar reduction can be expected for the C-12 carbonyl group

The position of the second carbonyl group at C-12 was established as follows Formation of the diosphenol from (Ia) and C-2 proton n m r signals of compounds (Ie) and

---

† The composition of all numbered compounds and their derivatives is based on high-resolution mass spectrometry and/or combustion analysis Spectroscopic support has been obtained for all structures

(IIc) excluded C-1, but left C-6 or C-11 and C-7 or C-12 as possible positions. Bromination of the (IIa) acetate furnished a crystalline compound $C_{22}H_{31}O_4Br$ (IId), m.p. 238·5—239·5°, τ 5·85 (1H, d, J 7 Hz) indicating bromination at C-6 or C-11 next to either a C-7 or C-12 keto-group, respectively. The final choice was provided unequivocally by the rearranged compound (III), m.p. 183—185°, [λ_{max}(obs) 230, 273, 281, and 300sh. nm (ϵ 31,530, 1090, 873, and 53, respectively) λ_{max}(calc) 232[3]], τ 4·25 (2H, q, $J_{15,16}$ 9 Hz), 5·44 (1H, s, C-17 *cis*-proton), 5·56 (1H, s, C-17 *trans*-proton), 8·84, 9·00, and 9·24 (3 × 3H, 3 × s, 3 × CH_3), obtained by the following reaction sequence. Controlled $NaBH_4$ reduction of the parent ketol benzoate produced the 12α-hydroxy-product which was converted into the corresponding 12α-mesylate (IV). On solvolysis in boiling NaOAc-buffered acetic acid this equatorial 12α-mesylate (IV) underwent in good yield an elimination–rearrangement reaction (IV to III) by a mechanism reminiscent of the steroidal C-nor–D-homo rearrangement.[4] The absence in (III) of one of the usual four methyl group signals coupled with the obvious presence of a transoid diene system (u.v. and n.m.r.) can be rationalised as due to migration of the C–13 : C-14 σ-electrons towards the developing carbonium ion at C-12, followed by elimination of a proton from C-17 to establish a C-13 : C-17 double bond.

The above evidence established the structure of the ketol (Ia) as *ent*-3β-hydroxybeyer-15(16)-ene-2,12-dione.‡ The ready formation of the diene (III) from the 12-oxy-beyer-15(16)-ene (IV) suggests that the structure of (III) represents a new type of diterpene skeleton which may eventually be found in Nature.

This work was supported by grants from the South African Council for Scientific and Industrial Research.

(*Received, August 4th,* 1971; *Com.* 1351.)

---

‡ For the systematic nomenclature of diterpenoids see ref. 5.

[1] D. Lavie, Y. Shvo, O. R. Gottlieb, R. B. Desai, and M. L. Khorana, *J. Chem. Soc.*, 1962, 3259.
[2] J. R. Hanson, *Tetrahedron*, 1970, **26**, 2711.
[3] L. F. Fieser and M. Fieser, "Steroids", Reinhold, New York, 1959, p. 15.
[4] R. Hirschmann, C. S. Snoddy, C. F. Hiskey, and N. L. Wendler, *J. Amer. Chem. Soc.*, 1954, **76**, 4013; J. Elks, G. H. Phillips, D. A. H. Taylor, and L. J. Wyman, *J. Chem. Soc.*, 1954, 1739.
[5] E. Fujita and T. Fujita, *Bull. Inst. Chem. Res., Kyoto Univ.*, 1969, **47**, 522.