The Isolation of Seven New Taxane Derivatives from the Heartwood of Yew (*Taxus baccata* L.)

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Summary Seven new taxane derivatives have been isolated, and characterised on the basis of spectroscopic and other physical data.

RECENTLY we[1] described the isolation of taxa-4(20),11-diene-5α,9α,10β,13α-tetraol (IX), a new taxane derivative from the heartwood of yew (*T. baccata* L.) together with four complex esters named baccatins I—IV. Further examination of the constituents of the heartwood has revealed the presence of a number of other taxane derivatives. The compounds which we have so far fully characterised and assigned structures to on the basis of n.m.r., mass spectral, and other physical data are as follows.

(i) Taxa-4(20),11-diene-5α,9α,10β,13α-tetraol tetra-acetate (taxusin)[2,3] (I) (0·13% yield), $C_{28}H_{40}O_8$, m.p. 126°, $[\alpha]_D$ + 111°, λ_{max} 221 nm., ϵ 6900. Hydrolysis afforded the tetraol, m.p. 198°, referred to above.

(ii) Taxa-4(20),11-diene-5α,9α,10β,13α-tetraol 9α,10β-di-acetate (II) (3·8 × 10^{-4}% yield), $C_{24}H_{36}O_6$, m.p. 235°, $[\alpha]_D$ + 146°, λ_{max} 223 nm., ϵ 4800. Acetylation afforded taxusin.

(iii) Taxa-4(20),11-diene-2α, 5α,9α,10β,13α-pentaol penta-acetate (III) (3·5 × 10^{-4}% yield), $C_{30}H_{42}O_{10}$, m.p. 165°, $[\alpha]_D$ + 46°, λ_{max} 217 nm., ϵ 11,600.

(iv) Taxa-4(20),11-diene-5α,7β,9α,10β,13α-pentaol penta-acetate (IV) (1·4 × 10^{-3}% yield) $C_{30}H_{42}O_{10}$, m.p. 205—207°, $[\alpha]_D$ + 92°, λ_{max} 211nm., ϵ 8100. Hydrolysis afforded the pentaol, m.p. 194—195°, $[\alpha]_D$ + 65° λ_{max} 224 nm., ϵ 8700, and the pentaol 9α,10β,13α-triacetate m.p. 180°, $[\alpha]_D$ + 106°, λ_{max} 225 nm., ϵ 6400.

(v) Taxa-4(20),11-diene-2α,5α,7β,9α,10β,13α-hexaol hexa-acetate (V) (4·5 × 10^{-4}% yield) $C_{32}H_{44}O_{12}$, m.p. 197°, $[\alpha]_D$ + 31°, λ_{max} 213 nm., ϵ 11,100. The corresponding 5α-cinnamate (TJ) has been found by Nakanishi and his co-workers[4] in *T. cuspidata* Sieb et Zucc.

(vi) Taxa-4(20)11-diene-2α,5α,7β,10β-tetraol 5α,7β,10β-triacetate 2α-α-methylbutyrate (2 × 10^{-3}% yield) (VI) $C_{31}H_{46}O_8$, m.p. 115°, $[\alpha]_D$ 45, λ_{max} 209 nm., ϵ 9100.

The α-methylbutyrate group is placed at C-2 because partial hydrolysis of the 3-acetate groups afforded a tetraol α-methylbutyrate the n.m.r. spectrum of which still had the C-2 proton at τ 4·38 bs, $W_{\frac{1}{2}}$ 6Hz.

(vii) Taxa-4 (20)11-diene-2α,5α,7β,9α,10β-pentaol 7β,9α, 10β-triacetate 2α-α-methylbutyrate (VII) (1·2 × 10^{-3}% yield) $C_{31}H_{46}O_9$, m.p. 227—229°, $[\alpha]_D$ + 63°, λ_{max} 215 nm., ϵ 10,400. Acetylation afforded the 5α, 7β,9α,10β-tetra-acetate 2α-α-methylbutyrate (VIII), m.p. 155—156°, $[\alpha]_D$ + 56°, λ_{max} 214 nm., ϵ 9200, which was also obtained in 8 × 10^{-4}% yield from the heartwood.

The n.m.r. data are given in the accompanying table.

All the compounds showed the very typical bands due to the four methyls of the tax-11-ene system together with the bands at *ca.* τ 4·7 and 5·1 due to the =CH_2 of the $\Delta^{4(20)}$

N.m.r. data (*τ units*) (J *and* W$_{\frac{1}{2}}$ *values given in Hz*)

		H on carbon atom carrying oxygen						CH_3 groups on				
Compound	$=CH_2$	C-2	C-5	C-7	C-9	C-10	C-13	C-8	C-12	C-15	C-15	*H* C-3
(I)	4·79, 5·21	—	4·64t *J* 3	—	4·12d *J* 10·8	3·95d *J* 10·8	4·14q *J* 8 & 3	9·25	7·75	8·37	8·88	7·0m $W_{\frac{1}{2}}$ 7
(II)	4·92, 5·26	—	5·69bs $W_{\frac{1}{2}}$ 7	—	4·16d *J* 10·8	3·90d *J* 10·8	5·66q *J* 5 & 8	9·29	7·78	8·48	9·09	6·71 $W_{\frac{1}{2}}$ 7
(III)	4·65, 5·20	4·52q *J* 2 & 7	4·68bs $W_{\frac{1}{2}}$ 6	—	4·05d *J* 10·5	3·95d *J* 10·5	4·09q *J* 8 & 2	9·10	7·83	8·32	8·86	6·78d *J* 6
(IV)	4·68, 5·01	—	4·58t *J* 3	4·41q *J* 6 & 10·5	4·03d *J* 11·5	3·75d *J* 11·5	4·01	9·13	7·86	8·35	8·85	7·05m $W_{\frac{1}{2}}$ 7
(V)	4·60, 5·13	4·45q *J* 3 & 7	4·52t	4·67q *J* 3 & 8	4·06d *J* 10·5	3·82d *J* 10·5	4·05	8·97	7·75	8·22	8·83	6·78d *J* 7
(VI)	4·70, 5·18	4·60q *J* 2·5 & 6	4·68	5·00q *J* 4 & 9	—	3·91q *J* 6 & 11	—	9·18	7·83	8·32	8·86	7·04d *J* 6
(VII)	4·80, 5·19	4·57q *J* 3 & 7	5·77bs $W_{\frac{1}{2}}$ 7	4·93q *J* 5 & 9	4·16d *J* 10	3·88d *J* 10	—	9·14	7·83	8·26	8·88	6·66d *J* 7
(VIII)	4·68, 5·11	4·54q *J* 2·5 & 6	4·64	5·00q *J* 5 & 9	4·15d *J* 11	4·02d *J* 11	—	9·12	7·81	8·28	8·85	6·99d *J* 6

double bond. The presence of ester oxygen at C-9 and C-10 is indicated by the characteristic doublets with *J ca.* 10 Hz at *ca.* τ 3·9 and 4·1. Oxygen at C-2 is indicated by both the signal of the hydrogen at the carbon and by the doublet (*J ca.* 7) due to the hydrogen at C-3. The presence of ester oxygen at C-5 leads to a triplet or broad singlet for the hydrogen at C-5 at about τ 4·6 (or τ 5·8 for OH) while oxygen at C-7 leads to a quartet for the C-7 hydrogen with *J ca.* 5 and 9 Hz. Finally, the hydrogen at C-13 carrying ester oxygen appears at *ca.* τ 4·0—4·1 as a quartet. The pairs of compounds (I) and (II) and compounds (III) and (IV) differ from one another by the presence or absence of an acetate group at C-2. With the first pair ΔM_D is 325°, for the second 291°.

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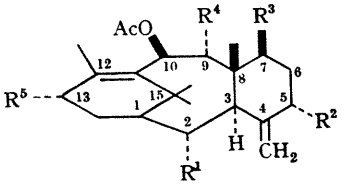

	R¹	R²	R³	R⁴	R⁵	
(I)	H	OAc	H	OAc	OAc	
(II)	H	OH	H	OAc	OH	
(III)	OAc	OAc	H	OAc	OAc	
(IV)	H	OAc	OAc	OAc	OAc	
(V)	OAc	OAc	OAc	OAc	OAc	
(VI)	*	OAc	OAc	H	H	
(VII)	*	OH	OAc	OAc	H	
(VIII)	*	OAc	OAc	OAc	H	
(IX)	H	OH	H	OH	OH	and OH at C-10

* α-Methylbutyrate.

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