

NEW LIGNANS FROM DACRYDIUM INTERMEDIUM: PMR AND CMR SPECTROSCOPY
OF PHENYLTETRALIN LACTONES AND ACETALS

Richard C. Cambie* and John C. Parnell

Department of Chemistry, University of Auckland, New Zealand

Russell Rodrigo

Department of Chemistry, Wilfrid Laurier University, Waterloo, Canada

During an examination of the New Zealand Podocarpaceae¹ we have investigated the heartwood constituents of Dacrydium intermedium T. Kirk, the bark of which has been shown to be a rich source of ecdysones.² We report here the structure of three compounds related to α - and β -conidendrins, which are the first examples of lignan acetals. Extraction of the wood with ether followed by chromatography of the extract on silica gel gave a lignan fraction which was acetylated and separated into five major components by reversed-phase preparative HPLC (water - methanol). Three were obtained pure by this means (but not by any other) and were identified as (1) (mp 201^o, $[\alpha]_D -76.3^o$), (2) (mp 156-157^o, $[\alpha]_D + 59.3^o$), and (3) (mp 164-165^o, $[\alpha]_D + 57.7^o$)

¹H nmr (220 MHz) spectral details of the non-aromatic ring protons of 1, 2, and 3 and of the diacetates 4 and 5 of α - and β -conidendrin are given in Table 1; other absorptions were unexceptional and are consistent with the proposed structures. The close correspondence of the coupling constants and chemical shifts of 1 and 4 allows their assignment to the same stereochemical series (all trans C₁-C₂-C₃) while the results for 2, 3, and 5 clearly indicate that their B/C ring junction is *cis*. Models and observed couplings indicate a chair conformation for ring B in 1 and 4 but a twist boat in 2, 3, and 5 where ring D adopts a quasi-axial conformation. Models also establish the relative configurations at C_{3a} in 1, 2, and 3 to be as shown since their H₂ - H_{2a} couplings constitute an internal standard for the *cis* and *trans* E/C systems. The appearance of H_{3a} as a singlet in the spectra of 2 and 3 is consistent with a dihedral angle of ca. 90^o observed in models.

The mass spectral behaviour of 1, 2, and 3 reinforces the structural proposals, each compound giving peaks corresponding to the molecular ions and to the stepwise loss of two ketene units. Strong peaks corresponding to the loss of the fragments ROH and RO• from both the molecular ions and the deacetylated products were also evident. In addition, plausible structures consistent with the decomposition of a phenyltetralin skeleton can be drawn for common ions which appeared at m/e 341, 340, 216, 175, and 137.

^{13}C nmr assignments for 1 - 5 are given in Table 2. These are based on standard chemical shift theory and are aided by observed SFORD multiplicities, published and unpublished model studies, and by first order interpretation of spin coupling patterns in the fully coupled spectra. C_1 (in 1, 2, 4 and 5) and C_{3a} (in 1 and 2) were assigned by high power irradiation of H_1 and H_{3a} respectively. C_2 and C_3 in α -conidendrin diacetate (4) were differentiated by comparison of the shifts resulting from the closure of ring B in a model system³ of identical stereochemistry (Table 3). Results obtained by this method for C_1 and C_4 are also in good agreement with the assignments made independently for these atoms. Assignments for C_1 , C_2 , and C_3 in the B/C *cis* isomer β -conidendrin diacetate (5) depend upon high power irradiation (C_1) and specific deuteration⁴ (C_3). Assignments of C_2 and C_3 in the acetals 1, 2, and 3 are based on similar comparisons to the above with published resonances⁵ of 9 and 10 (Table 3). Again, independently assigned resonances of C_{2a} and C_4 provide an internal test.

The structures of 1 and 2 were confirmed by conversion into optically active samples of 4 and 5 respectively, by treatment of the former with BF_3 -etherate and *m*-chloroperbenzoic acid.⁶ Since the absolute configurations of 4 and 5 are known⁷ the absolute configuration of 1 and 2 follows. Cubebin, a hemi-acetal, is the only previous example of a reduced lactonic lignan.⁸ Compound (3), the least abundant of the acetals from D. intermedium is a rare example of a natural product containing an O-ethyl group.

TABLE 1. ^1H nmr resonances (δ) and coupling constants (Hz) of non-aromatic protons (CDCl_3)

Lignan	H_1	H_2	$\text{H}_{2a}\text{-eq}$	$\text{H}_{2a}\text{-ax}$	H_3	H_{3a}	$\text{H}_4\text{-eq}$	$\text{H}_4\text{-ax}$
<u>4</u>	4.08 d(10)	2.60 m	4.27 q(9,6.5)	4.02 q(9,10)	2.65 m		3.30 q(16.5,5)	3.05 q(16.5,11)
<u>1</u> ^a	3.93 d(10)	2.4 m	3.87 q(8.5, 6.5)	3.84 q(8.5,10)	2.3 m	5.05 d(5.5)	3.11 q(15.5,5)	2.91 q(15.5,11.5)
<u>5</u> ^b	3.67 d(10.5)	3.00 m	4.06 q(10,3)	4.36 q(10,7)	3.1 m ^c		3.23 (16) ^c	2.96 (16) ^c
<u>2</u>	3.59 d(10)	2.50- 2.82 m	3.68 q(9,2.5)	3.96 q(9,7)	2.50- 2.82 m	4.89 s	3.05 m	2.50- 2.52 m
<u>3</u>	3.59 d(10)	2.50- 2.82 m	3.68 q(9,2.5)	3.98 q(9,7)	2.50- 2.82 m	5.0 s	3.05 m	2.50- 2.82 m

^a in pyridine- d_5

^b H_2 and H_4 determined from 3-deutero compound

^c ABC system

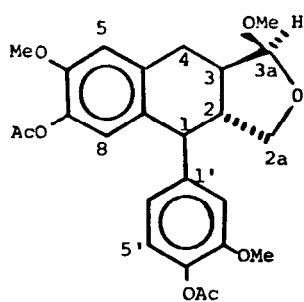
TABLE 2. ^{13}C nmr resonances (δ in p.p.m. from TMS)

	4	1	5	2	3		4	1	5	2	3	
C ₁	d	49.7	49.1	46.6	47.5	47.6	C _{8a}	s	130.5	131.3	131.4	133.1
C ₂	d	47.3	49.5	41.2	45.8	46.0	C _{1'}	s	140.8	142.6	138.6	140.1
C _{2a}	t	71.5	70.9	71.2	70.6	70.8	C _{2'}	d	111.9	112	113.1	113.4
C ₃	d	41.5	47.6	38.6	44.8	45.1	C _{3'}	s	151.5	151.2	151.4	151.2
C _{3a}	s	176.4		179.1			C _{4'}	s	139	138.6	139	138
C ₄	d		109.9		110.6	109.6	C _{5'}	d	123.1	122.8	121.9	121
C _{4a}	t	29.6	31.9	28.4	31.6	31.7	C _{6'}	d	120.6	120.6	120.9	121.4
C ₅	s	133.6	134.9	133.9	136	136.1	ArOMe	t	55.9	55.7	55.8	55.8
C _{5a}	d	113	112.8	112.1	111.7	111.8	C _{3a} OMe	t	-	56.4	-	54.4
C ₆	s	149.9	149.5	149.9	149.3	149.6	OCOMe	t	20.5	20.5	20.7	20.6
C ₇	s	138.3	138	138	137.8	138.1	OCOMe	s	168.9	168.6	168.9	168.9
C ₈	d	123.6	123.5	123.2	123	123.1	C _{3a} OEt	t,q	-	-	-	-

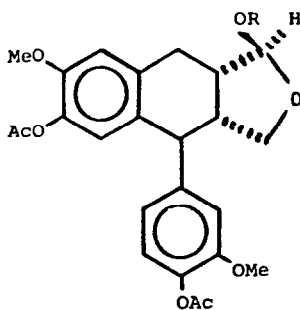
TABLE 3. Shift parameters for C₁ - C₄ and C_{2a}

	6	7	$\Delta(7-6)$	8	4 _{obs}	4 _{calc.}	$\Delta(1-4)$	$\Delta(2-5)$	$\Delta(9-10)^*$
C ₁	35.8	48.0	+ 12.2	38.3	49.7	50.5	- 0.6	+ 0.9	
C ₂	43.7	48.2	+ 4.5	40.9	47.3	45.4	+ 2.2	+ 4.6	+ 4.0
C ₃	43.7	39.9	- 3.8	46.5	41.5	42.7	+ 6.1	+ 6.2	+ 5.8
C ₄	35.8	33.2	- 2.6	34.5	29.6	31.9	+ 2.3	+ 2.2	
C _{2a}				71.5			- 0.6	- 0.6	- 1.4

* for atoms equivalent to C₂, C₃, and C_{2a}

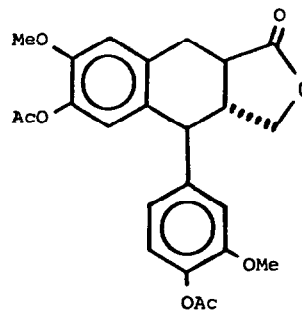


(1)

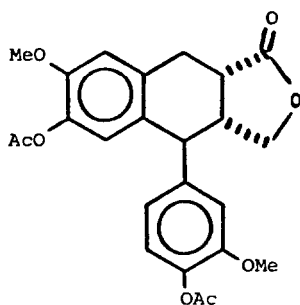


(2) R = Me

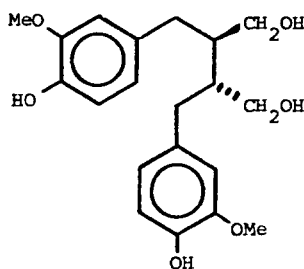
(3) R = Et



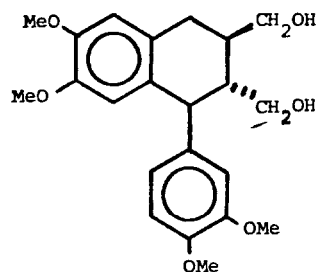
(4)



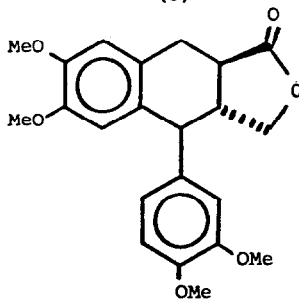
(5)



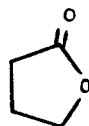
(6)



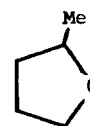
(7)



(8)



(9)



(10)

References:

1. For a summary of constituents see R.C. Cambie, *J. Roy. Soc. N.Z.*, **6**, 307 (1976).
2. G.B. Russell, P.G. Fenemore, D.H.S. Horn, and E.J. Middleton, *Aust. J. Chem.*, **25**, 1935 (1972)
3. S.F. Fonseca, J. de P. Campello, L.E.S. Barata, and E.A. Ruveda, *Phytochem.*, **17**, 499 (1978).
4. W.M. Hearon, H.B. Lackey, and W.W. Moyer, *J. Org. Chem.*, **73**, 4005 (1951).
5. L.F. Johnson and W.C. Jankowski, 'Carbon-13 NMR Spectra', Wiley Interscience, 1972. Spectra Nos. 60 and 123.
6. P.A. Grieco, T. Oguri, and Y. Yokoyama, *Tetrahedron Lett.*, 419 (1978).
7. T.J. Petcher, H.P. Weber, M. Luhn, and A. von Wartburg, *J.C.S. Perkin II*, 288 (1973); J.L. Hartwell and A.W. Schrecker, *Fortschr. Chem. Org. Naturstoffe*, **15**, 83 (1958).
8. J.E. Batterbee, R.S. Burden, L. Crombie, and D.A. Whiting, *J. Chem. Soc. C*, 2470 (1969).

Acknowledgements: One of us (RR) thanks the National Research Council of Canada for support.