

Synthesis and X-Ray Crystal Structure of Fruticosonine, a Novel Indole Alkaloid from a New Zealand *Aristotelia* sp. (Elaeocarpaceae)

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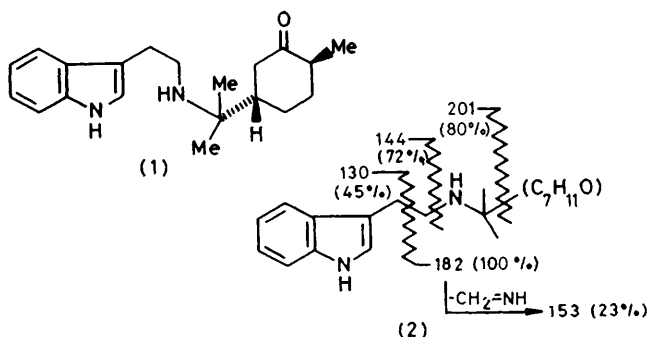
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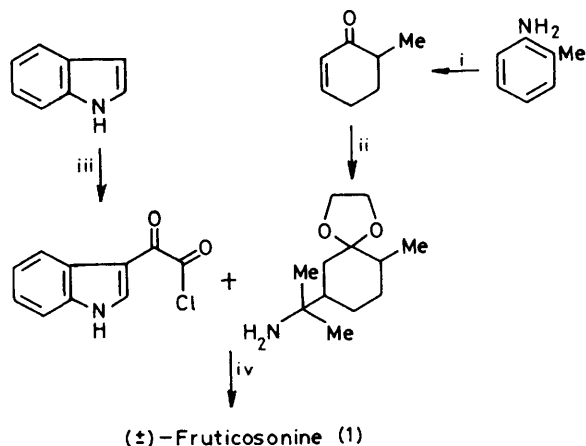
Summary The structure of fruticosonine, a new type of indole alkaloid from *A. fruticosa*, has been determined by X-ray crystallography and by synthesis.

A RANGE of novel indole alkaloids has been isolated from *Aristotelia* spp. from Tasmania,¹ New Zealand,² and Chile.³ Another New Zealand species not previously examined, *A. fruticosa* Hook. f., contains small amounts of at least four alkaloids in its roots and stems. One of these, isolated in 0.005% yield from dry plant material, crystallised from ether, m.p. 120–121 °C, $[\alpha]_D^{20} + 45.7^\circ$ ($c = 0.5$, CHCl_3). Spectroscopic examination showed it had the molecular formula $\text{C}_{20}\text{H}_{28}\text{N}_2\text{O}$ with an open-chain or 6-membered ring oxo group; it also had an indole nucleus unsubstituted at position 2, which was confirmed by a positive Ehrlich test. Furthermore, n.m.r. spectroscopy indicated that two geminal C-methyl groups were present, but no olefinic group. The mass spectrum suggested the partial structure (2); the presence of two methylene groups between the indole

ring and the aliphatic nitrogen atom were in accordance with a 4-proton multiplet between δ 2.96 and 2.86 in the ^1H n.m.r. spectrum, which suggested, moreover, that the $\text{C}_7\text{H}_{11}\text{O}$ fragment could be present as a 2-methylcyclohexanone residue. These tentative deductions have been confirmed by X-ray crystallography and by synthesis.



Crystal data: fruticosonine (**1**), $C_{20}H_{23}N_2O$, M 312.5, tetragonal, $a = 8.847(2)$, $c = 47.857(9)$ Å; $D_m = 1.12(2)$, $D_c = 1.108$ g cm $^{-3}$, $Z = 8$, space group $P4_32_12$, $F(000) = 1360$. Single crystal X-ray data between the limits $6^\circ < 2\theta < 120^\circ$ were measured with a Philips PW 1100 diffractometer, using the ω -scan technique with graphite



SCHEME. i, Li, NH $_3$, BuOH (G. Stork and W. N. White, *J. Amer. Chem. Soc.*, 1956, **78**, 4604); ii, (a) Me $_2$ CHNO $_2$, EtONa, (b) HOCH $_2$ -CH $_2$ OH, MeC $_6$ H $_4$ -*p*-SO $_3$ H, (c) NaBH $_4$, Pd-C, MeOH; iii, ClCO-COCl (K. N. F. Shaw, A. McMillan, A. G. Gudmundson, and M. D. Armstrong, *J. Org. Chem.*, 1958, **23**, 1171); (a) LiAlH $_4$, (b) H $_2$ O, H $^+$.

monochromated Cu-K $_{\alpha}$ radiation; 1428 unique data [$I \geq 3\sigma(I)$] were recorded. The structure was partially solved using direct methods (MULTAN 4), and the remaining non-hydrogen atoms were located in the subsequent difference Fourier synthesis. Hydrogen atom co-ordinates were calculated (Sheldrick 5) and all atomic parameters (non-hydrogen with anisotropic, hydrogen with isotropic thermal parameters) were refined by least-squares techniques. At convergence the R -factor for the 1428 data was 0.062. It was not possible to determine the absolute configuration; structure (**1**) represents the relative stereochemistry.†

Racemic fruticosonine, synthesised by the route shown in the Scheme, had identical spectra to those of the natural base.

Fruticosonine or a close analogue, formed from tryptophan and a simple unarranged terpene unit, probably constitutes an early stage in the biosynthesis of other *Aristolelia* alkaloids.

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† The atomic co-ordinates for this work are available on request from the Director of the Cambridge Crystallographic Data Centre, University Chemical Laboratory, Lensfield Road, Cambridge CB2 1EW. Any request should be accompanied by the full literature citation for this communication.

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³ D. S. Bhakuni, M. Silva, S. A. Matlin, and P. G. Sammes, *Phytochemistry*, 1976, **15**, 574; M. Bittner, M. Silva, E. M. Gopalakrishna, W. H. Watson, V. Zabel, S. A. Matlin, and P. G. Sammes, *J.C.S. Chem. Comm.*, 1978, 79.

⁴ G. Germain, P. Main, and M. M. Woolfson, 'MULTAN: a System of Computer Programs for the Automatic Solution of Non-centrosymmetric Crystal Structures,' see: *Acta Cryst.*, 1970, **B26**, 274.

⁵ G. M. Sheldrick, 'SHELX-76, a Program for Crystal Structure Determination,' Cambridge, 1976.