

## Iridoids: The Revised Structure of Specionin

Erik Van der Eycken, Johan Van der Eycken, and Maurits Vandewalle\*

State University of Gent, Department of Organic Chemistry, Laboratory for Organic Synthesis, Krijgslaan, 281 (S.4), B-9000 Gent, Belgium

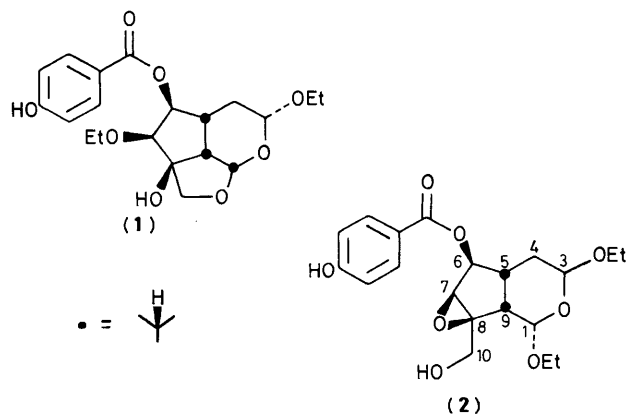
The revised structure of specionin has been proved by total synthesis; the key step involves a Norrish I type fragmentation of a norbornanone precursor.

The iridoid specionin has been isolated from the leaves of *Catalpa speciosa* Warder and has been assigned the structure (1) on the basis of spectral data.<sup>1</sup> It is an effective antifeedant against the Eastern spruce budworm which infests North American fir and spruce forests.

Recently we have synthesized substance (1) and observed that it was not identical with the natural material.<sup>2</sup> Comparison of the spectral data of the synthetic and natural substances led us to propose structure (2) for specionin. For both substances the relative configurations of H-1, -5, -6, -7, and -9 are identical as has been confirmed by nuclear Overhauser effect measurements.<sup>1,2†</sup> The proposed structure (2) was mainly based on the <sup>13</sup>C n.m.r. data.<sup>2,3</sup>

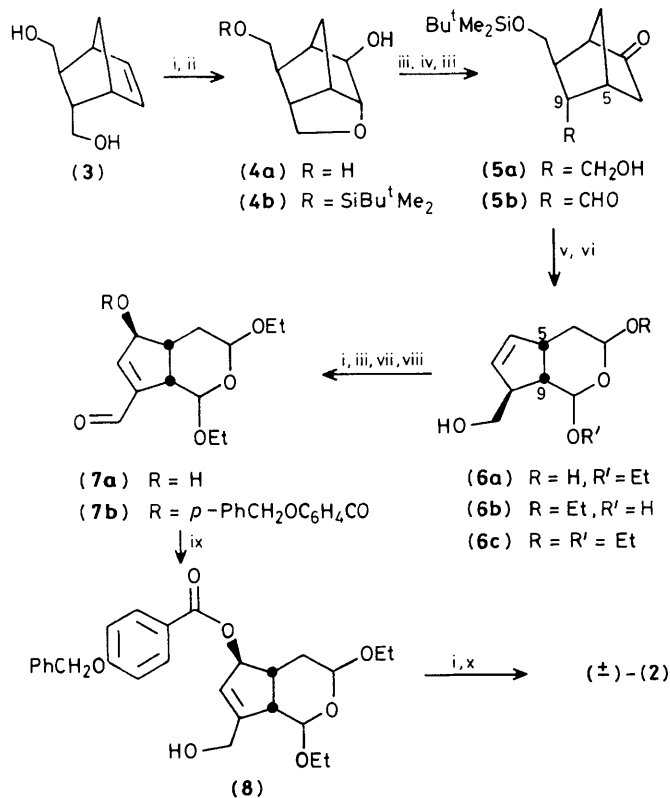
In this communication we describe the synthesis of (±)-(2) which confirms this structure for specionin.‡ The starting material is the known compound (3);<sup>4</sup> *m*-chloroperbenzoic acid (*m*CPBA) induced cyclization to (4a) (95%) followed by selective protection of the primary hydroxy function afforded (4b) (81%). Successive Swern oxidation<sup>5</sup> (77%) and reductive cleavage of the ether bond, to the carbonyl function, led to (5a) (94%). After oxidation of the hydroxy function to the

aldehyde (5b) (96%), Norrish I type fragmentation of the norbornanone framework and direct acid treatment of the crude intermediates (6a) and (6b) (no dialdehyde could be detected) afforded with concomitant silyl ether cleavage a mixture of the four diastereoisomers (at C-1 and C-3) (6c) in 64% overall yield (ratio 1 : 4 : 1 : 4 for respectively C-1 and C-3 OEt; αβ, ββ, βα, and αα). The stage was now set for the functionalization of the five-membered ring. Although the isomers can be separated we decided, as a first approach, to use the mixture in the subsequent steps. Epoxidation of (6c), from the least hindered *exo* face (94%) followed by oxidation of the alcohol to the aldehyde and 1,8-diazabicyclo[5.4.0]-



† The relative configuration of 3-H has only been proved for (1); the configuration at C-3 in the natural material is uncertain (see ref. 1).

‡ Satisfactory spectroscopic (<sup>1</sup>H n.m.r., i.r., and mass) data were obtained for all isolated pure compounds. For the mixtures (6) to (8) only details of the <sup>1</sup>H n.m.r. spectra were of diagnostic value. All yields are isolated yields.



**Scheme 1.** Reagents: i, *m*CPBA, CH<sub>2</sub>Cl<sub>2</sub>, room temp.; ii, Bu<sup>t</sup>Me<sub>2</sub>SiCl, DBU, CH<sub>2</sub>Cl<sub>2</sub>, room temp.; iii, (COCl)<sub>2</sub>, dimethyl sulphoxide, Et<sub>3</sub>N, CH<sub>2</sub>Cl<sub>2</sub>, -60 °C; iv, Al-Hg, EtOH, tetrahydrofuran, room temp.; v, irradiation at 254 nm, EtOH; vi, MeC<sub>6</sub>H<sub>4</sub>SO<sub>2</sub>OH, EtOH, room temp.; vii, DBU, CH<sub>2</sub>Cl<sub>2</sub>, room temp.; viii, *p*-PhCH<sub>2</sub>OC<sub>6</sub>H<sub>4</sub>COCl, Et<sub>3</sub>N, CH<sub>2</sub>Cl<sub>2</sub>, room temp.; ix, NaBH<sub>4</sub>, EtOH, 0 °C; x, Pd-C, H<sub>2</sub>, EtOH.

undec-7-ene (DBU) mediated epoxide opening (β-elimination) gave (7a) (52%). Formation of the 6-(*p*-benzyloxy)benzoate (7b) and reduction of the aldehyde function led to (8) (45% unoptimised yield). Because of problems in separating the products from the reagent (h.p.l.c.) only part of the mixture (with a different ratio) was carried through the final steps. Finally, epoxide formation and deprotection of the phenolic function (*ca.* 60% unoptimised yield) gave a mixture of the four (C-1, C-3) diastereoisomers. H.p.l.c. separation (reversed phase column RSiL-C18-HL-D, eluent MeOH-H<sub>2</sub>O) allowed isolation of a sample of synthetic (±)-(2) which was identical (<sup>1</sup>H n.m.r. spectroscopy, h.p.l.c. and g.c. retention times on co-injection) with an authentic sample of spicinin.

As the starting material (3) is available in enantiomerically pure form<sup>6,7</sup> the route described would permit the asymmetric synthesis of (2).

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