

THE ISOLATION OF HORDENINE AND NORSECURININE
FROM *SECURINEGA VIROSA* (Baill.).
THE STRUCTURE OF NORSECURININE

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From the ground roots of *Securinega virosa*, hordenine and a new alkaloid (norsecurinine) have been isolated. The structure of the latter alkaloid has been elucidated.

By extracting the ground roots of *Securinega virosa* Baill. with ether, two crystalline bases have been isolated. Of these the first has been shown to be *p*-hydroxy-*NN*-dimethyl- β -phenylethylamine (hordenine). Its identity was established by mixed melting-points of the free base, its hydrochloride and its methiodide, with authentic samples: in no case was any depression noted. Ultra-violet and infra-red spectra were superimposable on those of authentic samples determined under the same conditions. The alkaloid "fluggine" isolated from the same source by Paris, Moyses, Mignon and Le Men (1955) has also been shown to be hordenine. We are indebted to Professor Paris for his kindness in allowing us to examine a sample of his material.

Analysis of the second base and also of the derivatives detailed in the experimental section, suggested a formula of $C_{12}H_{13}O_2N$: a titration equivalent of 197 and a molecular weight (Rast) of 200 confirmed this. A monoacidic base, this material contains no *N*-methyl groups and forms a quaternary salt with one molecular proportion of methyl iodide thus indicating a tertiary nitrogen: this is confirmed by the absence of NH bands in the infra-red spectrum. Carbon methyl, oxygen methyl, and OH groups are likewise absent.

A similar compound (I; $n = 2$) has been isolated from *S. suffruticosa* (Pall) Rehd and from *S. virosa* (Murav'eva and Ban'kovskii, 1959; Saito, Kodera, Sugimoto, Horii and Tamura, 1962; Nakano, Yang and Terao, 1962, 1963; Nakano, Yang, Terao and Durham, 1963). The present material differs in that it is a lower homologue (I; $n = 1$) of the compound isolated by the Russian and Japanese workers. For it we propose the name Norsecurinine.

Absorption at $256\text{ m}\mu$ and at 1802, 1770 and 1640 cm.^{-1} is in agreement with an $\alpha\beta$ unsaturated five membered lactone, where the conjugation is extended by a further double bond. The splitting of the carbonyl peak (1802 and 1770 cm.^{-1}) implies a hydrogen atom alpha to the carbonyl group.

On catalytic hydrogenation over platinum, one molecule of hydrogen is rapidly absorbed, with a second, more slowly.

The mass spectrum of norsecurinine was recorded on an A.E.I. high resolution mass spectrometer type M.S.9; we are grateful to Dr. Snedden and Dr. Bowen, of Shell Research Limited, for carrying this out and for

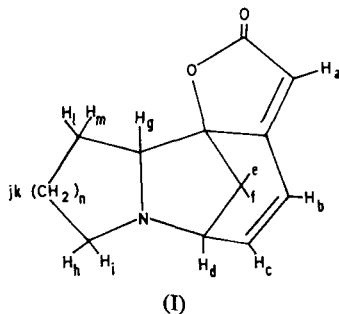
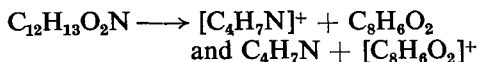
THE STRUCTURE OF NORSECURININE

commenting upon the results. The parent peak at m/e 203 confirms the molecular weight. Major peaks occur at m/e 69, 70, 78, 106, 134, 157 and 203. The precise mass of four of these was determined at a resolution of 1 in 15,000 and led to the unequivocal assignments below:

m/e	Formulae
70	$[C_4H_8N]^+$
78	$[C_8H_6]^+$
106	$[C_7H_6O]^+$
134	$[C_8H_6O_2]^+$

As the ratio of peak intensities at m/e 69 and 70 is dependent on instrumental conditions, this is strong evidence that the 70 peak is due to a rearrangement ion and that the true fragment ion has a mass of 69; it is therefore $[C_4H_7N]^+$.

Fragmentation of the molecule on electron impact thus proceeds readily in the following fashion:



The $[C_8H_6O_2]^+$ ion then loses CO in two separate stages.

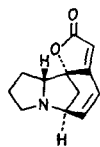


The mass spectrum is therefore clear evidence of the absence of a six membered nitrogen containing ring, and is consistent not only with structure I ($n = 1$) but also with the structure where the nitrogen lies at the alternative bridgehead position between the two five membered rings.

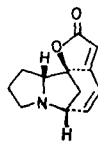
It is on the basis of I ($n = 1$) alone, however, that the proton magnetic resonance spectrum is interpreted. In this two main groups of lines appear; one between 3 and 4.4 τ represents *three* ethylenic protons (a, b and c), the other between 6.2 and 8.4 τ has an integrated area equivalent to *ten* protons (d to m inclusive). Of the lines at low field, a single peak at 4.33 τ arises from H_a . Protons b and c with d form an ABX system and a pattern of six lines between 3 and 3.6 τ forms the AB part of this. The triplet centred at 6.37 τ constitutes the X part of the system. H_d is coupled in turn to H_b ($J \approx 0.5$ c/s.) to H_c ($J \approx 6$ c/s.) and also vicinally to H_e and H_f . Since only a *cis* fusion of the methylene bridge

across the seven membered ring can obtain, there are two geometric forms II (a) and II (b).

In both, Dreiding models indicate dihedral angles $\theta \simeq 40^\circ$ and 70° for H_d with H_e and H_f . From the data of Conroy (1960) this yields coupling constants $J \simeq 4.5$ and 0.5 c/s. respectively. These lead to the triplet in which unresolved fine splitting is apparent. For H_f which appears at higher field to the triplet the coupling constant J_{fd} may be extracted and the geminal coupling constant for the protons f and e ($J \simeq 11$ c/s.) then follows as in Fig. 1. This is also seen in the five proton multiplet at highest field to which j, k, l and m are also assigned. This leaves protons g, h, and i all positioned α to the nitrogen atom. One of these three gives part of the signal between 7.2 and 7.8τ , the other two the signal between 6.6 and 7.1τ . Proton g should be found in the latter group since it is β to the oxygen as well as α to the nitrogen atom: it is thus the least shielded of g, h, and i. Proton h is also assigned with g, these two being *cis* with respect to one another. By elimination H_1 falls in the multiplet 7.2 – 7.8τ . We conclude from these results that II(a) or II(b) or their mirror images represents the structure of norsecurinine.



(IIa)



(IIb)

EXPERIMENTAL

Isolation of bases from *Securinega virosa*: Powdered whole root (12 kg.) was defatted with light petroleum (b.p. 60 – 80°). After drying, it was macerated (18 hr.) with 15 per cent ammonia in ethanol (6 litres) then extracted (24 hr.) in a soxhlet apparatus with ether. Total bases were removed from the ether extract with N hydrochloric acid, the acid extract was made alkaline with ammonium hydroxide (0.88) and extracted again with ether. Evaporation of this extract gave a viscous yellow oil (A).

The residual aqueous mother liquors were evaporated to dryness under reduced pressure (temp. $\gt 60^\circ$) and the crude mixture of ammonium chloride and organic bases washed with ethanol. The ethanol extract was evaporated to half-volume then diluted with twice its volume of ether and refrigerated. A mixture of ammonium chloride and Base II hydrochloride (1.9 g.) resulted. The mother liquors were again evaporated to half-volume, diluted with thrice their volume of ether and again refrigerated: a further quantity of Base II hydrochloride (4 g.) was obtained. Two more cycles of the mother liquors yielded crops of 2 g. and 8 g. of Base I and Base II hydrochlorides (B) respectively.

Hordenine. The viscous yellow oil (A) crystallised from carbon tetrachloride in colourless prisms m.p. 117.5° (Henry 1949, cites m.p. 117 – 118°). Found: C, 72.4; H, 9.2; N, 8.9; O, 9.8; NCH_3 , 24.1.

THE STRUCTURE OF NORSECURININE

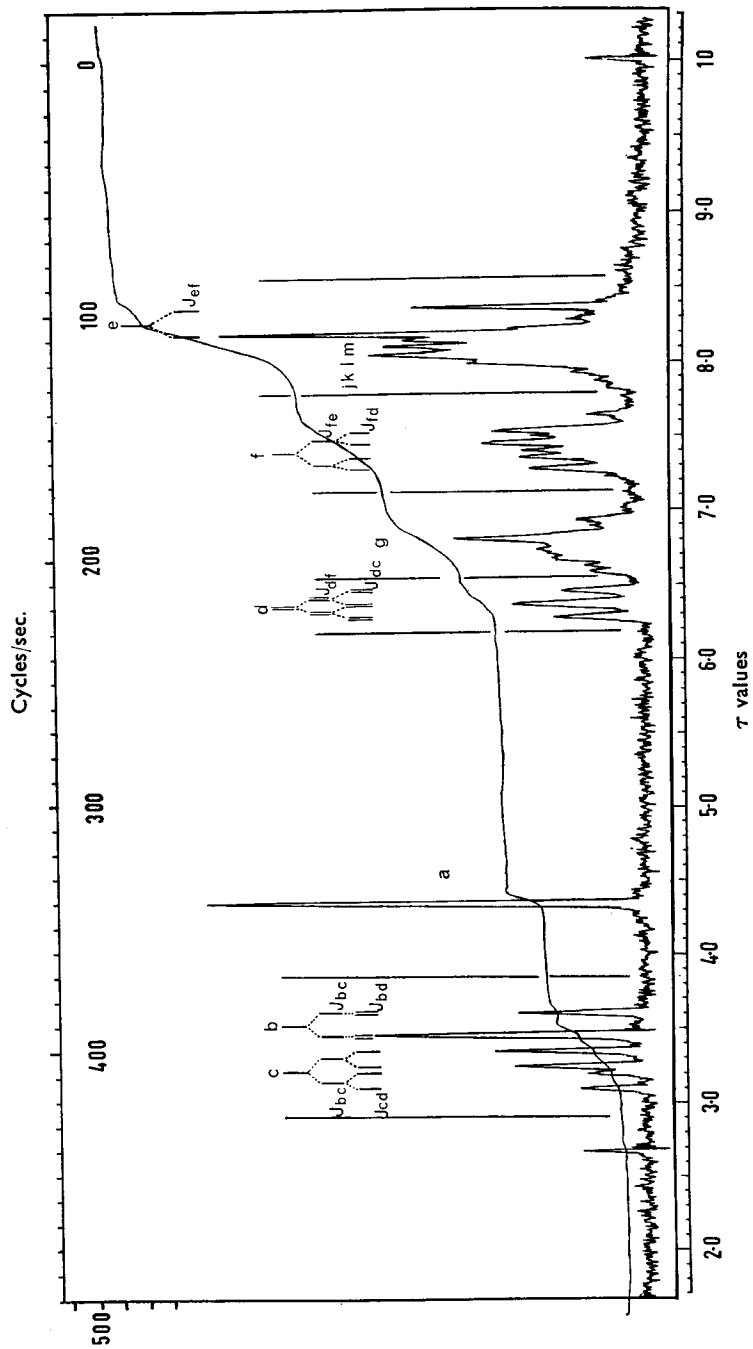


FIG. 1. N.M.R. spectrum of norsecurinine.

Calc. for $C_{10}H_{15}NO$, C, 72.7; H, 9.2; N, 8.4; O, 9.7; NCH_3 , 26.7 per cent. The base had a titration equivalent 165; pK_a 8.55; λ_{max} in N HCl 222 $m\mu$ (ϵ 7,700), 275 $m\mu$ (ϵ 1,350), in N NaOH 237.5 $m\mu$ (ϵ 9,500) 293.5 $m\mu$ (ϵ 2,150) ν_{max} 3570 cm^{-1} (phenolic OH) 1169 cm^{-1} (phenol) 825 cm^{-1} (1,4) disubstituted benzene.

The hydrochloride crystallised from ethanol ether in colourless prisms m.p. 177–178° (Henry, 1949, cites m.p. 176.5–177.7°).

The methiodide crystallised from methanol m.p. 226–228° [lit. (Henry, 1949) cites m.p. 229–230°].

Norsecurinine: the hydrochloride (B) (4 g.) was mixed with anhydrous sodium carbonate (4 g.). To this, water (1 ml.) was added and the mixture was dried at 20° *in vacuo*. The dried material was then extracted for several hours in a soxhlet extractor with light petroleum (b.p. 40–60°). On cooling, norsecurinine was obtained in colourless needles, m.p. 81–82°, $[\alpha]_D^{20}$ – 19.5° (*c*, 0.2 in ethanol). Found: C, 70.8; H, 6.4; N, 7.1; O, 16.3. $C_{12}H_{13}NO_2$ requires C, 70.9; H, 6.4; O, 15.8; N, 6.9 per cent. Molecular weight (Rast) 200; titration equivalent 197; pK_a 6.85. λ_{max} (in ethanol) 255.5 $m\mu$ (ϵ 22,000); in 2*N* NaOH 260 $m\mu$ (ϵ 22,000) ν_{max} (in carbon tetrachloride) 1802 and 1770 cm^{-1} (CO of an $\alpha\beta$ unsaturated lactone) 1640 cm^{-1} (C=C). In ethanol over Adams' platinum oxide, norsecurinine absorbed 2 molecular proportions of hydrogen, the first rapidly, the second slowly.

Norsecurinine sulphate: a solution of conc. sulphuric acid (4 drops) in ether (1 ml.) was added to the above base (49 mg.) in ether (2 ml.). The precipitated sulphate (57 mg.) was recrystallised from ethanol/ether to give m.p. 224–225°. Found: C, 47.9; H, 4.6; N, 4.8; O, 29.5; S, 11.1; $C_{12}H_{13}NO_2$, H_2SO_4 requires C, 47.8; H, 5.0; O, 31.9; S, 10.6 per cent.

The *methiodide* was made in the usual way from methyl iodide in dry ether and crystallised from ethanol/ether in bright yellow prisms m.p. 194–195°. Found: C, 45.0; H, 4.6; I, 36.9; N, 4.1; O, 9.4; NCH_3 , 8.5. $C_{13}H_{16}O_2$ N I requires C, 45.3; H, 4.6; I, 36.8; N, 4.1; O, 9.3 per cent.

The *metho-p-toluenesulphonate* prepared in the usual way crystallised from ethanol-ether in colourless needles, m.p. 234–235° C. Found: C, 61.7; H, 6.0; N, 3.7; S, 8.3. $C_{20}H_{23}NO_5S$ requires C, 61.7; H, 5.9; N, 3.6; S, 8.2 per cent.

The *picrate* crystallised from acetone in yellow needles, m.p. 232–233° (decomp.). Found: C, 49.7; H, 3.8; N, 13.3. $C_{18}H_{16}N_4O_9$ requires C, 50.0; H, 3.7; N, 13.0 per cent.

The N.M.R. spectrum was recorded in deuterochloroform with tetramethylsilane as an internal standard (Fig. 1).

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THE STRUCTURE OF NORSECURININE

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