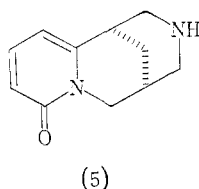
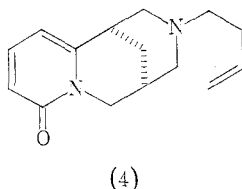
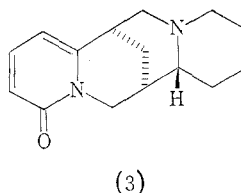
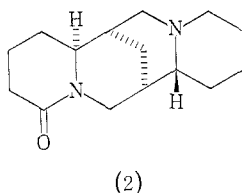
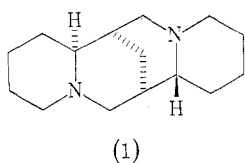


# ALKALOIDS OF *HOVEA ELLIPTICA*

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The genus *Hovea* belongs to the tribe Genisteae of the plant family Leguminosae and it is endemic to Australia. It contains twelve species, six of which are found in south-western Australia.<sup>1,2</sup> Previous chemical work on this genus appears to have been restricted to the isolation of (+)-sparteine (1) from the leaves of two Queensland species—*H. longifolia* R. Br. and *H. acutifolia* A. Cunn.<sup>3</sup>



*H. elliptica* (Sm.) DC. is a tall shrub, known locally as "blue bush", which grows in the karri forests of Western Australia. A methanolic extract of the leaves and terminal branches of this species has now yielded (+)-sparteine (1), (-)-lupanine (2), (-)-anagyrine (3), and (-)-cytisine (5), and the major alkaloid present in the seeds has been identified as (-)-cytisine (5).

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<sup>1</sup> Burbidge, N. T., "Dictionary of Australian Plant Genera." (Angus & Robertson: Sydney 1963.)

<sup>2</sup> Gardner, C. A., "Enumeratio Plantarum Australiae Occidentalis." (Govt. Printer: Perth 1931.)

<sup>3</sup> Morrison, J. H., and Neill, K. G., *Aust. J. scient. Res* (A), 1949, 2, 427.

In 1955, Robinson<sup>4</sup> suggested that the biogenesis of C<sub>15</sub> lupin alkaloids involves stepwise oxidative degradation of sparteine (1). This suggestion has been extended by Leete<sup>5</sup> who has proposed the sequence (1) → (2) → (3) → (4) → (5). The present investigation appears to provide one of the few records of the isolation of (1), (2), (3), and (5) from the same plant. Although rhombifoline (4) could not be detected in the crude bases it seems that *H. elliptica* might prove to be a useful species for further biogenetic studies on these lupin alkaloids.

### Experimental

General remarks concerning experimental procedures which have been made previously<sup>6</sup> also apply to the present work.

#### Extraction of *H. elliptica*

Leaves and terminal branches were collected from flowering plants growing near Denmark, W.A., in November, 1963. The milled, air-dried material (5.8 kg) was extracted with methanol at room temperature, the extract was evaporated under reduced pressure, and the resulting tar was partitioned between ether and water. The ether layer, which gave a negative test for alkaloids, was discarded. The aqueous layer was basified with aq. NH<sub>3</sub> (*d* 0.88) and extracted with chloroform. The alkaloids were re-extracted with 1% HCl, then recovered by basification and extraction with chloroform; evaporation of the solvent then afforded the crude base as a brown gum (9 g). This product was dissolved in the minimum volume of 6% HCl and the solution was washed with methylene chloride, basified, and extracted first with benzene (3 × 80 ml) and then with chloroform (4 × 100 ml). Evaporation of these solutions gave the benzene-soluble bases (3.86 g) and the chloroform-soluble bases (3.73 g) as gums.

#### Isolation of (+)-Sparteine (1), (−)-Lupanine (2), and (−)-Anagyrene (3)

The above benzene-soluble bases were subjected to countercurrent distribution between 0.17M aq. NH<sub>4</sub>OH/0.785M aq. NH<sub>4</sub>Cl buffer (50 ml) and benzene (50 ml) over 17 tubes. The contents of each tube were then analysed by t.l.c., combined, and evaporated to give the following fractions: A (tubes 1–2; 0.1 g), B (tubes 3–6; 0.4 g), C (tubes 7–10; 0.9 g), D (tubes 11–13; 0.6 g), E (tubes 14–17; 0.5 g).

Fraction A was not examined further.

Fraction B was chromatographed on alumina (25 g); elution with a mixture of light petroleum and ether (9 : 1) gave (+)-sparteine as an oil (198 mg),  $[\alpha]_D^{20} + 17^\circ$  (*c*, 1.61 in ethanol) (lit.<sup>3</sup>  $[\alpha]_D^{20} + 16.8^\circ$ , *c*, 7.2 in ethanol). The infrared spectrum (liquid film) of the oil was identical with that of authentic (−)-sparteine prepared from a commercial sample (B.D.H.) of the sulphate. The dipicrate of (+)-sparteine crystallized from methanol as yellow needles, m.p. 203–205° (lit.<sup>3</sup> 203–204.5°) (Found: C, 47.2; H, 4.7; N, 16.3. Calc. for C<sub>27</sub>H<sub>32</sub>N<sub>8</sub>O<sub>14</sub>: C, 46.8; H, 4.7; N, 16.2%).

Further elution of the column with mixtures of light petroleum and ether (3 : 1, then 1 : 1) yielded (−)-lupanine as a gum (140 mg),  $[\alpha]_D^{20} - 78.6^\circ$  (*c*, 3.12 in ethanol) (lit.<sup>7</sup>  $[\alpha]_D - 61.0^\circ$ ; *c*, 3.146 in acetone; lit.<sup>8</sup>  $[\alpha]_D^{20} + 77^\circ$  (ethanol) for (+)-lupanine). The gum had an infrared spectrum (liquid film) identical with that of (+)-lupanine isolated from the seeds of *Lupinus angustifolius*.

<sup>4</sup> Robinson, R., "The Structural Relations of Natural Products." (Clarendon Press: Oxford 1955.)

<sup>5</sup> Leete, E., in "Biogenesis of Natural Compounds." (Ed. P. Bernfeld.) (Pergamon Press: London 1963.)

<sup>6</sup> Cannon, J. R., Joshi, K. R., Meehan, G. V., and Williams, J. R., *Aust. J. Chem.*, 1969, **22**, 221.

<sup>7</sup> Clemo, G. R., Raper, R., and Tenniswood, C. R. S., *J. chem. Soc.*, 1931, 429.

<sup>8</sup> White, E. P., *N.Z. J. Sci. Technol. (B)*, 1943, **25**, 109.

L.<sup>8</sup> The methiodide crystallized from ethanol as prisms, m.p. 258–259° (cap.) (lit.<sup>9</sup> m.p. of (–)-lupanine methiodide 274° (corr.); lit.<sup>8</sup> m.p. of (+)-lupanine methiodide 258°), mixed m.p. with (+)-lupanine methiodide 240–241° (lit.<sup>10</sup> m.p. of (±)-lupanine methiodide 239–241°) (Found: C, 49.2; H, 7.2; N, 7.2. Calc. for C<sub>16</sub>H<sub>27</sub>IN<sub>2</sub>O: C, 49.2; H, 7.0; N, 7.2%). The identification was confirmed by comparison of the infrared spectra (Nujol) of the enantiomeric methiodides.

Fraction C was chromatographed on alumina (30 g). Elution of the column with mixtures of light petroleum and ether (9:1, then 4:1) gave further quantities of (+)-sparteine and (–)-lupanine; elution with ether then yielded (–)-anagryne as a gum (240 mg). The infrared spectrum (liquid film) of the gum corresponded with that recorded for (–)-anagryne.<sup>9</sup> The picrate crystallized from methanol as yellow needles, m.p. 243–244° or 250–251° (dec.), depending on the rate of heating. The same behaviour was shown by an authentic sample of (–)-anagryne picrate, and by a mixture of the two samples. The identification was confirmed by comparison of the infrared spectra (Nujol) of the two samples.

Fraction D also gave (+)-sparteine, (–)-lupanine, and (–)-anagryne after chromatography on alumina.

Fraction E yielded (–)-anagryne and traces of two other bases neither of which was obtained in sufficient quantity to permit characterization.

#### Isolation of (–)-Cytisine (5)

(i) The above chloroform-soluble base was dissolved in benzene and chromatographed on alumina (activity I, 20 g); evaporation of the eluate and crystallization of the residue from dry acetone then yielded prisms (2.9 g), m.p. 155–156° (lit.<sup>11</sup> 155–156°), which was undepressed on admixture with an authentic specimen of (–)-cytisine;  $[\alpha]_D^{20} -120^\circ$  (c, 0.7 in water) (lit.<sup>10</sup>  $[\alpha]_D -119.6^\circ$ , water). The picrate crystallized from water as yellow needles, m.p. and mixed m.p. 287–288° (lit.<sup>11</sup> 288–289°).

(ii) Seeds of *H. elliptica* were obtained from the Western Australian Forestry Department. The seeds (120 g) were milled and extracted with methanol. The crude base, obtained as described above, crystallized. When this product was recrystallized from acetone, (–)-cytisine was obtained as needles, m.p. and mixed m.p. 155–156° (Found: C, 69.7; H, 7.6; N, 14.4. Calc. for C<sub>11</sub>H<sub>14</sub>N<sub>2</sub>O: C, 69.4; H, 7.4; N, 14.7%).

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<sup>9</sup> Marion, L., and Ouellet, J., *J. Am. chem. Soc.*, 1948, **70**, 3076.

<sup>10</sup> Leonard, N. J., in "The Alkaloids." (Eds R. H. F. Manske and H. L. Holmes.) Vol. III. (Academic Press: New York 1953.)

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