

essentially identical with those reported previously.<sup>7,9</sup> The two peaks observed with  $\beta$ -lactoglobulin A can be identified as monomer (slow) and aggregate (rapid). In the "normal" protein an intermediate peak due to  $\beta$ -lactoglobulin B is also present. The ultracentrifugal and electrophoretic data on  $\beta$ -lactoglobulin A as a function of concentration were analyzed in terms of the Gilbert theory,<sup>11</sup> yielding equilibrium constants for the aggregation in good agreement with those obtained from light scattering.<sup>12,13</sup>

From our ultracentrifugal data we conclude, therefore, that the association of  $\beta$ -lactoglobulin in the pH range of 3.7 to 5.2 is due primarily to  $\beta$ -lactoglobulin A, while pure  $\beta$ -lactoglobulin B does not aggregate. This is in direct contradiction of the conclusion of Klostergaard and Pasternak<sup>9</sup> and in agreement with that of Ogston and Tombs.<sup>7</sup> One should remark, however, that the latter reached their conclusion from electrophoretic data alone, which could be open to question in the absence of supporting measurements.

(11) G. A. Gilbert, *Disc. Faraday Soc.*, No. 20, 68 (1955).

(12) R. Townend and S. N. Timasheff, to be published.

(13) The concentration dependence of Klostergaard and Pasternak's<sup>9</sup> electrophoretic data on  $\beta$ -lactoglobulin A is also strong evidence for association.<sup>11</sup>

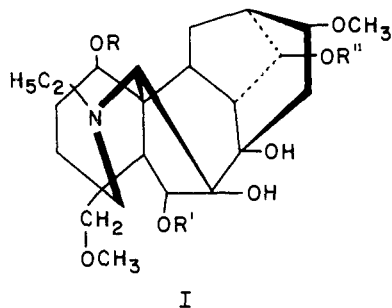
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#### THE INTERRELATION OF DELCOSINE AND DELSOLINE

Sir:

The previous investigation of delcosine (isolated from *Delphinium consolida* L.) had led Anet, Clayton and Marion<sup>1</sup> to assume that the alkaloid possessed the same carbon-nitrogen nucleus as lycotonine<sup>2</sup> and to suggest for it the tentative structure I ( $R = \text{CH}_3$ ,  $R' = R'' = \text{H}$ ). In this formula although  $R'' = \text{H}$  had been established



the evidence for  $R' = \text{H}$  was meager and rested only on the interpretation of the formation of a carbinolamine ether.<sup>1</sup> The presence of a di-tertiary vicinal glycol has been demonstrated chemically.<sup>3</sup> An attempt now has been made to find further evidence for  $R' = \text{H}$ .

(1) R. Anet, D. W. Clayton and L. Marion, *Can. J. Chem.*, **35**, 397 (1957).

(2) M. Przybylska and L. Marion, *ibid.*, **34**, 185 (1956).

(3) R. Anet and L. Marion, *ibid.*, **36**, 786 (1958).

It has been found that diacetyldecosine,<sup>4</sup> when oxidized with potassium permanganate in acetone gave a lactam, diacetyloxodelcosine, m.p. 103–105°.  $[\alpha]^{25\text{D}} + 24.6 \pm 1.4^\circ$  ( $c$ , 0.71 in chloroform). Infrared band at 1644  $\text{cm}^{-1}$  (lactam carbonyl). *Anal.* Calcd. for  $\text{C}_{28}\text{H}_{41}\text{O}_5\text{N}$ : C, 60.96; H, 7.49. Found: C, 60.95; H, 7.42. The formation of a lactam shows the presence of a methylene group next to the nitrogen. Hydrolysis of diacetyloxodelcosine with aqueous methanolic potassium hydroxide produced oxodelcosine, m.p. 245–246°,  $[\alpha]^{25\text{D}} + 44.3 \pm 0.6^\circ$  ( $c$ , 1.84 in chloroform), infrared absorption, 1649 and 1622  $\text{cm}^{-1}$  (split lactam band). *Anal.* Calcd. for  $\text{C}_{24}\text{H}_{37}\text{O}_5\text{N}$ : C, 61.65; H, 7.98. Found: C, 61.75; H, 7.98. Oxodelcosine was oxidized by sodium bichromate in acetic acid to a diketonic product, didehydro-oxodelcosine, m.p. 211–212°,  $[\alpha]^{25\text{D}} + 135.1 \pm 0.9^\circ$  ( $c$ , 1.11 in chloroform), infrared bands at 3446  $\text{cm}^{-1}$  (OH), 1757  $\text{cm}^{-1}$  (cyclopentanone), 1720  $\text{cm}^{-1}$  (cyclohexanone), 1653  $\text{cm}^{-1}$  (lactam carbonyl); ultraviolet,  $\lambda_{\text{max}}$  297  $\text{m}\mu$ ,  $\log \epsilon$  2.07. *Anal.* Calcd. for  $\text{C}_{24}\text{H}_{33}\text{O}_8\text{N}$ : C, 62.19; H, 7.18. Found: C, 62.35; H, 7.12.

The oxidation product is a diketone as expected, but one of the keto groups is in a five-membered ring while the other is in a six-membered ring. According to structure I ( $R = \text{CH}_3$ ,  $R' = R'' = \text{H}$ ), the oxidation product of oxodelcosine should have contained two cyclopentanone rings. Hence, the substituents cannot be as shown in that structure and, to account for the experimental result, it is necessary to alter the suggested structure of delcosine to I ( $R = R'' = \text{H}$ ,  $R' = \text{CH}_3$ ). If this structure be the correct one, then delcosine must be very closely related to delsoline which has been assigned structure I ( $R = \text{H}$ ;  $R' = R'' = \text{CH}_3$ ).<sup>5</sup> Indeed, delsoline should be an O-methyldecosine.

In order to ascertain this point, delcosine was methylated by means of sodium hydride and methyl iodide in dioxane.<sup>6</sup> The product obtained after chromatography on alumina melted at 215–216° undepressed on admixture with delsoline, and its optical activity,  $[\alpha]^{25\text{D}} + 53.4 \pm 0.5^\circ$  ( $c$ , 2.04 in chloroform) was the same as that of delsoline  $[\alpha]^{25\text{D}} + 53.5 \pm 0.5^\circ$  ( $c$ , 2.11 in chloroform). *Anal.* Calcd. for  $\text{C}_{25}\text{H}_{41}\text{O}_7\text{N}$ : C, 64.22; H, 8.84. Found: C, 64.43; H, 8.79. Its infrared spectrum was superimposable on that of delsoline, and its Debye-Scherrer powder diagram was identical with that of delsoline. The methylation was therefore selective and affected only the secondary hydroxyl located on the five-membered ring. The conversion of delcosine to delsoline thus supports the new structure I ( $R = R'' = \text{H}$ ,  $R' = \text{CH}_3$ ) suggested for delcosine.

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(4) W. I. Taylor, W. E. Wallis and L. Marion, *ibid.*, **32**, 780 (1954).

(5) F. Sparatore, R. Greenhalgh and L. Marion, *Tetrahedron*, in press.

(6) M. Carmack, J. P. Ferris, J. Harvey Jr., P. L. Magat, E. W. Martin and D. W. Mayo, *THIS JOURNAL*, **80**, 497 (1958), have used this methylation procedure to establish the relationship of deltaline, delpheline and lycotonine.

(7) National Research Council of Canada Postdoctorate Fellow.