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THREE NEW C_{19}-DITERPENOID ALKALOIDS FROM *DELPHINIUM OCCIDENTALE* S. WATS.

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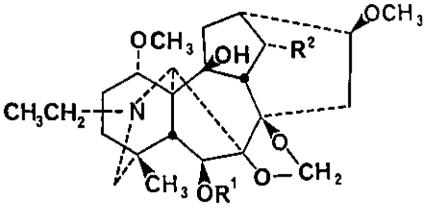
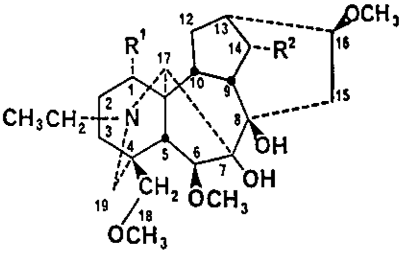
Abstract - Three new C_{19}-diterpenoid alkaloids have been isolated from Delphinium occidentale S. Wats.: occidentaline (16), occidentalidine (17) and 6-acetyldelpheline (18). Structures were deduced by spectroscopic methods and chemical correlations. Twelve known C_{19}- and two C_{20}-diterpenoid alkaloids were also isolated.

Previous chemical studies of *Delphinium occidentale* S. Wats. revealed the presence of deltaline (**1**), deltamine (**2**), dictyocarpine (**3**), delcosine (**4**), delsoline (**5**), delpheline (**6**) and three unidentified alkaloids.[1-3] As part of our continuing study of *Delphinium* species[4] (Ranunculaceae) which elaborate a variety of diterpenoid alkaloids, we have investigated aerial parts of *D. occidentale* collected from semi-open areas in an aspen tree community on the Logan River drainage in northern Utah. Gradient pH extraction and extensive chromatography, including vacuum liquid chromatography (vlc)[5] and centrifugally accelerated, radial, thin-layer chromatography (Chromatotron)[6,7] resulted in the isolation of deltaline (**1**),[1,2,8] deltamine (**2**),[8,9] dictyocarpine (**3**),[10,11] delcosine (**4**),[12] delpheline (**6**),[8,13,14] 14-dehydrodelcosine (**7**),[15] browniine (**8**),[11,16] 14-dehydrobrowniine (**9**),[8,17] dictyocarpinine (**10**),[18] glaucerine (**11**),[18] glaucenine (**12**),[18] glaucedine (**13**),[18] hetisine (**14**)[19] and hetisinone (**15**).[20] The identity of these alkaloids were determined spectroscopically and by direct comparison with known samples. The three new alkaloids designated as *occidentaline* (**16**), *occidentalidine* (**17**) and *6-acetyldelpheline* (**18**) were isolated in very small amounts.

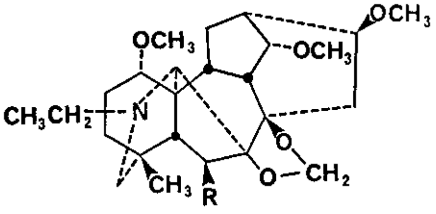
Occidentaline has a molecular formula $C_{25}H_{39}NO_5$ (ms) and showed no carbonyl or hydroxyl absorptions (ir). Analysis of the ^1H nmr ($CDCl_3$) spectrum indicated the following functional groups: methylenedioxy (δ 5.02 and 4.92, each d, J = 0.9 Hz), three methoxyls (3.43, 3.33 and 3.26), N-ethyl (1.06, t, J = 7 Hz) and a tertiary methyl (0.78, s). Absence of resonances in the range 3.7 to 4.2 ppm suggested lack of an oxygen substituent at C-6, a fact consistent with the upfield shift (Δ 0.1 ppm) of the C-4 methyl group when compared with those of deltaline (**1**), delpheline (**6**) and related alkaloids possessing such substituent.[21] The triplet at 3.66 ppm (J = 4.5 Hz) was assigned to H-14β bearing a methoxyl group. These facts and the molecular formula which showed one less oxygen when compared with that of delpheline (**6**) led to the structure **16** for occidentaline. To verify the conclusions drawn from the spectral data and to confirm the structure of occidentaline, a partial synthesis from delpheline (**6**) was effected. Thus conversion of **6** to the

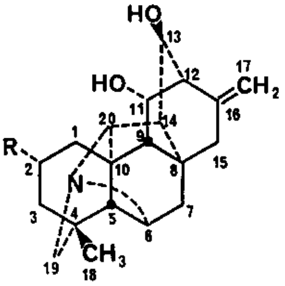




1 R^1 = Ac; R^2 = OCH_3
2 R^1 = H; R^2 = OCH_3
3 R^1 = Ac; R^2 = OH
10 R^1 = H; R^2 = OH
11 R^1 = Ac; R^2 = $O\overset{O}{\overset{\|}{C}}-CH(CH_3)_2$
12 R^1 = Ac; R^2 = $O\overset{O}{\overset{\|}{C}}-\underset{H}{\overset{CH_3}{C}}-CH_2CH_3$

4 R^1 = R^2 = OH
5 R^1 = OH; R^2 = OCH_3
7 R^1 = OH; R^2 = O
8 R^1 = OCH_3; R^2 = OH
9 R^1 = OCH_3; R^2 = O
13 R^1 = OCH_3; R^2 = $O\overset{O}{\overset{\|}{C}} - \underset{H}{\overset{CH_3}{C}} - CH_2CH_3$
17 R^1 = OCH_3; R^2 = $O\overset{O}{\overset{\|}{C}} - CH(CH_3)_2$





6 R = OH
16 R = H
18 R = OAc
19 R = $-O\underset{S}{\underset{\|}{C}}-SCH_3$

14 R = OH
15 R = O

S-methyl dithiocarbonate **19** and subsequent reduction with tributyltin hydride produced **16**, mp 119.5-120.5°C and $[\alpha]_D^{28}$ -40.5° (c 0.64, $CHCl_3$). The synthetic alkaloid[22] showed identical ir (nujol) and ^1H nmr ($CDCl_3$) spectra with those of the natural substance.

Occidentalidine was admixed with glaucedine (**13**) and careful chromatography furnished about 2 mg of reasonably pure (90%) sample, molecular formula, $C_{29}H_{47}NO_8$ (ms). Structure **17** was appar-

ent from the analysis of the ^{1}H nmr ($CDCl_3$) spectrum: δ 4.77 (t, J = 4.5 Hz, H-14β), 3.88 (br, H-6α), 3.41 (s, OMe), 3.30 (s, 2XOMe), 3.25 (s, OMe), 1.17 (d, J = 6 Hz, $CH\text{-}(C\underline{H}_3)_2$) and 1.04 (t, J = 7 Hz, $N\text{-}CH_2\text{-}C\underline{H}_3$); comparison of the above shifts with those of glaucedine (**13**)[18] indicated that they differed only in the nature of the C-14 ester side chain, a result was also suggested by the difference of 14 mass units between the two compounds in their mass spectra. Finally, the structure of occidentalidine was confirmed by acylation of browniine (**8**) with isobutyryl chloride, which gave a compound identical (^{1}H nmr and mass spectra) with the natural alkaloid. The synthetic alkaloid melted at 137-140°C and had $[\alpha]^{22}_{D}$ +31.3° (*c* 0.32, $CHCl_3$) and ir (nujol): 3450, 3400 and 1722 cm^{-1}. The ^{13}C nmr data are provided in Table 1.

Table 1. ^{13}C NMR (22.49 MHz, $CDCl_3$) Spectra of Compounds **17** and **18**

Carbon*	**17**	**18**	**Carbon**	**17**	**18**
1	84.2	83.3	17	64.7	64.2
2	26.2	26.9	18	78.4	25.4
3	32.4	36.7	19	52.6	56.7
4	38.0	33.8	$N\text{-}CH_2$	51.1	50.3
5	43.0	55.9	CH_3	14.1	13.9
6	90.4	78.4	1'	55.7	55.3
7	88.3	91.8	6'	57.2	-
8	77.4	83.3	$-OCH_2O-$	-	93.4
9	49.5	48.2	14'	-	57.6
10	45.6	39.8	16'	55.8	56.1
11	48.8	50.2	18'	58.9	-
12	28.1	27.9	C=O	177.2	-
13	37.7	38.6	CH	34.2	-
14	75.6	81.6	$(CH_3)_2$	18.8	-
15	33.7	33.8			
16	82.2	82.0	C=O		170.0
			CH_3		21.7

*Multiplicities were determined by a DEPT sequence

The third new alkaloid, mp 120-122°C, and molecular formula $C_{27}H_{41}NO_7$ (ms) was a monoacetate as evidenced by ir (1732 cm^{-1}), ^{1}H (δ 2.05, 3H, s) and ^{13}C nmr (170, 21.7 ppm) spectra. The location of the acetate group at C-6 was discerned from the downfield proton signal at δ 5.39 (br). This evidence in conjunction with the remaining ^{1}H nmr signals at δ 4.91, 4.88 (each s, $-OCH_2O-$), 3.42, 3.32 and 3.25 (each s, OMe), 1.03 (t, J = 7 Hz, $N\text{-}CH_2\text{-}C\underline{H}_3$) and ^{13}C nmr (Table 1) spectral data established the structure as 6-acetyldelpheline (**18**). This alkaloid was identical in all respects (ir, ^{1}H and ^{13}C nmr spectra) with the substances prepared from deoxygenation of deltaline (**1**)[22] and acetylation of delpheline (**6**). 6-Acetyldelpheline has been prepared previously[13,14] from delpheline, but never to our knowledge had it been isolated as a natural product.

The literature[18] assignments of ^{13}C nmr shifts for glaucerine (**11**), glaucenine (**12**) and glaucedine (**13**) require comment as a result of the present study. The chemical shifts for C-3 and C-13 need to be reversed in **11** and **12**. The following are the correct assignments for **13**: C-4 (38.4 ppm), C-9 (49.6), C-10 (45.7), C-11 (48.9), C-13 (37.7) and N-$\underline{C}H_2$-CH_3 (51.1). These changes in assignments are based on a DEPT (distortionless enhancement by polarization transfer) experiment in determining the carbon multiplicities.

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