

NEW ALKALOIDS FROM *DELPHINIUM ANDERSONII* GRAY

S. William Pelletier* and Palaniappan Kulanthaivel
 Institute for Natural Products Research and the School of Chemical Sciences,
 The University of Georgia, Athens, Georgia 30602, USA

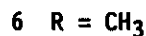
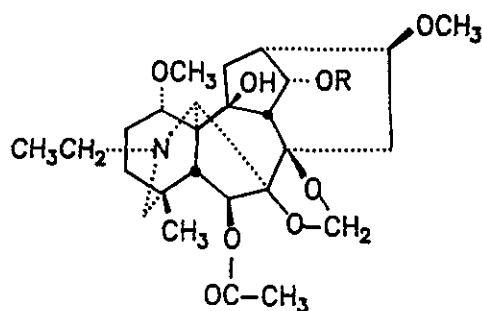
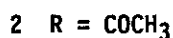
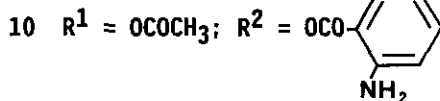
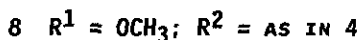
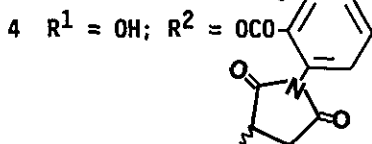
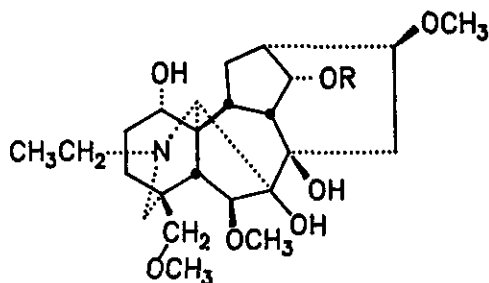
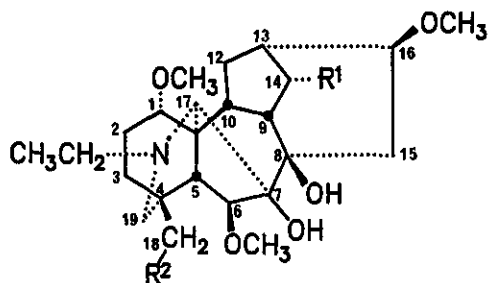
John D. Olsen
 U. S. Department of Agriculture, Poisonous Plant Research Laboratory
 Logan, Utah 84321, USA

Abstract - Investigation of *Delphinium andersonii* Gray afforded, in addition to ten known diterpenoid alkaloids, two new alkaloids, andersonidine (10) and 14-acetylnudicaulidine (11). Structures were deduced on the basis of spectroscopic evidence.

Earlier¹, we reported the isolation of andersonine and 14-deacetylnudicauline (4) and six known diterpenoid alkaloids (delavaine, delectinine, lycoctonine, methyllycaconitine, nudicauline, and takaosamine) from the aerial parts of *Delphinium andersonii* Gray. In continuation of our work on the minor constituents of *D. andersonii* we report here the isolation of two new and ten known alkaloids. Of the ten known alkaloids six of them have not been reported previously from *D. andersonii*.

Extraction of the aerial parts of *D. andersonii* with 95% EtOH gave an extract.¹ A portion of this extract was treated with CHCl₃ and the CHCl₃-soluble portion was subjected to gradient pH fractionation² to yield 9.85 g of an alkaloid mixture. Vacuum liquid chromatography (vlc)³ and centrifugally accelerated, radial, thin-layer chromatography^{4,5} in succession afforded 14-acetylbrowniine (1)^{6,7}, 14-acetyldecosine (2)^{6,8}, browniine (3)^{9,10}, 14-deacetylnudicauline (4)¹, decosine (5)^{6,8}, deltaline (6)^{11,12}, dictyocarpine (7)⁷, methyllycaconitine (8)⁷, nudicauline (9)¹³ and two new alkaloids, andersonidine (10) and 14-acetylnudicaulidine (11). The plant material left after extraction with 95% EtOH was further extracted with 75% EtOH. Investigation of this extract as indicated above gave lycoctonine (12)^{8,14} as well as 5, 6, 10 and 11. Of the known alkaloids, 14-acetylbrowniine, 14-acetyldecosine, browniine, decosine, deltaline, and dictyocarpine have not previously been reported from *D. andersonii*. The identity of known alkaloids was established spectroscopically and by direct comparison with authentic samples.

Andersonidine (10), mp 127-130°C cor. and $[\alpha]_D^{27} +39.1^\circ$ (c 0.565, CHCl₃), has the molecular formula C₃₃H₄₆N₂O₉ (eims: M⁺, 614). Its infrared spectrum (nujol) indicated the presence of hydroxyl (3500 and 3450 cm⁻¹), amine (3320 cm⁻¹) and ester (1740 and 1685 cm⁻¹) functionalities. The existence of an anthranoyl ester moiety was readily inferred by the presence of aromatic protons at δ 7.79 (dd, J = 8,1, 1.2 Hz), 7.29 (dt, J = 1.2, 8.1 Hz), 6.68 (tbr, J = 7.8 Hz) and 6.67 (dbr, J = 7.8 Hz) and amino protons at δ 5.77 (2H, br) in the ¹H nmr spectrum. The ¹³C nmr data (Table 1) as well as the mass spectrum (base peak at m/z 120) supported this assignment. Further analysis of the ¹H nmr spectrum indicated the presence of a downfield proton (δ 4.77, t, J = 4.8 Hz) and an AB

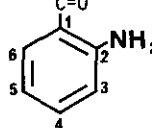


system of two protons (δ 4.14 and 4.09, $J = 11.5$ Hz) with ester functions, three methoxyls (δ 3.36, 3.32 and 3.25), an acetate (δ 2.06) and an *N*-ethyl group (δ 1.06, t, $J = 7$ Hz). The above data indicate that C-14 and C-18 bear the ester functions. The assignment of the acetate at C-14 and the anthranoyl ester at C-18 as shown in 10 was based on the chemical shift (δ 4.77) of H-14 (H-14 resonates near δ 5.00 in the presence of an aryl ester¹⁵), and by the fact that all the naturally-occurring lycoctonine-type alkaloids known to date possess anthranoyl and its analogous ester groups only at C-18.¹⁵ Confirmatory evidence for structure 10 was provided by the comparison of the ¹³C nmr resonances of 1 with those of nudicauline (9)¹³, an alkaloid which differs in the nature of the C-18 ester moiety.

The structure of 14-acetylnudicaulidine (11), amorphous, $[\alpha]_D^{26} +18.9^\circ$ (c 0.54, CHCl_3), was deduced on the basis of the following spectral data. Ir (nujol): ν_{max} 3460 (OH) and 1740 (ester) cm^{-1} ; eims: m/z 479 (M^+ , $\text{C}_{26}\text{H}_{44}\text{NO}_7$), 464 (M-15) and 448 (M-31); ¹H nmr (CDCl_3): δ 4.73 (t, $J = 4.5$ Hz, H-14 β), 3.38, 3.30 and 3.22 (each s, OMe), 2.04 (s, OAc), 1.02 (t, $J = 7$ Hz, *N*-CH₂-CH₃) and 0.95 (s, CH₃-18). The alkaloid is unstable in CDCl_3 when kept overnight; hence its nmr data were determined in CD_3CN . ¹H Nmr (CD_3CN): δ 4.65 (H-14), 3.37, 3.22 and 3.19 (OMe), 1.91 (OAc), 0.98 (*N*-CH₂-CH₃) and 0.96 (CH₃-18). The above shifts were similar to those of nudicaulidine

(13)⁹, except for the acetate signal and paramagnetic shift of H-14 ($\Delta\delta 0.77$). The differences in their ¹³C nmr shifts (Table 1), especially in the vicinity of C-14, also supported this assignment.

Table 1. ¹³C nmr Spectral Data of Andersonidine (10) and 14-Acetylnudicaulidine (11).

Carbon*	10 (CDCl ₃)	11 (CD ₃ CN)	Carbon	10	11
1	83.9	85.3	N-CH ₂	51.0	51.6
2	26.1	27.5	CH ₃	14.0	14.4
3	32.2	37.9	1'	55.7	55.9
4	37.6	34.8	6'	58.0	58.6
5	42.6	55.7	16'	56.2	56.1
6	90.7	92.2	C=O	171.8	171.9
7	88.3	89.4	CH ₃	21.5	21.6
8	77.4	78.0	C=O	167.7	
9	50.1	46.4			
10	45.7	43.4			
11	49.0	50.0		1	110.3
12	28.2	29.1		2	150.7
13	38.2	38.7		3	116.8
14	75.9	77.0		4	134.3
15	33.7	34.8	5	116.4	
16	82.3	83.6	6	130.7	
17	64.5	65.4			
18	68.5	27.1			
19	52.4	57.4			

*Multiplicities were determined by a DEPT sequence.

ACKNOWLEDGEMENT

We thank Dr. J. Siva Prasad for 300 MHz proton and 75 MHz carbon nmr spectra of andersonidine, and Mr. Courtney Pape for the mass spectra.

REFERENCES

1. A. M. Panu, P. Kulanthaivel, S. W. Pelletier, and J. D. Olsen, *Heterocycles*, in press.
2. S. W. Pelletier, B. S. Joshi, and H. K. Desai, "Techniques for Isolation of Alkaloids", in *Advances in Medicinal Plant Research*, editors: A. J. Vlietinck and R. A. Dommissse, Wissenschaftliche Verlagsgesellschaft mbH, Stuttgart, 1985, pp. 153-157.
3. S. W. Pelletier, H. P. Chokshi, and H. K. Desai, *J. Nat. Prod.*, 1986, **49**, 892.
4. H. K. Desai, B. S. Joshi, A. M. Panu, and S. W. Pelletier, *J. Chromatogr.*, 1985, **322**, 223.

5. H. K. Desai, E. R. Trumbull, and S. W. Pelletier, *J. Chromatogr.*, 1986, **366**, 439.
6. S. W. Pelletier, R. S. Sawhney, H. K. Desai, and N. V. Mody, *J. Nat. Prod.*, 1980, **43**, 395.
7. S. W. Pelletier, O. D. Dailey, Jr., N. V. Mody, and J. D. Olsen, *J. Org. Chem.*, 1981, **46**, 3284.
8. S. W. Pelletier, N. V. Mody, R. S. Sawhney, and J. Bhattacharrya, *Heterocycles*, 1977, **7**, 327.
9. M. H. Benn, M.A.M. Cameron, and O. E. Edwards, *Can. J. Chem.*, 1963, **41**, 477.
10. S. W. Pelletier and K. I. Varughese, *J. Nat. Prod.*, 1984, **47**, 643.
11. J. F. Couch, *J. Amer. Chem. Soc.*, 1936, **58**, 684.
12. S. W. Pelletier, N. V. Mody, K. I. Varughese, J. A. Maddry, and H. K. Desai, *J. Amer. Chem. Soc.*, 1981, **103**, 6536.
13. P. Kulanthaivel and M. H. Benn, *Heterocycles*, 1985, **23**, 2155.
14. S. Sakai, N. Shima, S. Hasegawa, and T. Okamoto, *J. Pharm. Soc. Japan*, 1978, **98**, 1376.
15. S. W. Pelletier, N. V. Mody, B. S. Joshi, and L. C. Schramm, in *Alkaloids: Chemical and Biological Perspectives*, Ed., S. W. Pelletier, Vol. 2, Chapter 5, pp. 205-462, John Wiley, New York, 1984.

Received, 15th August, 1988