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TWO NEW NORDITERPENOID ALKALOIDS FROM THE ROOTS OF *DELPHINIUM AJACIS*

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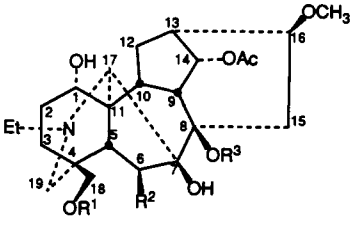
ABSTRACT.—Two new norditerpenoid alkaloids, ajadelphine [**1**] and ajadelphinine [**2**], have been isolated from the roots of *Delphinium ajacis* L. The structure of **2** was determined with the aid of ^{1}H- and ^{13}C-nmr spectroscopy, including DEPT, COSY-90, and inverse detected HETCOR (heteronuclear multiple-quantum coherence-HMQC) experiments. Ajadelphine [**1**] is the first lycoctonine-type norditerpenoid alkaloid having a methoxyl group at C-8 and a hydroxyl group at C-18. Ajadelphinine [**2**] is the first lycoctonine-type norditerpenoid alkaloid having a C-7–C-8-methylenedioxy group and an 18-OH group. Also isolated were the known norditerpenoid alkaloids delcosine [**3**], delsoline [**4**], deltaline [**5**], gigactonine [**6**], 18-methoxygadesine [**7**], and delphisine [**8**]. The latter has not been previously reported in this plant.

In continuation of our studies on the alkaloids present in the different plant organs of *Delphinium ajacis* L. (Ranunculaceae) (1–3), we now report the isolation of two new norditerpenoid alkaloids, ajadelphine [**1**] and ajadelphinine [**2**], together with six known ones: delcosine [**3**], delsoline [**4**], deltaline [**5**], gigactonine [**6**], 18-methoxygadesine [**7**], and delphisine [**8**]. This is the first time that delphisine [**8**], an aconitine-type norditerpenoid alkaloid, has been found in this plant.

RESULTS AND DISCUSSION

The air-dried and defatted powdered root material of *D. ajacis* was extracted exhaustively with 80% EtOH, and the crude alkaloidal mixture was processed as indicated in the Experimental section. Extensive chromatographic separations afforded eight alkaloids, of which three have not been reported previously in this plant.

Ajadelphine [**1**] was obtained in an amorphous form, $[\alpha]_D$ +2.0° (c = 0.13, $CHCl_3$), and its molecular formula $C_{25}H_{39}NO_7$ was deduced from the mass spectral ($[M]^+$, 465.1), ^{1}H-nmr, and ^{13}C-nmr data. The ^{1}H-nmr spectrum of **1** exhibited the following signals: δ 1.11 (3H, t, J = 7.5 Hz, N-CH_2-CH_3), 2.06 (3H, s, OAc), 3.34 and 3.38 (each 3H, s, OMe), 3.65 (1H, br s, H-1β), and 4.82 (1H, t, J = 4.7 Hz, H-



1 R^1=R^2=H, R^3=CH_3 Ajadelphine
10 R^1=R^3=CH_3, R^2=OH Pubescenine
11 R^1=CH_3, R^2=R^3=H 14-Acetylvirescenine

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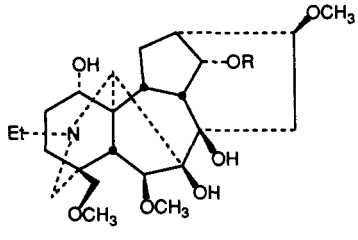
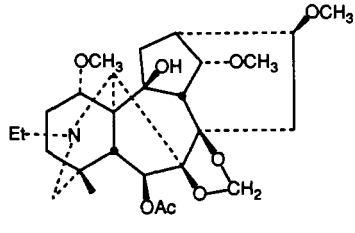
14β). The ^{13}C-nmr spectrum together with the DEPT spectra of **1** revealed the presence of 25 signals for the 25 carbons present in the molecule, of which eight each were methine and methylene carbons, four methyl carbons, and five quaternary carbons.

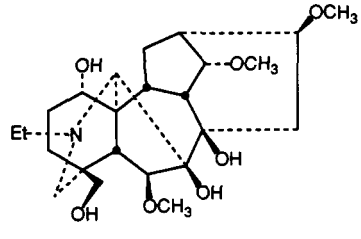
A three-proton singlet at δ 2.06 ppm was attributed to an acetate group at C-14. This assignment is supported by the presence of a one-proton signal at δ 4.82 (t) that is characteristic for an H-14β when a C-14α acetate is present (2). The H-14β appears at δ 4.79 in 14-acetyldelcosine [**9**] (1), δ 4.76 in pubescenine [**10**] (4), and δ 4.88 in 14-acetylvirescenine [**11**] (5). The acetate group at C-14 was assigned an α configuration based on the following analysis. The general range of the chemical shift for C-14 with an α acetate in lycoctonine-type norditerpenoid alkaloids with no substitution at C-9, C-10, or C-13 is 74.5–77.0 ppm (2). There are no examples in the literature of any diterpenoid alkaloids having an acetate group (or any substituent) at C-14 in a β configuration (2,6). Since the chemical shift for C-14 in the ^{13}C nmr of **1** is 75.3 ppm, the acetate group at C-14 was assigned an α configuration. An oxygenated methine carbon at 72.2 ppm in the ^{13}C-nmr spectrum of **1** is assigned to C-1 bearing an α-OH group. This assignment is supported by the presence of two methylene carbons at 26.6 and 29.4 ppm, which can be assigned to C-2 and C-3, respectively. For all the lycoctonine-type norditerpenoid alkaloids bearing an α-OH group on C-1, the C-2 and C-3 methylene carbons appear in the general range of 26.0–30.0 ppm. The C-3 appears as a methylene at 31.0–32.5 ppm when an α-OMe group is present at C-1 (2). This is true



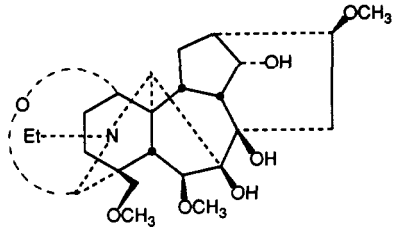
3 R=H Delcosine
4 R=CH_3 Delsoline
9 R=Ac 14-Acetyldelcosine



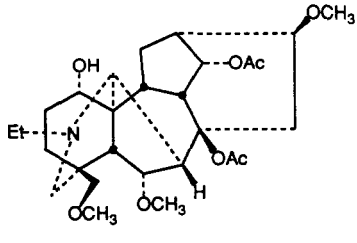
5 Deltaline



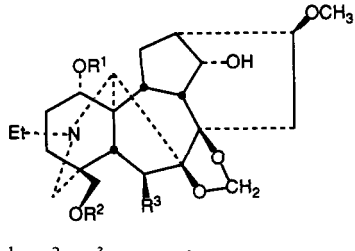
6 Gigactonine



7 18-Methoxygadesine



8 Delphisine



2 $R^1=R^2=R^3=H$ Ajadelphinine
12 $R^1=H$, $R^2=CH_3$, $R^3=OCH_3$ Delbrunine
13 $R^1=R^2=CH_3$, $R^3=H$ Nudicaulamine

since an -OH group on C-1 will have a γ effect on C-3. A β-OH or a β-OMe group on C-1 is ruled out since the chemical shifts for C-1 having these groups would appear as methine carbons at 68.0–69.0 ppm and 78.4 ppm, respectively (6); these chemical shifts are not present in the ^{13}C-nmr spectrum of **1**. The QUATD spectrum of **1**, as well as the combination of ^{13}C-nmr and DEPT spectra, revealed the presence of five quaternary carbons at 170.4, 87.3, 81.4, 50.5, and 38.2 ppm. The signal at 170.4 ppm is assigned to the carbonyl carbon of the α-acetate group at C-14 in **1**. The two downfield signals at 87.3 and 81.4 ppm are assigned to the two oxygenated quaternary carbons C-7 and C-8, respectively, while the upfield signals at 50.5 and 38.2 ppm are assigned to the non-oxygenated quaternary carbons C-11 and C-4, respectively.

Alkaloid **1** possesses two methoxyl functions, the protons of which showed signals in the ^{1}H-nmr spectrum at δ 3.34 and δ 3.38 ppm (each 3H, s), while the carbons were detected as two methyl carbons at 56.4 and 51.8 ppm in the ^{13}C-nmr spectrum. The signal at 56.4 ppm (q) is assigned to the methoxyl carbon of the 16-OMe group and the doublet resonance at 82.4 ppm to the oxygenated methine carbon C-16, values which are in good agreement with the chemical shifts of the corresponding carbons in pubescenine [**10**] (56.6 and 83.1 ppm, respectively) and 14-acetylvirescenine [**11**] (56.3 and 82.1 ppm, respectively) (Table 1). The quaternary carbon at 38.2 ppm in the ^{13}C-nmr spectrum of **1**, assigned to C-4, shows that C-4 is substituted either by a -CH_2OH or by a -CH_2OMe group (the possibility of -CH_2OAc is excluded, as the only acetate group in **1** has already been unambiguously assigned to C-14). The general range of the chemical shifts for the methoxyl carbon at C-18 is 58.5–59.5 ppm, whereas the chemical shift for C-18 substituted by a methoxyl group in all lycoctonine-type alkaloids, with no 3-OH is in the range of 77.5–79.5 ppm (2). In marked contrast, the chemical shift of C-18 substituted by a hydroxyl group will be shifted upfield by about 10 ppm and occurs in the range of 66.5–68.5 ppm (7). In the ^{13}C-nmr spectrum of **1**, there is neither a methoxyl methyl signal at ~59.0 ppm corresponding to the methoxyl carbon on C-18, nor a methylene signal corresponding to C-18 above 68.1 ppm. This very clearly indicates that the triplet at 68.1 ppm must correspond to C-18 substituted by a hydroxyl group, thereby supporting the assignment of a -CH_2OH group at C-4 in the structure of **1**. The occurrence of C-6 and C-17 signals in the ^{13}C-nmr spectrum of **1** at 34.4 and 64.2 ppm, respectively, clearly indicates that **1** is a lycoctonine-type alkaloid with oxygenation at C-7.

The position of the remaining methoxyl group of **1** (at 51.8 ppm) can be assigned to C-7 (with an 8-OH) or to C-8 (with an 7-OH). However, a review of all the reported norditerpenoid alkaloids reveals that placement of the methoxyl group at C-7 (and therefore a hydroxyl at C-8) would not only be unprecedented, but also less likely in view of the facile loss of an OMe group (*m/z* at 434.1, 32% rel. int., due to $[M - OMe]^+$) in the eims fragmentation of **1**. Also, the methyl of 7-*O*-methyldelcosine (prepared from delcosine) appears at 57.4 ppm (6). In view of the above, the low-field quaternary carbon signal at 81.4 ppm may be assigned to C-8 substituted by a methoxyl group, and the unusually high field signal at 51.8 ppm to the methoxyl carbon on C-8. These values are in good agreement with the corresponding chemical shifts in pubescenine [**10**].

A comparison of the ^{13}C-nmr data of **1** and that reported for 14-acetylvirescenine [**11**] (Table 1) reveals that the chemical shift of C-15 in **1** appears at a higher field (28.9 ppm) than that of **11** (35.9 ppm). This is in accord with the case of ambiguine (with 8-OMe and 28.5 ppm for C-15) and 14-acetylbrowniine (with 8-OH and 33.7 ppm for C-15) (9). This upfield shift of the C-15 chemical shift is generally expected when the 8-OH group is replaced by an 8-OMe group (the so-called β effect) (8). These data indicate that ajadelphine has a 7-OH group and a methoxyl group at C-8. Since C-7 in the

TABLE 1. ^{13}C-nmr Chemical Shifts[a] and Assignments for Ajadelphine [**1**], Pubescenine [**10**], 14-Acetylvirescenine [**11**], Ajadelphinine [**2**], Delbrunine [**12**], and Nudicaulamine [**13**].

Carbon	Compound					
	1[b]	**10**	**11**	**2**[b,c]	**12**	**13**
C-1	72.2 d	72.5	72.4	71.7 d	71.8	84.9
C-2	26.6 t[d]	29.6	29.0	27.7 t	27.2	26.0
C-3	29.4 t[e]	29.8	29.4	29.4 t	29.4	31.9
C-4	38.2 s	38.5	37.7	38.1 s	37.1	38.3
C-5	40.6 d	44.1	41.7	45.3 d	42.0	44.0
C-6	34.4 t	70.8	33.7	31.8 t	88.3	31.6
C-7	87.3 s	85.4	85.9	89.8 s	92.1	88.3
C-8	81.4 s	80.7	76.9	81.6 s	83.4	79.2
C-9	44.0 d	43.5	45.9	45.3 d	45.7	47.5
C-10	42.7 d	47.0	42.9[f]	39.3d	46.6	46.2[f]
C-11	50.5 s	47.7	50.0	51.3 s	50.7	50.1
C-12	26.2 t[d]	28.8	26.8	26.2 t	29.0	26.6
C-13	37.2 d	38.3	37.7[f]	38.7 d	38.6	36.2[f]
C-14	75.3 d	75.8	77.1	74.6 d	74.7	74.2
C-15	28.9 t[e]	29.9	35.9	33.9 t	36.5	32.4
C-16	82.4 d	83.1	82.1	81.2 d	81.7	81.6
C-17	64.2 d	63.7	64.9	63.7 d	65.8	62.6
C-18	68.1 t	80.9	78.8	67.7 t	77.9	78.9
C-19	55.8 t	56.7	56.1	56.0 t	57.4	52.6
N-CH_2	50.6 t	50.8	50.6	50.6 t	50.1	50.8
Me	13.8 q	13.8	13.9	13.5 q	13.5 q	14.1
C-1′	—	—	—	—	—	56.0
C-6′	—	—	—	—	58.1	—
C-8′	51.8 q	52.9	—	—	—	—
C-16′	56.4 q	56.6	56.3	56.4 q	56.2	56.5
C-18′	—	59.3	59.4	—	59.2	59.5
C=O	170.4 s[b]	170.8	170.9	—	—	—
Me	21.3 q	21.2	21.3	—	—	—
-O-CH_2-O-	—	—	—	93.8 t	94.1	93.6

[a]In ppm downfield from TMS; solvent $CDCl_3$.
[b]Quaternary carbon determined by QUATD pulse program of Bruker.
[c]Assignments through DEPT, COSY-90, and HMQC experiments.
[d–f]These assignments may be interchanged.

structure of **1** carries a hydroxyl group, the singlet at 87.3 ppm in the ^{13}C-nmr spectrum of **1** must correspond to C-7. This assigned chemical shift for C-7 is in agreement with the expected range of chemical shift, 87.5–89.0 ppm, for a hydroxyl-substituted C-7 in a lycoctonine-type alkaloid (2).

Ajadelphine [**1**] is the first lycoctonine-type norditerpenoid alkaloid to have a methoxyl group at C-8 and an 18-OH group.

Ajadelphinine [**2**] was obtained in an amorphous form, $[\alpha]_D$ −22.6° (c = 0.32, $CHCl_3$), and its molecular formula $C_{23}H_{35}NO_6$ was deduced from the mass spectral ($[M]^+$, 421.2), ^{1}H-nmr, and ^{13}C-nmr data. The ^{1}H-nmr spectrum of ajadelphinine showed the following signals: δ 1.14 (3H, t, J = 7.5 Hz, N-CH_2-CH_3), 3.37 (3H, s, OMe), 3.76 (1H, br s, H-1β), 4.18 (1H, t, J = 6.0 Hz, H-14β), 4.96 and 5.05 (each 1H, s, -O-CH_2-O-).

The ^{13}C-nmr spectrum of **2** exhibited twenty-two signals for the 23 carbon atoms

of the molecule with a signal at 45.3 ppm accounting for two carbons as shown by the DEPT spectra of **2**. Of the 23 carbons, the DEPT spectra revealed the presence of eight methine carbons, nine methylene carbons, two methyl carbons, and four quaternary carbons.

The ^{1}H-nmr spectrum of **2** was characteristic of a norditerpenoid alkaloid containing a 7,8-methylenedioxy group. The signals at δ 4.96 (s) and δ 5.05 (s) ppm, each integrating for one proton, clearly confirm the presence of this grouping in **2**. The signal at δ 4.18 (t, $J = 6.0$ Hz) integrating for one proton was assigned to the hydrogen in the β configuration at C-14 (bearing an α-OH group). The H-14β appears at δ 4.15 in delelatine (10) which also has an α-hydroxyl group at C-14. The assignment of an α-OH group at C-14 in **2** is supported by the observation of a methine carbon resonance at 74.6 ppm in the ^{13}C-nmr spectrum of **2**, since the general range of chemical shift for C-14 with an α-OH group in lycoctonine-type alkaloids with no substitution at C-9, C-10, or C-13 is 74.5–77.0 ppm (2). The possibility of a 14α-OMe group in **2** is ruled out by the absence of a methine carbon resonance at ca. 84.0 ppm (corresponding to C-14 substituted by an α-OMe group) and a quartet signal at ca. 58 ppm (for the carbon atom of the methoxyl group at C-14). There is also a doublet resonance at 71.7 ppm, thus supporting the assignment of an α-hydroxyl group at C-1. This fact is further established by the presence of matching methylene triplets at 27.2 and 29.4 ppm assigned to C-2 and C-3, respectively. The chemical shifts assigned for C-1, C-2, and C-3 in the structure of **2** are in excellent agreement with the chemical shifts of the corresponding carbon atoms in delbrunine [**12**] (6,11) (Table 1). The DEPT spectra of **2** in conjunction with the ^{13}C-nmr spectrum revealed the presence of four quaternary carbons at 38.1, 89.8, 81.6, and 51.3 ppm assigned to C-4, C-7, C-8, and C-11, respectively. The two downfield signals at 89.8 and 81.6 ppm, indicative of carbons with oxygenation, are clearly due to methylenedioxy substitution at C-7 and C-8. These values are in agreement with the expected range of chemical shifts, 90.5–93.5 ppm for C-7 and 81.5–84.0 ppm for C-8, for alkaloids containing C-7–C-8 methylenedioxy substitution with no C-14 ketone. The quaternary carbon at 38.1 ppm in the ^{13}C-nmr spectrum of **2** indicates that position C-4 is substituted either by a $-CH_2OH$ or $-CH_2OMe$ group. However, the absence of a methylene signal in the 77.5–79.5 ppm range, corresponding to a C-18 substituted by a methoxyl group, and a methyl carbon at ca. 59.0 ppm for the carbon atom of the 18-OMe group, proves beyond doubt that the C-18 position in ajadelphinine is substituted by a hydroxyl group. This confirms the assignment of a $-CH_2OH$ group at C-4 in the structure of **2**.

Inasmuch as C-1 and C-14 are each assigned an -OH group in an α configuration and C-18 too has a hydroxyl substitution, the only methoxyl group present in **2** can be assigned to either C-6 or C-16 since substitution at C-9, C-10, or C-13 requires the presence of an additional singlet, five in all, instead of the observed four. The absence of a methine signal above 81.5 ppm excludes the presence of a 6β-OMe (a methoxyl substituted C-6 in a lycoctonine-type alkaloid resonates in the 89.5–92.0 ppm range) (2). This leaves the only -OMe group in **2** to be assigned to C-16. Not only is the presence of a C-16 methoxyl group biogenetically favored (12), but also the assigned chemical shifts for C-16 (81.4 ppm) and the methoxyl carbon of 16-OMe (56.4 ppm) in **2** are in excellent agreement with the chemical shifts for the corresponding carbon atoms in alkaloids with structures similar to **2**, such as delbrunine [**12**] (6,12), nudicaulamine [**13**] (13), and 6-deoxydelcorine (6,13,14). The ^{13}C chemical shift assignments for the remaining carbon atoms in **2** are in agreement with the postulated structure and correspond closely with the ^{13}C-nmr spectral data reported for nudicaulamine [**13**]. Finally, the unambiguous ^{1}H- and ^{13}C-nmr chemical shift assignments for **2** were achieved through a study of its 2D ^{1}H-^{1}H correlation spectra (COSY-90) and 2D ^{1}H-^{13}C nmr

correlation spectra (HMQC). These 2D experiments were useful in assigning the chemical shifts for C-6, C-10, and C-13. The chemical shift at δ 31.8 (t) ppm for C-6 correlated with H-6β (δ 1.51 ppm, dd, $J_{6\beta,6\alpha} = 14.7$ Hz, $J_{6\beta,5} = 7.5$ Hz) and H-6α (δ 2.59 ppm, m) in the 2D ^{1}H-^{13}C correlation nmr spectrum (HMQC). The chemical shifts at δ 39.3 and 38.7 ppm were assigned to C-10 and C-13, respectively. The C-10 correlated with H-9 (δ 3.61 ppm, m) and H-12α (δ 2.51 ppm, dd, $J_{12\alpha,12\beta} = 14.3$ Hz, $J_{12\alpha,10} = 4.7$ Hz) in the HMQC spectrum, and C-13 correlated with H-13 (δ 2.34 ppm, dd), which showed coupling to H-14 and H-12β ($J_{13,14} = 6.7$ Hz, $J_{13,12\beta} = 4.5$ Hz). The chemical shift (δ 39.3 ppm) assigned to C-10 in **2** appears upfield from those reported for C-10 of compounds **12** and **13**; the shifts reported for C-14 (ca. 74.2 to 74.7) in **2**, **12**, and **13** are in good agreement. The C-10 being a γ-carbon to the C-14 bearing an -OH group should experience a γ-effect, i.e., an upfield shift (of ca. 3–4 ppm). The chemical shifts reported (11,13) for C-10 in compounds **12** and **13** (ca. 46.0 ppm) may therefore require a revision through a study of their 2D nmr spectra. The ^{13}C-nmr chemical shift assignments for **2** are given in Table 1, and the complete proton assignments in the Experimental section.

Ajadelphinine [**2**] is thus the first lycoctonine-type norditerpenoid alkaloid having a C-7–C-8 methylenedioxy group and a C-18 hydroxyl group.

All the six known alkaloids isolated from the roots of *D. ajacis* were identified by comparison with authentic samples of known alkaloids.

EXPERIMENTAL

GENERAL EXPERIMENTAL PROCEDURES.—Mp's are corrected and were taken on a Thomas-Kofler hot stage equipped with a microscope and a polarizer. Fourier transform nmr spectra were recorded in the specified solvent on a Bruker AC-300 and on a Bruker AMX-400 nmr spectrometer. The pulse sequences employed in the 1D and 2D nmr experiments were obtained from the standard Bruker software. Dispersive ir spectra were taken on a Perkin-Elmer model 1420 spectrophotometer. Optical rotations were taken on a Perkin-Elmer model 141 polarimeter. For chromatographic separations on a Chromatotron, rotors were coated with a 1 mm thick layer of Al_2O_3, 60 PF 254 + 366 (Type E), EM Art. 1104-3 (15), or Si gel, PF 254 (Type 60), EM Art. 7749; for vacuum liquid chromatography (vlc) (16), Si gel, EM Art. 7736, was used; for tlc, Al_2O_3, 150 PF 254 (Type T), EM Art. 1064, or Si gel, 60 H, EM Art. 7736, was used.

PLANT MATERIAL.—The plants of *D. ajacis* were cultivated in September 1988 in the experimental station of the Faculty of Pharmacy, Assiut University, Assiut, Egypt and collected during the flowering stage in April 1989. The seeds were supplied and the plants identified by Professor Naeem E. El-Keltawy, Faculty of Agriculture, Assiut University. A voucher specimen (no. 105) has been deposited in the Herbarium of the Department of Pharmacognosy of Assiut University.

EXTRACTION OF CRUDE ALKALOIDS FROM THE ROOTS.—A 1004.3 g sample of air-dried powdered root material of *D. ajacis* was defatted with hexane (2 × 2.5 liters) and percolated at room temperature with 80% EtOH (8 × 4.4 liters); the percolate was evaporated in vacuo to give 101.9 g of the dried extract. The latter (101.9 g) was dissolved in 80% EtOH (7 liters), and the solution was passed over a column of 500 g of Dowex 50W X2 resin prewashed until neutral to litmus with H_2O (3.5 liters) and subsequently with 80% EtOH (1.5 liters). The column was basified with 600 ml of 10% NH_4OH solution, and the basic eluent was extracted with CH_2Cl_2 (2 × 1200 ml). The combined CH_2Cl_2 extract (2.4 liters) was backwashed with H_2O, dried over anhydrous Na_2SO_4, filtered, and evaporated to give 0.68 g of the crude alkaloid. The resin containing liberated alkaloids was air-dried and extracted with CH_2Cl_2 (2 × 3.3 liters) in a Soxhlet extractor. The CH_2Cl_2 extract was evaporated in vacuo to yield an additional 3.34 g of the crude alkaloid mixture.

GRADIENT pH FRACTIONATION OF THE CRUDE ALKALOID MIXTURE.—The crude alkaloidal concentrate (4.02 g) was dissolved in 150 ml of CH_2Cl_2, and the solution was extracted with cold 2% H_2SO_4 solution (6 × 150 ml). The acidic extract (900 ml) was then basified in an ice-H_2O bath with solid $NaHCO_3$ to pH 7.5–8.0 and extracted with $CHCl_3$ (6 × 200 ml). The $CHCl_3$ extract (1.2 liters) was washed with H_2O (500 ml), dried over anhydrous Na_2SO_4, filtered, and concentrated to give 2.02 g of the concentrate. The aqueous layer at pH 7.5–8.0 was further basified in an ice-H_2O bath with 10% NaOH solution to pH 12.0, extracted with $CHCl_3$ (6 × 200 ml), washed with H_2O (500 ml), dried over anhydrous Na_2SO_4, and concentrated to furnish 0.07 g of residue.

ALKALOIDS OF pH 8.0 FRACTION: DELSOLINE, 18-METHOXYGADESINE, DELCOSINE, AJADELPHINE, GIGACTONINE, DELTALINE, AJADELPHININE.—The pH 8.0 fraction (2.02 g) adsorbed on Si gel (10 g) was chromatographed using vlc on a Si gel column (50 g). Elution was performed with hexane, $CHCl_3$, and MeOH in the order of increasing polarity. In all, fifteen fractions (100 ml each) were collected. The first nine fractions were combined (986 mg, oily residue) and gave a negative test for alkaloids with Dragendorff's reagent. Fraction 10 (109 mg eluted with 3% MeOH-$CHCl_3$) was separated on a Si gel Chromatotron rotor by elution with hexane/$CHCl_3$ and $CHCl_3$ with increasing percentages of MeOH to give nine fractions. Fraction 6 (28 mg) was further purified on an Al_2O_3 rotor by elution with hexane/Et_2O and Et_2O with increasing percentages of MeOH to give 15.8 mg of delsoline [**4**], mp 214–214.5° (from Me_2CO/hexane) [lit. (2,17) mp 215–216°], identical with an authentic sample of delsoline [**4**] in its co-tlc behavior and ir, ^{1}H-nmr, and ^{13}C-nmr spectra.

Fraction 11 (151 mg eluted with 4% MeOH/$CHCl_3$) was separated on a Si gel rotor by elution with hexane and $CHCl_3$ to give ten fractions. The major fraction (83.6 mg) was further purified on a Si gel rotor by elution with a similar solvent system to give a minor product (4.1 mg) in amorphous form, which was identical with an authentic sample of the known alkaloid 18-methoxygadesine [**7**] in its co-tlc behavior, and ir, ^{1}H-nmr, and ^{13}C-nmr spectra. A major product (44.4 mg) was identified as delcosine [**3**]. Crystallization of the delcosine from Me_2CO/hexane gave a crystalline sample, mp 202.5–203.5° [lit. (2,18) mp 203–204°], identical with an authentic sample of delcosine [**3**] in co-tlc behavior and ir, ^{1}H-nmr, and ^{13}C-nmr spectra. Fraction 12 (103 mg, eluted with 5% MeOH/$CHCl_3$) gave a negative test for the presence of alkaloids with Dragendorff's reagent on a tlc plate. The combined fractions 13–15 (179 mg eluted with 10% and 50% MeOH/$CHCl_3$) was separated on an Al_2O_3 rotor by elution with hexane/Et_2O and Et_2O with increasing percentages of MeOH to give eleven fractions. Each of the major fractions 9 (9.4 mg), 10 (11.1 mg), and 11 (34.3 mg) was further purified as described below. Fraction 9 (9.4 mg) was purified on a Si gel rotor by elution with hexane/$CHCl_3$ and $CHCl_3$ with increasing percentages of MeOH to give 2.1 mg of an amorphous alkaloid named ajadelphine [**1**]: $C_{25}H_{39}NO_7$, $[\alpha]_D$ +2.0° (c = 0.13, $CHCl_3$); ms m/z (% rel. int.) $[M]^+$ 465 (3.1), 448 (7.7), 434 (32.0), 407 (4.0), 390 (2.2), 374 (2.9), 164 (1.3), 148 (1.7), 109 (5.1), 98 (3.5), 91 (6.2), 79 (4.7), 71 (9.0), 58 (29.8), 43 (100.0); ir (neat) ν max 3450, 1732, 1465, 1365, 1250, 1080, 925, 770, 750 cm^{-1}; ^{1}H nmr (300 MHz, $CDCl_3$) δ 1.11 (3H, t, J = 7.5 Hz, N-CH_2-CH_3), 2.06 (3H, s, OAc), 3.34 and 3.38 (each 3H, s, OMe), 3.65 (1H, br s, H-1β), 4.82 (1H, t, J = 4.7 Hz, H-14β); ^{13}C nmr see Table 1.

Fraction 10 (11.1 mg) was purified on a Si gel rotor by elution with hexane/$CHCl_3$ and $CHCl_3$ with increasing percentages of MeOH to give 6.5 mg of gigactonine [**6**]. Crystallization from Me_2CO/C_6H_6 gave a material with mp 168.5–169.5° [lit. (2,19) mp 168–169°], identical with an authentic sample of gigactonine [**6**] in its co-tlc behavior and ir, ^{1}H-nmr, and ^{13}C-nmr spectra.

Fraction 11 (34.3 mg) was charomatographed on a Si gel rotor by elution with hexane/Et_2O and Et_2O with increasing percentages of MeOH to give two fractions. The major fraction (21.4 mg) was found by tlc to be a mixture of at least two alkaloids in a ratio of 1:1. This major fraction (21.4 mg) was repurified on a Si gel rotor by elution with hexane/$CHCl_3$ and $CHCl_3$ with increasing percentages of MeOH to produce four fractions. Fraction 1 (5.2 mg, amorphous) was identical with an authentic sample of deltaline [**5**] in its co-tlc behavior and ir, ^{1}H-nmr, and ^{13}C-nmr spectra. Fraction 4 (4.1 mg), also amorphous in nature, was named ajadelphinine [**2**]: $C_{23}H_{35}NO_6$, $[\alpha]_D$ −22.6° (c = 0.32, $CHCl_3$); ms m/z $[M]^+$ 421 (14.2), 404 (64.7), 391 (40.9), 376 (26.6), 360 (21.6), 350 (3.5), 223 (12.3), 105 (11.4), 95 (10.5), 91 (28.4), 79 (20.9), 71 (42.3), 61 (32.8), 58 (78.9), 45 (40.0), 40 (100.0); ir (neat) ν max 3460, 3020, 2950, 1460, 1380, 1300, 1220, 1080, 950, 900, 760, 660 cm^{-1}; ^{1}H nmr (400 MHz, $CDCl_3$) (COSY-90 and HMQC), δ 1.14 (3H, t, J = 7.5 Hz, N-CH_2CH_3), 1.19 (1H, m, H-3β), 1.23 (1H, s, $W_{1/2}$ = 6.9 Hz, H-5), 1.51 (1H, dd, H-6β, $J_{6\beta6\alpha}$ = 14.7, $J_{6\beta5}$ = 7.5 Hz), 1.55 (1H, br d, H-3α, $J_{3\alpha,3\beta}$ = 13.2, $J_{3\alpha,2\beta}$ = 2.5, $J_{3\alpha2\alpha}$ = 4.9 Hz), 1.79 (1H, m, H-12β), 1.85 (1H, m, H-15β, J_{gem} = 14.7, $J_{15\beta16}$ = 7.5 Hz), 1.99 (1H, m, H-2β), 2.08 (1H, m, H-10), 2.11 (1H, m, H-2α), 2.34 (1H, dd, H-13, $J_{13,14}$ = 6.7, $J_{13,12\beta}$ = 4.5 Hz), 2.35 (1H, AB, H-19β, J_{gem} = 10.9), 2.41 (1H, AB, H-19α, J_{gem} = 10.9 Hz), 2.45 (1H, dd, H-15α, $J_{15\alpha,16}$ = 8.9, J_{gem} = 14.7 Hz), 2.51 (1H, dd, H-12α, $J_{12\alpha,12\beta}$ = 14.3, $J_{12\alpha,10}$ = 4.7 Hz), 2.59 (1H, m, H-6α), 2.77, 2.91 (each 1H, m, N-CH_2), 3.00 (1H, s, H-17, $W_{1/2}$ = 6.2 Hz), 3.31 (1H, d, H-18β, J = 10.5 Hz), 3.37 (3H, s, -OMe), 3.40 (1H, m, H-16), 3.46 (1H, d, H-18α, J = 10.5 Hz), 3.61 (1H, m, H-9), 3.76 (1H, br m, H-1β), 4.18 (1H, t, H-14, J = 4.6 Hz), 4.96 (1H, s, -OCH_βO-), 5.05 (1H, s, -OCH_αO-); ^{13}C nmr see Table 1.

ALKALOIDS OF pH 12.0 FRACTION: DELCOSINE, DELPHISINE.—The pH 12.0 fraction (70 mg) was purified on an Al_2O_3 rotor by elution with hexane and $CHCl_3$ to give three fractions. The minor fraction (3.7 mg) was amorphous and identical with an authentic sample of delcosine [**3**] in its co-tlc behavior and ^{1}H- and ^{13}C-nmr spectra. The major fraction (15.3 mg) was identified as delphisine [**8**]. Crystallization from Me_2CO/hexane, afforded crystalline delphisine: mp 121.3–122.3° [lit. (2,20) mp 122–123°], identical with an authentic sample of delphisine [**8**] in its co-tlc behavior and ir, ^{1}H-nmr and ^{13}C-nmr spectra.

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