Certain Norditerpenoid Alkaloids and Their Cardiovascular Action

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Thirteen new derivatives of norditerpenoid alkaloids, namely, 8-deacetyl-8-*p*-aminobenzoyldelphinine (**1**), 8-deacetyl-8-anthranoyldelphinine (**2**), 8-deacetyl-8-(4-hydroxy-3-methoxycinnamoyl)delphinine (**3**), 16-demethoxy-15,16-didehydro-8-*p*-anisoyl-14-benzoyldelphonine (**4**), 6-acetylheteratisine *N*-oxide (**6**), 3,8-diacetylfalconerine (**7**), 8-stearoylfalconerine (**8**), 8-linolenylfalconerine (**9**), 13-acetylpyrodelphinine (**11**), 13-acetyldelphinine *N*-oxide (**13**), *N*-deacetyl-8,9-diacetyllappaconitine (**14**), 8,9-(methylenedioxy)lappaconine (**15**), and 16-epipyroaconitine *N*-oxide (**17**), were prepared, and their structures were established by analysis of spectroscopic data (1D and 2D NMR, HRFABMS). The preliminary in vivo cardiovascular action (hypotensive, bradycardic, and ventricular arrhythmias) of these new compounds was tested in male Sprague−Dawley rats. The results are reported herein.

Certain diterpenoid alkaloids isolated from plant species in the genera *Aconitum and Delphinium* have hypotensive and bradycardic actions that may be due to activation of autonomic reflexes.[1,2] These alkaloids share with veratridine the ability to sensitize sensory nerves by impeding closing of Na^+ channels.[2] These alkaloids may also elicit cardiovascular effects because of CNS activity.[3,4] In a continuing study of the hypotensive and bradycardic activity of diterpenoid alkaloids and their derivatives,[5] we have evaluated these alkaloids and their derivatives. The norditerpenoid alkaloid, lappaconitine, at a dose of 150 μg/kg (iv, in dog) increased cardiac vagal afferent nerve activity (16.2%) and reduced cardiac sympathetic efferent nerve activity (12.5%). An analogue, *N*-deacetyllappaconitine (NDAL), at this same dosage, increased cardiac vagal afferent nerve activity (40%) and reduced cardiac sympathetic efferent nerve activity (23.5%). Both of these compounds also reduced arterial blood pressure and heart rate.[5] In this work, the activity of the new compounds was compared with that of NDAL (see Table 1). We wish to report herein the preparation, characterization, and preliminary cardiovascular activity of 13 new derivatives of norditerpenoid alkaloids.

Table 1. Hypotensive and Bradycardic Actions of Compounds **1**−**5**, **7**−**10**, **12**−**14**, **16**, and **18**

	Dosage			
	200 μg/kg		400 μg/kg	
compound	%ΔHR[a]	%ΔBP[b]	%ΔHR[a]	%ΔBP[b]
NDAL[c]	−12.7	−27.2	−14.8	−57.6
1	−8.4	−42.4	−14.8	−38.0
2	−4.2	−20.8	−2.0	0.0
3	−8.3	−8.8	−8.3	−10.6
4	−3.7	0.0	−3.8	−9.2
5	−18.8	−28.1	−8.9	−7.6
7	caused ventricular arrhythmias			
8	0.0	−15.3	−24.5	−53.4
9	−8.5	−30.3	−24.5	−53.4
10	−5.4	−13.2	0.0	0.0
12	−7.7	−23.1	−8.1	− 14.3
13	−3.8	0.0	−8.7	−13.4
14	0.0	0.0	0.0	0.0
16	−5.7	−26.0	−5.6	−16.4
18	0.0	−22.6	−3.0	−27.6

[a] ΔHR = Diference in heart rate. [b] ΔBP = Diference in blood pressure. [c] NDAL = *N*-deacetyllappaconitine as reference agent (tested in 3 rats).

Results and Discussion

Compounds **1**−**3**, **8**, and **9** were prepared from their parent alkaloids according to our method of *trans*-esterification.[6] The reactions were carried out as described, and the major products (40−70%) that were formed were isolated by fractionation on Al_2O_3 or SiO_2 rotors of a Chromatotron.[7] The compounds were identified and characterized on the basis of their spectroscopic data (IR, HRMS, ^1H and ^{13}C NMR including 2D NMR), which are reported in the Experimental Section. In the case of the *trans*-esterification reaction of *p*-anisic acid with delphinine, no reaction occurred under the usual conditions. All of the *p*-anisic acid sublimed, and the starting material, delphinine, was recovered unchanged. Heating a mixture of delphinine and *p*-anisic acid in pyridine resulted in *trans*-esterification, and the major product formed was identified as 16-demethoxy-15,16-didehydro-8-*p*-anisoyl-14-benzoyldelphonine (**4**) (31.3%). This result indicates that isomerization occurred during *trans*-esterification, and an isopyrocompound (**4**) was formed. Earlier we have observed this type of reaction taking place during *trans*-esterification.[6]

Compounds **7**, **10**, and **14** were prepared by acetylating the parent alkaloids with acetyl chloride. Acidic hydrolysis of 8,9-diacetyllappaconitine afforded compound **14**.

Compounds **15** and **16** were prepared in yields of 61 and 32%, respectively, by methylenation of the *cis*-diol, as described in our published work on methylenation of some lycoctonine-type norditerpenoid alkaloids.[8] Details of the preparation, and physical and spectroscopic data are reported in the Experimental Section.

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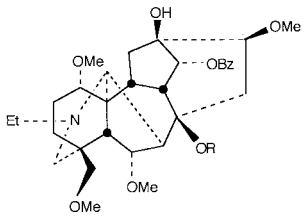
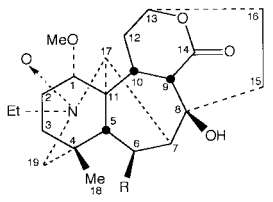
The *N*-oxides **13** and **15** were prepared according to our published procedure.[9] Their characterization is also reported here.

Compounds **1**−**5**, **7**−**10**, **12**−**14**, **16**, and **18** were tested in two to three rats (male Sprague−Dawley, 250−300 g), at doses of 200 and 400 μg/kg (iv) for their ability to produce hypotension, bradycardia, and cardiac arrhythmias (Table 1). The testing was carried out as described in the Experimental Section. 3,8-Diacetylfalconerine (**7**) caused arrhythmias at both doses. The following compounds exhibited prominent hypotensive and bradycardic activity without prominent arrhythmias: heteratisine *N*-oxide (**5**);[7] 8-deacetyl-8-*p*-aminobenzoyldelphinine (**1**); 8-deacetyl-8-anthranoyldelphinine (**2**); 8-stearoylfalconerine (**8**); 8-linolenylfalconerine (**9**); pyrodelphinine (**12**);[6] 16-epipyroaconitine (**18**);[6] and 8,9-(methylenedioxy)lappaconitine (**16**).[11] These compounds produced at least a 10% fall in heart rate or a 20% decline in blood pressure with either the 200 or 400 μg/kg (iv) dose. Responses routinely lasted from 5 to 10 min. The other agents 16-demethoxy-15,16-didehydro-8-*p*-anisoyl-14-benzoyl delphonine (**4**); 8-deacetyl-8-(4-hydroxy-3-methoxycinnamoyl)delphinine (**3**); 3,13-diacetylpseudaconitine (**10**), *N*-deacetyl-8,9-diacetyllappaconitine (**14**); and 13-acetyldelphinine *N*-oxide (**13**) did not show good hypotensive and bradycardic activity (Table 1).

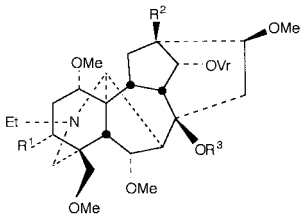
Compounds showing prominent hypotensive and bradycardic activity without cardiac arrhythmias in rats will be further tested in dog models. The results will be published when available.



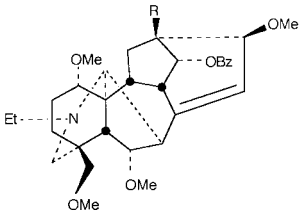
1 R = *p*- aminobenzoyl
2 R = anthranoyl
3 R = 4-hydroxy-3-methoxycinnamoyl



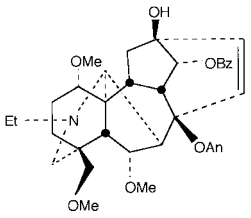
5 R = OH
6 R = OAc



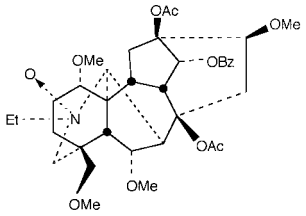
7 R^1 = OAc, R^2 = H, R^3 = Ac
8 R^1 = OH, R^2 = H, R^3 = stearoyl
9 R^1 = OH, R^2 = H, R^3 = linolenyl
10 R^1 = R^2 = OAc, R^3 = Ac



11 R = OAc
12 R = OH



4 An = *p*-anisoyl



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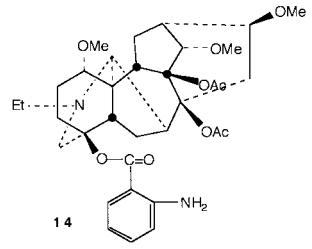
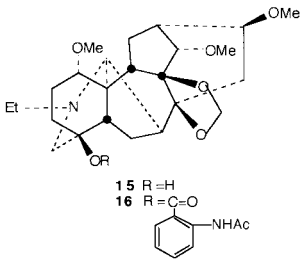
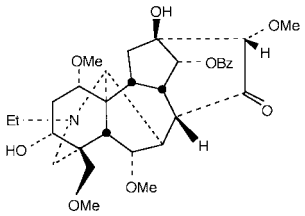


14



15 R = H
16 R = C=O



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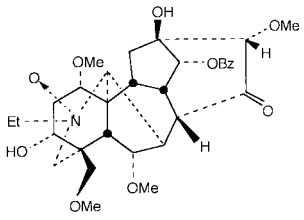

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Experimental Section

General Experimental Procedures. Melting points are corrected and were determined on a Thomas−Kofler hot stage equipped with a microscope and a polarizer. Optical rotations were measured on a Perkin−Elmer model 141 polarimeter in $CHCl_3$. IR spectra were obtained on a Perkin−Elmer model 1420 spectrophotometer in Nujol. ^{1}H, ^{13}C (including DEPT), and 2D NMR spectra were recorded in $CDCl_3$, on a Bruker AC-300 instrument equipped with the standard Bruker software. HRFABMS were recorded on AutoSpec FAB$^+$ and ESIMS were recorded on a Perkin−Elmer SCIEX API-1 mass spectrometer. Isolation of the reaction products was carried out through separations on Al_2O_3 (1 mm, EM-1104) or SiO_2 (1 mm, EM-7741) rotors of a Chromatotron. Purification of a sample was carried out by passing a $CHCl_3$ solution over a small column (9-in. disposable pipette filled with 3−4 g Al_2O_3) of Al_2O_3 (neutral, activity III).

Pharmacological Testing. Male Sprague−Dawley rats (250−300 g) were anesthetized with pentobarbital sodium (50 mg/kg, ip). Rats were intubated and artificially ventilated with a Harvard respirator under a positive pressure of 10 cm of H_2O. The left jugular vein was cannulated with a polyethylene catheter for agent administration. A second catheter (PE-50) filled with heparinized saline was inserted in the left carotid artery and connected to a Statham pressure transducer for blood pressure measurements as monitored on a Grass 7D polygraph. Systolic blood pressure signals were used to trigger a cardiotachometer for measuring heart rate. A lead II electrocardiogram was also monitored. After a stabilization period of 30 min, agents were infused intravenously using a micro-syringe infusion pump. Agents were dissolved in distilled H_2O (250−500 μg/mL) after being solubilized by the addition of small volumes of 0.1N HCl. Agents were given initially at a dosage level of 200 μg/kg in a volume of 0.2 mL. When the hemodynamic functions returned back to baseline values, a second dosage of 400 μg/kg (also in 0.2 mL) was infused. The infusion rate was 0.4 mL/min.

The mean baseline blood pressure value in rats was 96.2 ± 4.7 mm Hg. The mean heart rate for rats was 352.6 ± 18.3 beats/min.

General Procedure for Preparation of C-8-Substituted Esters (Compounds 1−3, 8, and 9). The

norditerpenoid alkaloids having a C-8 acetyl group and the appropriate acid (in excess) were mixed and placed into a small sublimation apparatus and then heated in an oil bath (110 °C) for 3 h. High vacuum was applied during heating (0.1−0.5 mm/Hg). The cold reaction mixture was then dissolved in $CHCl_3$, and the solution was passed through a basic Al_2O_3 (activity III) column followed by a separation on a Chromatotron rotor (Al_2O_3 or SiO_2) with a gradient of hexane, $CHCl_3$, and EtOH.

8-Deacetyl-8-*p*-aminobenzoyldelphinine (1). Delphinine (101 mg, 0.168 mmol) and *p*-aminobenzoic acid (150 mg, 1.09 mmol) were mixed thoroughly, and the reaction was carried out as described above. The workup and fractionation of the reaction mixture on a SiO_2 rotor of a Chromatotron (as described in the general procedure) gave the amorphous product **1** (47 mg, 53.1%): $[\alpha]_D$ + 37.2° (*c* 1.1); IR ν_{max} 3470, 3370, 3230, 1715, 1695, 1605, 1520, 1450, 1275, 1170, 1120, 1093, 752 and 705 cm^{-1}; ^1H NMR δ 2.35 (3H, s, *N*-Me), 2.86, 3.22, 3.27, 3.55 (each 3H, s, 4 × OMe), 4.95 (1H, d, J = 4.9 Hz, H-14$_\beta$), 6.28 (2H, d, J = 8.5 Hz, H-3″,5″), 7.12 (2H, t, J = 7.4 Hz, H-3′,5′), 7.28 (1H, t, J = 7.2 Hz, H-4′), 7.43 (2H, d, J = 8.6 Hz, H-2″,6″), 7.87 (2H, d, J = 8.5 Hz, H-2′,6′); ^{13}C NMR δ 85.0 (d, C-1), 26.3 (t, C-2), 34.6 (t, C-3), 39.2 (s, C-4), 48.6 (d, C-5), 83.0 (d, C-6), 48.3 (d, C-7), 85.4 (s, C-8), 45.4 (d, C-9), 41.2 (d, C-10), 50.2 (s, C-11), 35.5 (t, C-12), 74.9 (s, C-13), 79.0 (d, C-14), 39.3 (t, C-15), 83.6 (d, C-16), 63.3 (d, C-17), 80.2 (t, C-18), 56.1 (t, C-19), 42.5 (q, C-20), 56.5 (q, OMe-1), 57.9 (q, OMe-6), 58.6 (q, OMe-16), 59.0 (q, OMe-18), 166.2 (s, C═O benzoyl), 129.3 (s, C-1′), 128.5 (d, C-2′,6′), 129.7 (d, C-3′,5′), 132.6 (d, C-4′), 165.3 (s, C═O, *p*-aminobenzoyl), 119.9 (s, C-1″), 127.8 (d, C-2″,6″), 113.2 (d, C-3″,5″), 150.3 (s, C-4″); HRFABMS m/z 677.3438 [M + 1]$^+$ for $C_{38}H_{48}N_2O_9$ (calcd [M + 1]$^+$ m/z 677.3438).

8-Deacetyl-8-anthranoyldelphinine (2). Delphinine (100 mg, 0.166 mmol) and anthranilic acid (200 mg, 1.45 mmol) were mixed thoroughly. The reaction and workup were carried out as described in the general procedure. The residue obtained after purification of the reaction mixture over an alumina column, was fractionated on a silica rotor of a Chromatotron. On the basis of the TLC results fractions were combined to give amorphous product **2** (47.3 mg 53.4%): $[\alpha]_D$ + 40.3° (*c* 1.2); IR ν_{max} 3485, 3365, 1715, 1680, 1608, 1585, 1480, 1452, 1280, 1230, 1115, 1090, 1030, 985, 750 and 720 cm^{-1}; ^1H NMR δ 2.60 (3H, s, N-Me), 2.94, 3.24, 3.29, 3.54 (each 3H, s, 4 × OMe), 4.96 (1H, d, J = 4.5 Hz, H-14$_\beta$), 6.24 (1H, t, J = 7.4 Hz, H-5″), 6.41 (1H, d, J = 8.1 Hz, H-6″), 7.00 (1H, t, J = 7.3 Hz, H-4″), 7.15 (2H, t, J = 7.5 Hz, H-3′,5′), 7.30 (1H, t, J = 7.1 Hz, H-4′), 7.37 (1H, d, J = 8.2 Hz, H-3″), 7.89 (2H, d, J = 8.5 Hz, H-2′,6′); ^{13}C NMR δ 83.7 (d, C-1), 25.2 (t, C-2), 39.5 (t, C-3), 38.9 (s, C-4), 48.5 (d, C-5), 83.1 (d, C-6), 46.9 (d, C-7), 85.2 (s, C-8), 45.1 (d, C-9), 40.9 (d, C-10), 50.5 (s, C-11), 35.3 (t, C-12), 74.8 (s, C-13), 78.8 (d, C-14), 32.7 (t, C-15), 82.8 (d, C-16), 64.0 (d, C-17), 79.6 (t, C-18), 56.5 (t, C-19), 42.6 (q, C-20), 56.2 (q, OMe-1), 58.1 (q, OMe-6), 58.8 (q, OMe-16), 59.0 (q, OMe-18), 167.0 (s, C═O benzoyl), 129.5 (s, C-1′), 128.0 (d, C-2′,6′), 129.7 (d, C-3′,5′), 134.7 (d, C-4′), 166.9 (s, C═O anthranoyl), 110.6 (s, C-1″), 150.2 (s, C-2″), 116.2 (d, C-3″), 133.6 (d, C-4″), 131.0 (d, C-5″), 116.0 (d, C-6″); HRFABMS m/z 677.3438 [M + 1]$^+$ for $C_{38}H_{48}N_2O_9$ (calcd [M + 1]$^+$ m/z 677.3438).

8-Deacetyl-8-(4-hydroxy-3-methoxycinnamoyl)-delphinine (3). Delphinine (101.2 mg, 0.168 mmol) and *trans*-4-hydroxy-3-methoxycinnamic acid (Aldrich, 151.1 mg, 0.78 mmol) were thoroughly mixed, and the reaction and the workup were carried out as described in the general procedure. After fractionation on an Al_2O_3 rotor of a Chromatotron the product **3** (49.3 mg, 39.8%) was obtained as an amorphous solid: $[\alpha]_D$ + 18.2° (*c* 1.2); IR ν_{max}, 3500, 1715, 1695, 1630, 1600, 1525, 1455, 1270, 1155, 1120, 1095, 1032, 982, 752 and 710 cm^{-1}; ^1H NMR δ 2.36 (3H, s, *N*-Me), 2.89 (1H, s, H-17), 3.09, 3.26, 3.29, 3.52 (each 3H, s, 4 × OMe), 3.85 (3H, s, Ar-OMe), 4.97 (1H, d, J = 4.5 Hz, H-14$_\beta$), 5.12−6.72 (5H, complex cinnamoyl protons), 7.17 (2H, t, J = 7.5 Hz, H-3′,5′), 7.26 (1H, t, J = 7.3 Hz, H-4′), 8.00 (2H, d, J = 7.2 Hz, H-2′,6′); ^{13}C NMR δ 84.9 (d, C-1), 26.3 (t, C-2), 34.6 (t, C-3), 39.3 (s, C-4), 48.8 (d, C-5), 83.5 (d, C-6), 48.2 (d, C-7), 85.3 (s, C-8), 45.1 (d, C-9), 41.1 (d, C-10), 50.2 (s, C-11), 35.4 (t, C-12), 74.9 (s, C-13), 78.9 (d, C-14), 39.3 (t, C-15), 82.8 (d, C-16), 63.4 (d, C-17), 80.3 (t, C-18), 56.1 (t, C-19), 42.5 (q, C-20), 56.5 (q, OMe-1), 57.9 (q, OMe-6), 58.7 (q, OMe-16), 59.1 (q, OMe-18), 166.8 (s, C═O benzoyl), 129.5 (s, C-1′), 128.2 (d, 2′,6′), 129.6 (d, 3′,5′), 132.8 (d, C-4′), 165.9 (s, C═O cinnamoyl), 144.2 (d, C═O−*C*H═CH−), 136.5 (d, C═O−CH═*C*H−), 126.5 (s, C-1″), 122.9 (d, C-2″), 147.8 (s, C-3″), 146.4 (s, C-4″), 109.2 (d, C-5″), 120.0 (s, C-6″); HRFABMS m/z 734.3540 [M + 1]$^+$ for $C_{41}H_{51}NO_{11}$ (calcd [M + 1]$^+$ m/z 734.3540).

16-Demethoxy-15,16-didehydro-8-*p*-anisoyl-14-benzoyldelphonine (4).[10] Delphinine (90.2 mg, 0.15 mmol) and *p*-methoxybenzoic acid (150.1 mg, 0.98 mmol) were mixed thoroughly, and seven drops of pyridine were added to the mixture. The open flask was heated in an oil bath at 110 °C for 3 h. The reaction mixture was worked up as described in the general procedure. Fractionation (two times) of the residue on Al_2O_3 rotors gave an amorphous compound **4** (31.1 mg, 31.3%): $[\alpha]_D$ −3.2° (*c* 0.42); IR ν_{max} 3450, 1710, 1605, 1510, 1450, 1380, 1290, 1260, 1170, 1120, 1090, 1030, 985, 751 and 713 cm^{-1}; ^1H NMR δ 2.32 (3H, s, *N*-Me), 2.93 (3H, s, OMe-1), 3.27 (3H, s, OMe-6), 3.30 (3H, s, OMe-18), 3.03 (1H, br s, H-17), 3.22, 3.65 (each 1H, d, J = 8.6 Hz, H-18), 3.73 (3H, s, Ar-OMe), 4.22 (1H, d, J = 6.7 Hz, H-6$_\beta$), 5.05 (1H, d, J = 4.5 Hz, H-14$_\beta$), 6.08 (1H, dd, J = 10.5, 1.5 Hz, H-16), 6.53 (1H, d, J = 10.5 Hz, H-15), 7.03 (2H, t, J = 7.5 Hz, H-2′,6′), 6.51 (2H, d, J = 7.03 Hz, H-3″,5″), 7.60 (2H, d, J = 7.1 Hz, H-2″,6″); ^{13}C NMR δ 85.1 (d, C-1), 26.3 (t, C-23, 39.3 (t, C-3), 39.5 (s, C-4), 48.9 (d, C-5), 82.3 (d, C-6), 44.8 (d, C-7), 83.7 (s, C-8), 44.7 (d, C-9), 42.3 (d, C-10), 50.1 (s, C-11), 35.0 (t, C-12), 76.2 (s, C-13), 78.3 (d, C-14), 125.7 (d, C-15), 137.3 (d, C-16), 64.4 (d, C-17), 80.6 (t, C-18), 56.1 (t, C-19), 42.6 (q, C-20), 57.5 (q, OMe-1), 56.5 (q, OMe-6), 59.2 (q, OMe-18), 167.4 (s, C═O benzoyl), 129.6 (s, C-1′), 127.9 (d, C-2′,6′), 129.7 (d, C-3′,5′), 132.8 (d, C-4′), 164.7 (s, C═O *p*-anisoyl), 122.9 (s, C-1″), 131.2 (d, C-2″,6″), 162.7 (s, C-4″), 113.3 (d, C-3″,5″), 55.3 (q, OMe-Ar); HRFABMS m/z 660.3172 [M + 1]$^+$ for $C_{38}H_{45}NO_9$ (calcd [M + 1]$^+$ m/z 660.3172).

6-Acetylheteratisine *N*-oxide (6). To a solution of *m*-CPBA (300 mg, 1.73 mmol) in $CHCl_3$ (15 mL) a

solution of 6-acetylheteratisine (100 mg, 0.23 mmol) was added, and the reaction mixture was stirred for 7 h at room temperature and then left overnight (17 h) in a refrigerator. The reaction mixture was passed over a column of Al_2O_3 (50 g, neutral activity III), and the column was washed with $CHCl_3$ (3 × 100 mL fractions). The first two fractions gave the desired *N*-oxide **6** (85.1 mg, 82%) as an amorphous solid: $[\alpha]_D$ +10.5° (*c* 0.195); IR ν_{max} 3420, 1735, 1250, 1220, 1090, 1060 and 750 cm^{-1}; ^1H NMR δ 0.97 (3H, s, H-18), 1.42 (3H, t, J = 6.5 Hz, *N*-CH_2Me), 2.05 (3H, s, OAc), 2.69 (1H, d, J = 7.2 Hz, H-9), 3.29 (3H, s, OMe), 3.92 (1H, br s, H-17), 4.70 (1H, t, J = 6.4 Hz, H-13), 5.13 (1H, d, J = 7.1 Hz, H-6$_\alpha$); ^{13}C NMR δ 85.9 (d, C-1), 24.2 (t, C-2), 35.2 (t, C-3), 37.5 (s, C-4), 53.4 (d, C-5), 74.6 (d, C-6), 51.8 (d, C-7), 75.1 (s, C-8), 48.4 (d, C-9), 44.2 (d, C-10), 48.9 (s, C-11), 29.2 (t, C-12), 71.3 (d, C-13), 172.7 (s, C-14), 35.0 (t, C-15), 29.1 (t, C-16), 77.5 (d, C-17), 26.0 (q, C-18), 78.1 (t, C-19), 66.7 (t, C-20), 7.8 (q, C-21), 56.4 (q, OMe-1) 170.9 s and 21.5 q (OAc-6); ESIMS *m*/*z* 450.2 $[M + 1]^+$ for $C_{24}H_{35}NO_7$.

3,8-Diacetylfalconerine (7). 8-Acetylfalconerine (76 mg, 0.113 mmol) was dissolved in pyridine (0.5 mL) and Ac_2O (0.5 mL). The mixture was warmed on a steam bath for 5 min and then left at room temperature for 40 h. Distilled H_2O (10 mL) was added, and the ice-cold solution was basified to pH 10 with 10% NaOH solution and extracted with $CHCl_3$ (70 mL × 3). The combined $CHCl_3$ extract was washed with brine, dried (Na_2SO_4), and evaporated to give a gum (85 mg). Fractionation of the gum on an Al_2O_3 rotor of a Chromatotron furnished an amorphous solid (47 mg, 52%), which crystallized from Me_2CO−hexane as plates: mp 191−193 °C; $[\alpha]_D$ +18.6° (c 1.25); IR ν_{max} 1730, 1595, 1582, 1525, 1290, 1270, 1240, 1220, 1175, 1125, 1085, 1020, 970, 925, 892, 830, 752, 730 cm^{-1}; ^1H NMR δ 1.08 (3H, t, J = 7.1 Hz, *N*-CH_2-Me), 1.35 (3H, s, C-8 OAc), 2.05 (3H, s, C-3 OAc), 2.86 (1H, br s, H-17), 3.11 (1H, t, J = 8.1 Hz, H-6), 3.19, 3.20, 3.24, 3.37 (each 3H, s, 4 × OMe), 3.90, 3.92 (each 3H, s, 2 × Ar-OMe), 3.84 (1H, d, J = 8.9 Hz, H-18$_a$), 3.00 (1H, s, H-5), 2.94 (1H, d, J = 8.9 Hz, H-18$_b$), 3.30 (1H, t, J = 10.1 Hz, H-16), 4.14 (1H, m, H-1), 4.90 (1H, m, H-3$_\beta$), 5.02 (1H, t, J = 4.5 Hz, H-14$_\beta$), 6.87 (1H, d, J = 8.5 Hz, H-5′), 7.62 (1H, s, H-2′), 7.67 (1H, dd, J = 8.5, 1.7 Hz, H-6′); ^{13}C NMR δ 83.6 (d, C-1), 32.0 (t, C-2), 71.6 (d, C-3), 42.3 (s, C-4), 49.3 (d, C-5), 81.9 (d, C-6), 44.4 (d, C-7), 85.6 (s, C-8), 43.8 (d, C-9), 46.3 (d, C-10), 50.0 (s, C-11), 28.6 (t, C-12), 39.2 (d, C-13), 75.2 (d, C-14), 37.9 (t, C-15), 82.8 (d, C-16), 61.1 (d, C-17), 71.5 (t, C-18), 48.9 (t, C-19), 47.6 (t, C-20), 13.4 (q, C-21), 56.0 (q, OMe-1), 58.1 (q, OMe-6), 56.6 (q, OMe-16), 58.8 (q, OMe-18), 166.0 (s, C═O Vr), 123.2 (s, C-1′), 112.0 (d, C-2′), 148.6 (s, C-3′), 152.9 (s, C-4′), 110.3 (d, C-5′), 123.6 (d, C-6′), 170.3 (s) and 21.2 (q) (OAc-3), 169.7 (s) and 21.7 (q) (OAc-8); HRFABMS *m*/*z* 716.3646 for $C_{38}H_{53}NO_{12}$ (calcd $[M + 1]^+$ *m*/*z* 716.3645).

8-Stearoylfalconerine (8). 8-Acetylfalconerine (100 mg, 0.148 mmol) and stearic acid (200 mg, 0.7 mmol) were thoroughly mixed. The reaction and workup were carried out as described in the general procedure to give **8** (70 mg, 52.5%) as an amorphous solid, $[\alpha]_D$ +4.5° (*c* 1.4); IR ν_{max} 3520, 1720, 1600, 1515, 1375, 1350, 1295, 1270, 1220, 1180, 1100, 1030, 982, 915, 880, 785 cm^{-1}; ^1H NMR δ 0.86 (3H, t, J = 6 Hz, H-18″), 1.06 (3H, t, J = 7 Hz, *N*-CH_2Me), 1.90 and 2.31 (m, H-12), 1.89 and 2.30 (m, H-2), 2.13 (m, H-7), 2.42 (m, H-13), 2.43 (m, H-9), 2.36 and 2.82 (m, H-19), 2.50 (m, *N*-CH_2), 2.21 and 2.92 (m, H-15), 2.76 (m, H-10), 2.78 (s, H-17), 3.10 (m, H-1), 3.02 (s, H-5), 3.32 (m, H-16), 3.12, 3.20, 3.24, 3.35 (each 3H, s, 4 × OMe), 3.41 and 3.61 (each d, J = 8.8 Hz, H-18), 3.78 (1H, dd, J = 8 and 4 Hz, H-3), 4.08 (1H, d, J = 6 Hz, H-6), 5.02 (1H, t, J = 4.8 Hz, H-14$_\beta$), 6.82 (1H, d, J = 8 Hz, H-5′), 7.57 (1H, d, J = 1.8 Hz, H-2′), 7.64 (1H, dd, J = 8, 1.8 Hz, H-6′), 1.25 (m, H-4″, 5″, 6″, 17″), 1.38 (m, H-3″), 1.20 (m, H-7″, 8″, 9″, 10″, 11″, 12″, 13″, 14″, 15″), 1.10 (m, H-16″); ^{13}C NMR δ 82.3 (d, C-1), 33.1 (t, C-2), 71.6 (d, C-3), 42.9 (s, C-4), 48.5 (d, C-5), 83.5 (d, C-6), 44.9 (d, C-7), 85.5 (s, C-8), 46.3 (d, C-9), 43.5 (d, C-10), 50.5 (s, C-11), 28.1 (t, C-12), 39.4 (d, C-13), 75.3 (d, C-14), 38.4 (t, C-15), 82.8 (d, C-16), 61.2 (d, C-17), 77.8 (t, C-18), 48.6 (t, C-19), 47.6 (t, C-20), 13.2 (q, C-21), 55.6 (q, OMe-1), 57.9 (q, OMe-6), 55.7 (q, OMe-16), 59.1 (q, OMe-18), 55.9 and 55.8 (each q, OMe-Vr), 165.8 (s, C═O Vr), 122.8 (s, C-1′), 110.2 (d, C-2′), 148.6 (s, C-3′), 152.9 (s, C-4′), 111.9 (d, C-5′), 123.6 (d, C-6′), 172.5 (s, C═O stearoyl), 34.7 (t, C-2″), 24.2 (t, C-3″), 29.2 (t, C-4″), 29.2 (t, C-5″), 29.3 (t, C-6″), 29.4 (t, C-7″), 29.6 (t, C-8″,15″), 31.8 (t, C-16″), 22.6 (t, C-17″), 14.0 (q, C-18″); HRFABMS *m*/*z* 898.6044 $[M + 1]^+$ for $C_{52}H_{83}NO_{11}$ (calcd $[M + 1]^+$ *m*/*z* 898.6044).

8-Linolenylfalconerine (9). 8-Acetylfalconerine (80 mg, 0.12 mmol) and linolenic acid (200 mg, 0.73 mmol) were mixed thoroughly. The reaction and the workup were carried out as per the general procedure to give **9** (47.2 mg, 44.5%) as a thick oil: $[\alpha]_D$ +9.2° (*c* 1.42); IR ν_{max} 3505, 1715, 1600, 1513, 1345, 1270, 1225, 1180, 1100, 1040, 980, 910, 858, 765 cm^{-1}; ^1H NMR δ 0.94 (3H, t, J = 7 Hz, H-18″), 1.04 (3H, t, J = 7 Hz, H-21), 2.50 (m, H-20), 1.91 and 2.12 (m, H-2), 2.13 (m, H-7), 2.15 (m, H-10), 2.43 (m, H-13), 2.22 and 2.90 (m, H-15), 1.98 and 2.28 (m, H-12), 2.47 and 2.82 (m, H-19), 2.76 (m, H-9), 2.78 (1H, s, H-17), 3.17 (m, H-1), 3.05 (1H, s, H-5), 3.35 (m, H-16), 3.42 and 3.61 (each d, J = 8.8 Hz, H-18), 3.78 (1H, dd, J = 8.8 and 4 Hz, H-3), 3.15, 3.24, 3.31, 3.38 (each 3H, s, 4 × OMe), 4.07 (1H, d, J = 6 Hz, H-6), 5.00 (1H, t, J = 4.7 Hz, H-14), 6.85 (1H, d, J = 8.6 Hz, H-5′), 7.59 (1H, d, J = 1.8 Hz, H-2′), 7.68 (1H, dd, J = 8.4, 1.8 Hz, H-6′), 3.87, 3.88 (each 3H, s, Vr-OMe), 1.91 and 2.32 (m, H-2″), 1.07 and 25 (m, H-3″), 0.81−1.22 (m, H-4″, 5″, 6″), 1.25 (m, H-7″), 2.00 (m, H-8″), 5.35, 5.38 (m, H-9″, 10″), 2.78 (m, H-11″), 5.30, 5.35 (m, H-12″, 13″), 2.78 (m, H-14″), 5.35, 5.38 (m, H-15″, 16″), 2.06 (m, H-17″); ^{13}C NMR δ 83.5 (d, C-1), 33.0 (t, C-2), 71.8 (d, C-3), 43.0 (s, C-4), 48.5 (d, C-5), 82.3 (d, C-6), 46.3 (d, C-7), 85.5 (s, C-8), 46.3 (d, C-9), 43.6 (d, C-10), 50.5 (s, C-11), 28.1 (t, C-12), 39.4 (d, C-13), 75.3 (d, C-14), 38.5 (t, C-15), 82.8 (d, C-16), 61.3 (d, C-17), 77.5 (t, C-18), 48.5 (t, C-19), 47.8 (t, C-20), 13.2 (q, C-21), 55.6 (q, OMe-1), 58.0 (q, OMe-6), 56.7 (q, OMe-16), 59.1 (q, OMe-18), 165.9 (s, C═O Vr), 122.8 (s, C-1′), 110.3 (d, C-2′), 148.6 (s, C-3′), 153.0 (s, C-4′), 112.0 (d, C-5′), 123.7 (d, C-6′), 172.5 (s, C═O 1″), 34.8 (t, C-2″), 24.3 (t, C-3″), 29.1 (t, C-4″), 29.1 (t, C-5″, 6″), 29.6 (t, C-7″), 27.2 (t, C-8″), 130.2 (d, C-9″), 128.2 (d, C-10″), 25.5 (t, C-11″), 127.0 (d, C-12″), 127.7 (d, C-13″), 24.3 (t, C-14″), 127.7 (d, C-15″), 131.9 (d, C-16″), 20.6 (t, C-17″), 14.3 (q, C-18″); ESIMS *m*/*z* 892.5 $[M + 1]^+$ for $C_{52}H_{77}NO_{11}$.

3,13-Diacetylpseudaconitine (10).[12] Pseudaconitine (80 mg, 0.116 mmol) was dissolved in acetyl chloride (2 mL), and the reaction mixture was left at room temperature in a glass-stoppered flask for 3 days. Acetyl chloride was evaporated in vacuo, and the residue, in H_2O (15 mL), was basified to pH 10. Extraction of the base with $CHCl_3$ (30 mL × 3) gave a yellow foam (84 mg) that crystallized from Me_2CO−hexane (43 mg, 51%), mp 142−143 °C; $[\alpha]_D$ +19.1° (*c* 1.41); IR ν_{max} 1730, 1600, 1573, 1280, 1225, 1199, 1020, 765 cm^{-1}; ^1H NMR δ 1.08 (3H, t, J = 6.9 Hz, H-21), 1.28 (3H, s, C-8, OAc), 2.00 (3H, s, C-13, OAc), 2.03 (3H, s, C-3, OAc), 1.94 and 3.50 (m, H-12), 2.08 (m, H-10), 2.30 (1H, d, J = 5 Hz, H-5), 2.38 (m, H-2), 2.45 and 3.00 (m, H-15), 2.70 (m, H-19), 2.84 (dd, $J_{9,10}$ = 5 Hz, $J_{9,14}$ = 5 Hz, H-9), 2.90 (1H, br s, H-17), 2.99 (1H, s, H-7), 3.15 (6H, s, C-6, 18, OMe), 3.19 (3H, s, C-1, OMe), 3.33 (3H, s, C-16, OMe), 3.89 (6H, s, Vr, OMe), 3.07 (m, H-1), 3.98 (m, H-16), 2.92 and 3.81 (m, H-18), 4.03 (1H, d, J = 5 Hz, H-6), 4.88 (1H, dd, J = 11, 6 Hz, H-3), 5.05 (1H, d, J = 5 Hz, H-14), 6.83 (1H, d, J = 8.1 Hz, H-5′), 7.59 (1H, d, J = 1.7 Hz, H-2′), 7.65 (1H, dd, J = 8, 1.8 Hz, H-6′); ^{13}C NMR δ 81.6 (d, C-1), 31.6 (t, C-2), 71.5 (d, C-3), 42.3 (s, C-4), 46.2 (d, C-5), 83.4 (d, C-6), 49.2 (d, C-7), 85.2 (s, C-8), 43.8 (d, C-9), 41.2 (d, C-10), 49.9 (s, C-11), 35.2 (t, C-12), 82.1 (s, C-13), 76.9 (d, C-14), 39.7 (t, C-15), 80.1 (d, C-16), 61.2 (d, C-17), 71.6 (t, C-18), 46.6 (t, C-19), 48.9 (t, C-20), 13.4 (q, C-21), 56.0 (q, OMe-1), 58.1 (q, OMe-6), 58.2 (q, OMe-16), 58.8 (q, OMe-18), 55.8 and 56.0 (each q, Vr OMe), 166.1 (s, C═O Vr), 122.7 (s, C-1′), 110.5 (d, C-2′), 148.7 (s, C-3′), 153.1 (s, C-4′), 112.2 (d, C-5′), 124.1 (d, C-6′), 170.3 s and 21.2 q (OAc-3), 170.3 s and 21.4 q (OAc-13), 169.7 s and 21.6 q (OAc-8); HRFABMS m/z 774.3689 $[M + 1]^+$ for $C_{40}H_{55}NO_{14}$ (calcd $[M + 1]^+$ m/z 774.3700).

13-Acetylpyrodelphinine (11). 13-Acetyldelphinine (40 mg, 0.062 mmol) was placed in a vacuum sublimator and evacuated for 1.5 h. The apparatus was then immersed in an oil bath preheated to 200 °C and heated for 2 h. The cooled product was dissolved in $CHCl_3$ (15 mL), and the solution was passed through a small Al_2O_3 (neutral, activity III) column. The column was washed with an additional amount of $CHCl_3$ (70 mL). Evaporation of the eluate gave a yellow foam of **11**, which crystallized from benzene−hexane as fine cubes (27 mg, 51%): mp 105−107 °C; $[\alpha]_D$ +90.6° (*c* 1.126); IR ν_{max} 1730, 1600, 1280, 1235, 1095, 1052, 1020, 710 cm^{-1}; ^1H NMR δ 2.04 (3H, s, C-13, Ac), 2.38 (3H, s, N-CH_3), 3.23 (6H, s, 2 × OMe), 3.28 and 3.44 (each 3H, s, 2 × OMe), 2.15 (1H, d, J = 6.7 Hz, H-7), 2.25 (m, H-5), 2.43 and 2.78 (m, H-19), 2.90 (1H, br s, H-17), 3.00 (m, H-10), 3.03 (m, H-9), 3.05 (m, H-1), 3.31 and 3.59 (m, H-18), 4.13 (1H, d, J = 6.5 Hz, H-6), 4.29 (1H, d, J = 6.4 Hz, H-16), 5.36 (1H, br s, H-14), 5.59 (1H, d, J = 6.5 Hz, H-15), 7.41 (2H, t, J = 7.6 Hz, H-3′, 5′), 7.53 (1H, t, J = 6.1 Hz, H-4′); 8.11 (2H, dd, J = 8, 11.8 Hz, H-2′,6′), ^{13}C NMR δ 85.8 (d, C-1), 25.1 (t, C-2), 36.9 (t, C-3), 39.9 (s, C-4), 48.0 (d, C-5), 83.5 (d, C-6), 50.2 (d, C-7), 145.0 (s, C-8), 47.2 (d, C-9), 44.6 (d, C-10), 57.8 (s, C-11), 35.2 (t, C-12), 84.7 (s, C-13), 78.8 (d, C-14), 116.8 (d, C-15), 79.7 (d, C-16), 74.8 (d, C-17), 80.2 (t, C-18), 56.4 (t, C-19), 42.7 (q, C-20), 56.4 (q, OMe-1), 57.3 (q, OMe-6), 58.1 (q, OMe-16), 59.2 (q, OMe-18), 166.8 (s, C═O benzoyl), 130.5 (s, C-1′), 130.2 (d, C-2′, 6′), 128.1 (d, C-3′, 5′), 132.7 (d, C-4′), 170.6 (s) and 21.8 (q) (OAc-13); ESIMS m/z 582.3 $[M + 1]^+$ for $C_{33}H_{43}NO_8$.

13-Acetyldelphinine *N*-oxide (13). 13-Acetyldelphinine (100 mg, 0.156 mmol) was dissolved in $CHCl_3$ (30 mL), and the solution was added to a solution of *m*-CPBA (200 mg, 1.16 mmol) in $CHCl_3$ (7 mL). The reaction mixture was stirred at room temperature for 5 h. The reaction solution was then passed through a small column of basic Al_2O_3 (Woelm, activity III), and the column was eluted with more $CHCl_3$ (70 mL). The residue left after evaporation of the eluate was fractionated on a SiO_2 rotor of a Chromatotron. Fractions 29−39 eluted with EtOAc−MeOH (60:40) were combined on the basis of TLC results to give **13** as an amorphous white solid (43 mg, 41.9%): $[\alpha]_D$ +7.3° (*c* 1.12); IR ν_{max} 1721, 1705, 1600, 1280, 1270, 1100, 1095, 980, 850, 765 cm^{-1}; ^1H NMR δ 1.24 (3H, s, OAc-8), 1.68 (1H, m, H-3), 2.01 (3H, s, OAc-13), 2.20 (1H, br d, H-5), 2.25 (m, H-10$_\beta$), 2.79 (1H, br t, H-9), 3.09 (1H, br s, H-17), 3.15 (3H, s, OMe-6), 3.23 (3H, s, OMe-18), 3.24 (3H, s, OMe-1, 3.34 (3H, s, *N*-Me), 3.36 (3H, s, OMe-16), 3.35 and 3.73 (each 1H, d, J = 13.2 Hz, H-19), 3.97 (1H, d, J = 7 Hz, H-6$_\beta$), 4.09 (m, H-1), 5.12 (1H, d, J = 4.9 Hz, H-14$_\beta$), 7.42 (2H, t, J = 7.3 Hz, H-3′, 5′), 7.55 (1H, t, J = 7 Hz, H-4′), 8.06 (2H, d, J = 7.7 Hz, H-2′,6′); ^{13}C NMR δ 85.3 (d, C-1), 23.8 (t, C-2), 34.0 (t, C-3), 40.9 (s, C-4), 47.5 (d, C-C-5), 81.7 (d, C-6), 53.7 (d, C-7), 83.8 (s, C-8), 44.0 (d, C-9), 43.2 (d, C-10), 51.4 (s, C-11), 36.0 (t, C-12), 81.6 (s, C-13), 76.9 (d, C-14), 38.8 (t, C-15), 79.1 (d, C-16), 79.4 (d, C-17), 79.6 (t, C-18), 73.9 (t, C-19), 62.3 (q, C-20), 56.1 (q, OMe-1), 58.1 (q, OMe-6), 58.3 (q, OMe-16), 59.0 (q, OMe-18), 166.3 (s, C═O benzoyl), 129.8 (s, C-1′), 129.7 (d, C-2′, 6′), 128.5 (d, C-3′, 5′), 133.2 (d, C-4′), 170.0 (s) and 21.4 (q) (OAc-8 and 13); HRFABMS m/z 658.3227 $[M + 1]^+$ for $C_{35}H_{47}NO_{11}$ (calcd $[M + 1]^+$ m/z 658.3227).

***N*-Deacetyl-8,9-diacetyllappaconitine (14).** 8,9-Diacetyllappaconitine[13] (240 mg, 0.36 mmol) was dissolved in HCl (5 mL, 1% aqueous), and the solution was refluxed for 1.5 h in an oil bath. The ice-cold reaction mixture was basified to pH 12 with NaOH (10% aq) solution and then extracted with $CHCl_3$ (70 mL × 5) to afford a gummy residue (190 mg). The residue was fractionated on a basic Al_2O_3 rotor of a Chromatotron, and the fractions eluted with hexane−$CHCl_3$ (70:30) gave a homogeneous amorphous solid (110 mg, 42.9%) of **14**: $[\alpha]_D$ +27.3° (*c* 1.3); IR ν_{max} 1730, 1685, 1620, 1590, 1300, 1255, 1160, 1145, 725 cm^{-1}; ^1H NMR δ 1.11 (3H, t, J = 7 Hz, H-21), 2.03 and 2.12 (each 3H, s, 2 × OAc), 3.17, 3.22, 3.41 (each 3H, s, 3 × OMe), 4.89 (1H, d, J = 5.1 Hz, H-14$_\beta$), 5.67 (2H, br s, NH_2), 6.62 and 6.67 (each 1H, dt, J = 8, 7 Hz, H-3′, 5′), 7.24 (1H, t, J = 7 Hz, H-4′), 7.72 (1H, d, J = 8 Hz, H-6′); ^{13}C NMR δ 83.9 (d, C-1), 26.2 (t, C-2), 31.9 (t, C-3), 82.9 (s, C-4), 45.8 (d, C-5), 26.2 (t, C-6), 47.8 (d, C-7), 85.0 (s, C-8), 89.1 (s, C-9), 40.2 (d, C-10), 50.4 (s, C-11), 23.0 (t, C-12), 37.8 (d, C-13), 82.1 (d, C-14), 40.4 (t, C-15), 81.2 (d, C-16), 60.8 (d, C-17), 55.7 (t, C-19), 48.9 (t, C-20), 13.4 (q, C-21), 56.5 (q, OMe-1), 56.6 (q, OMe-16), 57.4 (q, OMe-14), 170.4 (s) and 23.6 q (OAc-8), 169.4 (s) and 22.6 (q) (OAc-9), 167.0 (s, C═O anthranoyl), 111.7 (s, C-1′), 150.5 (s, C-2′), 116.7 (d, C-3′), 133.9 (d, C-4′), 116.1 (d, C-5′), 131.2 (d, C-6′); HRFABMS m/z 627 3281 $[M + 1]^+$ for $C_{34}H_{46}N_2O_9$ (calcd $[M + 1]^+$ m/z 627.3282).

8,9-(Methylenedioxy)lappaconine (15). A solution of lappaconine (43 mg, 0.101 mmol) *p*-toluenesulfonic acid (43 mg, 0.22 mmol), diethoxymethane (2.92 mL, 0.33 mmol), and benzene (dry, 10 mL) was refluxed with a Dean Stark water separator for 14 h. Solvents were removed in vacuo giving a dark residue. A solution of the residue in $CHCl_3$ was passed through a small column of Al_2O_3 (neutral, activity III), and the column was washed with additional $CHCl_3$. The residue obtained on evaporating $CHCl_3$ was fractionated on an Al_2O_3 rotor of a Chromatotron and the homogeneous (TLC) fractions 12−25 eluted with hexane−$CHCl_3$ (30:70), furnished a gum (**15**, 27 mg, 61%): $[\alpha]_D$ +4.7° (*c* 0.92); IR ν_{max} 3450, 1150, 1120, 850, 760 cm^{-1}; ^1H NMR δ 1.06 (3H, t, J = 7.3 Hz, H-21), 1.57 (m, H-12$_\alpha$), 1.98 (m, H-12$_\beta$), 1.85 (m, H-3$_\beta$), 2.45 (m, H-3$_\alpha$), 2.31 (m, H-5), 2.50 (m, H-20), 2.50 and 3.31 (each m, H-19), 2.91 (1H, br s, H-17), 3.27 (3H, s, OMe-1), 3.30 (3H, s, OMe-16), 3.33 (3H, s, OMe-14), 3.55 (1H, d, J = 4.5 Hz, H-14$_\beta$), 5.09 and 5.45 (each d, J = 2.2 Hz, O-CH_2-O); ^{13}C NMR δ 85.2 (d, C-1), 26.8 (t, C-2), 37.1 (t, C-3), 71.1 (s, C-4), 50.0 (d, C-5), 27.4 (t, C-6), 35.5 (d, C-7), 83.0 (s, C-8), 86.1 (s, C-9), 48.1 (d, C-10), 50.9 (s, C-11), 24.2 (t, C-12), 45.6 (d, C-13), 88.5 (d, C-14), 38.7 (t, C-15), 83.0 (d, C-16), 60.4 (d, C-17), 58.1 (t, C-19), 49.0 (t, C-20), 13.4 (q, C-21), 56.7 (q, OMe-1), 57.4 (q, OMe-14), 56.3 (q, OMe-16), 96.6 (t, O-CH_2-O); HRFABMS m/z 436.2699 $[M + 1]^+$ for $C_{24}H_{37}NO_6$ (calcd $[M + 1]^+$ m/z 436.2699).

16-Epipyroaconitine *N*-oxide (17). 16-Epipyroaconitine (72 mg, 0.123 mmol) was dissolved in $CHCl_3$ (30 mL), and the solution was added to a solution of *m*-CPBA (127 mg, 0.738 mmol) in $CHCl_3$ (30 mL). The mixture was stirred for 3 h. The workup was carried out as described for compound **6** above. Purification on an Al_2O_3 rotor of a Chromatotron furnished compound **17** (21 mg, 28.4%) as a yellow foam: $[\alpha]_D$ −7.7° (*c* 0.95); IR ν_{max} 3400, 1715, 1645, 1600, 1320, 1220, 1210, 1095, 1045, 990, 935, 890, 805, 750 cm^{-1}; ^1H NMR δ 1.42 (3H, t, J = 7 Hz, H-21), 2.25−2.45 (m, H-2), 2.37 (br d, H-5), 2.85−2.95 (m, H-1), 3.26, 3.27, 3.31, 3.74 (each 3H, s, 4 × OMe), 3.59 (br s, H-17), 3.65 (m, H-16), 5.39 (1H, d, J = 4.7 Hz, H-14$_\beta$), 7.45 (2H, t, J = 7.6 Hz, H-3′, 5′), 7.59 (1H, t, J = 7.3 Hz, H-4′), 7.95 (2H, d, J = 7.1 Hz, H-2′, 6′); ^{13}C NMR δ 83.5 (d, C-1), 33.0 (t, C-2), 67.9 (d, C-3), 45.7 (s, C-4), 47.4 (d, C-5), 84.5 (d, C-6), 49.6 (d, C-7), 45.9 (d, C-8), 37.7 (d, C-9), 44.9 (d, C-10), 51.7 (s, C-11), 32.6 (t, C-12), 76.5 (s, C-13), 78.1 (d, C-14), 210.5 (s, C-15), 85.7 (d, C-16), 77.1 (d, C-17), 72.6 (t, C-18), 66.7 (t, C-19), 67.1 (t, C-20), 73 (q, C-21), 56.8 (q, OMe-1), 58.8 (q, OMe-6), 62.0 (q, OMe-16), 58.9 (q, OMe-18), 165.9 (s, C=O benzoyl), 129.1 (s, C-1′), 129.6 (d, C-2′, 6′), 128.6 (d, C-3′, 5′), 133.7 (d, C-4′); HRFABMS m/z 602.2965 $[M + 1]^+$ for $C_{32}H_{43}NO_{10}$ (calcd $[M + 1]^+$ m/z 602.2965).

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