Journal of Natural Products
Vol. 51, No. 3, pp. 572-577, May-Jun 1988

DELSTAPHISININE AND ACETYLDELPHISINE, NEW ALKALOIDS FROM *DELPHINIUM STAPHISAGRIA*

SAMIR A. ROSS[1] and S. WILLIAM PELLETIER*

Institute for Natural Products Research and The School of Chemical Sciences, The University of Georgia, Athens, Georgia 30602

ABSTRACT.—Delstaphisinine [**1**] and 1-acetyldelphisine [**5**], new C_{19}-diterpenoid alkaloids, have been isolated from the seeds of *Delphinium staphisagria*. The structures have been determined with the aid of mass, ^{1}H-, and ^{13}C-nmr spectroscopy and were confirmed by correlation with alkaloids of established structures and preparation of derivatives. The structure of the recently isolated delstaphisine [**9**] has also been confirmed.

The seeds of *Delphinium staphisagria* L. (Ranunculaceae) when extracted with ligroin yield an alkaloidal fraction of which delphinine (1) is the major component. The mother liquor accumulated during the isolation of delphinine furnished a large amorphous fraction from which several alkaloids have since been isolated (2–9). Recently we reported the isolation of the new alkaloids delstaphidine, neolinine [**8**], and α-oxodelphinine (10).

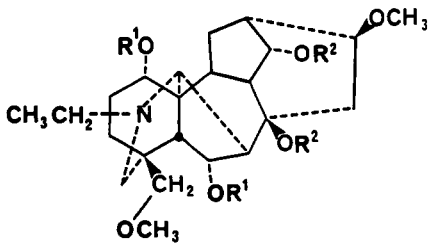
In this paper we report isolation of the new C_{19}-diterpenoid alkaloids delstaphisinine [**1**] and 1-acetyldelphisine [**5**]. The latter has not been reported in nature before but had been prepared from delphisine [**4**] (2). Also, the structure assigned to the recently isolated alkaloid delstaphisine [**9**] (8) has been confirmed.

RESULTS AND DISCUSSION

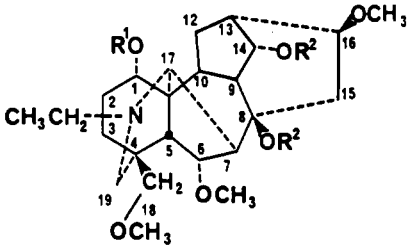
Delstaphisinine [**1**] was obtained as colorless crystals, mp 158–160°, and its molecular formula $C_{27}H_{41}NO_8$ was deduced from the mass spectral and ^{13}C-nmr data. The ^{1}H-nmr spectrum exhibited the following signals: δ 1.12 (3H, t, $J=7$ Hz, N-CH_2-CH_3), 1.97 and 2.03 (3H each, s, OCOCH_3), 3.31 and 3.32 (3H each, s, OCH_3), 4.80 (1H, dd, $J_1=J_2=4.5$ Hz, H-14β). The noise-decoupled ^{13}C-nmr spectrum of **1** exhibited 26 signals for the 27 carbon atoms of the molecule (Table 1). Most of the high molecular fragments of delstaphisinine [**1**] and delstaphisine [**9**] are identical but are 14 mass units less than the corresponding fragments in delphisine [**4**].

Structure **1** was deduced for delstaphisinine from the spectral data, from its comparison with the neoline group of aconitine-type C_{19}-diterpenoid alkaloids, preparation of its acetate derivative **2**, and correlation with the alkaloid, senbusine A [**3**] (11).

Of the two acetate groups observed in the ^{1}H-nmr spectrum at δ 1.97 and 2.03,



1 $R^1=H$, $R^2=Ac$ delstaphisinine
2 $R^1=R^2=Ac$
3 $R^1=R^2=H$ senbusine A



4 $R^1=H$, $R^2=Ac$ delphisine
5 $R^1=R^2=Ac$
6 $R^1=R^2=H$ neoline

[1]On leave from the Department of Pharmacognosy, Faculty of Pharmacy, Assiut University, Assiut, Egypt.

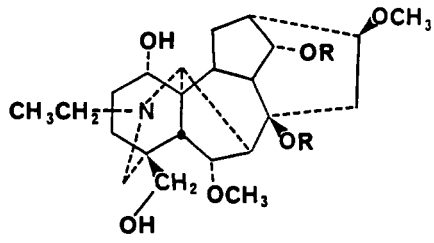
TABLE 1. ^{13}C-nmr Chemical Shifts and Assignments for Delstaphisinine [**1**], Delstaphisinine 1,6-diacetate [**2**], Senbusine A [**3**], 1-Acetyldelphisine [**5**], Delstaphisine [**9**], Delstaphisine 1,16-diacetate [**10**], and Delstaphisine 8,14-deacetate [**11**].

Carbon	1	2	3	5	9	10	11
C-1	71.9 d	77.1	72.2	77.4	72.0	77.3	72.4
C-2	29.4 t	27.7	29.7	27.8	29.4	27.8	29.4
C-3	29.7 t	34.4	29.7	34.4	30.0	34.5	29.9
C-4	37.8 s	38.5 s	38.0 s	38.9 s	38.1 s	38.9 s	38.3 s
C-5	46.3 d	49.1	48.5	49.1	44.0	49.3	44.8
C-6	73.1 d	73.1	73.0	83.4	84.0	83.3	83.3
C-7	49.9 d	49.6	55.6	49.3	47.9	49.3	52.5
C-8	85.8 s	84.5 s	75.4 s	85.5 s	85.9 s	85.0 s	74.5 s
C-9	43.1 d	44.4	45.8	44.2	43.1	43.9	48.1
C-10	38.7 d	38.0	40.4	38.5	42.9	36.2	44.1[a]
C-11	50.1 s	49.8 s	50.0 s	49.3 s	49.7 s	49.3 s	49.6 s
C-12	29.7 t	29.4	29.7	29.4	29.2	28.7	29.4
C-13	43.3 d	43.7	44.2	44.0	43.1	43.8	45.7
C-14	75.5 d	74.5	75.8	74.9	76.0	74.6[b]	76.1
C-15	38.3 t	37.4	42.4	37.6	41.3	39.5	44.8[a]
C-16	82.6 d	82.8	82.0	83.0	72.9	74.4[b]	72.5
C-17	62.6 d	60.5	64.0	60.6	62.5	60.8	63.3
C-18	80.5 t	79.9	80.3	80.0	79.8	79.9	80.2
C-19	56.8 t	54.3	57.2	54.2	56.8	54.0	57.3
N-CH_2	48.1 t	48.5	48.5	48.5	48.1	48.6	48.1
Me	12.8 q	13.3	12.8	13.3	12.9	13.3	13.0
C-6′	—	—	—	58.0	58.0	58.0	57.9
C-16′	56.5 q	56.4	56.4	56.4	—	—	—
C-18′	59.1 q	59.2	59.3	59.0	59.1	59.0	59.2
C(1)-C=O	—	169.9[a] s	—	170.2[a] s	—	170.2 s	—
Me	—	21.9[b]	—	21.9[b]	—	21.9[a]	—
C(6)-C=O	—	170.0[a] s	—	—	—	—	—
Me	—	21.3[b]	—	—	—	—	—
C(8)-C=O	169.5 s	169.3 s	—	169.4 s	169.4 s	169.4 s	—
Me	22.0 q	22.2	—	22.4	22.2	22.4	—
C(14)-C=O	170.6 s	170.6 s	—	170.7[a] s	170.3 s	170.2 s	—
Me	21.0 q	21.1	—	21.1[b]	21.1	21.1[a]	—
C(16)-C=O	—	—	—	—	—	170.2 s	—
Me	—	—	—	—	—	21.0[a]	—

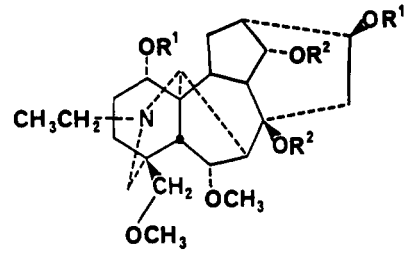
[a,b]Values with the same superscript in the same vertical column may be interchanged.

one is attributed to a C-14α-acetate group. This assignment is supported by the presence of a signal at δ 4.80 (dd, $J_1 = J_2 = 4.5$ Hz) that is characteristic of the C-14 acetate. The H-14β appears at δ 4.80 in delphisine [**4**] and at δ 4.86 in 1-*epi*-delphisine (2). In the ^{13}C-nmr spectrum, C-14 appeared as a doublet at its regular position of 75.5 ppm (same as in delphisine). The DEPT spectrum of delstaphisinine [**1**] showed the presence of five singlets at 170.6, 169.5, 85.8, 50.1, and 37.8 ppm. The downfield signals at 170.6 and 169.5 are assigned to the two acetate carbonyl carbons, whereas the upfield signals at 50.1 and 37.8 ppm are due to the nonoxygenated quaternary carbons C-11 and C-4, respectively. The remaining signal at 85.8 ppm is assigned to the only oxygenated quaternary carbon at C-8.

Substitution of an acetoxyl for a hydroxyl group at C-8 in delphisine [**4**] produces a downfield shift (α effect) of 11.5 ppm, relative to C-8 in neoline [**6**] (12). The acetate signal at 169.5 observed for delstaphisinine [**1**] is, therefore, assigned to C-8, as indicated by the presence of a singlet at 85.8 ppm with a downfield difference (α effect) of



7 R=Ac delstaphisagrine
8 R=H neolinine



9 R^1=H, R^2=Ac delstaphisine
10 R^1=R^2=Ac
11 R^1=R^2=H

11.5 ppm, relative to a shift of 74.3 ppm for C-8 in neoline (12). The chemical shift of C-8 in **1** is the same as in delphisine [**4**] (2).

Delstaphisinine [**1**] possesses two methoxyl functions, δ 3.31 and 3.32 (3H each, s), while the carbons were detected as two quartets at 59.1 and 56.5 ppm. The signal at 59.1 ppm is assigned to the C-18 methoxyl carbon (the usual signal for the C-18 methoxyl carbon in C_{19}-diterpenoid alkaloids carrying a C-18 methoxyl group); this assignment is supported by a triplet at 80.5 ppm. If the oxygen function at C-18 had been an OH group, this triplet would have been shifted upfield about 10 ppm, as in the case of delstaphisagrine [**7**] (70.2 ppm) (8) and neolinine [**8**] (70.9 ppm) (10).

On the basis of ample literature precedent (12), the methoxyl signal at 56.5 (q) ppm was assigned to C-16-OMe, while the triplet signal at 56.8 ppm was attributed to the C-19 methylene carbon, indicating the absence of a C-6 methoxyl group.

Comparison of the C-6 chemical shifts observed for senbusine A [**3**] (11) and foresticine (1-*O*-methylsenbusine A) (13) (with an OH-6α) with those observed for delphisine [**4**] and neoline [**6**] (with a C-6 α-methoxyl) show the expected β effect of 11 ppm upfield shift for the substitution of an OH for an OMe. Therefore, the chemical shift of 73.1 (d) ppm for delstaphisinine shows the 11 ppm upfield shift expected for OH-6.

The presence of a C-1-OMe group in delstaphisinine [**1**] is ruled out by the occurrence of C-2 and C-3 signals as triplets at 29.4 ppm and 29.7 ppm (DEPT, ^{13}C nmr), respectively, and the signal for C-1 bearing an α-OH as a doublet at 71.9 ppm. The signal at 71.9 ppm is analogous to that found for delphisine [**4**] at 72.1 ppm, for delstaphisagrine [**7**] (8) at 71.9 ppm, and for neoline [**6**] (12) at 72.3 ppm.

The presence of two free hydroxyls in delstaphisinine [**1**] was also confirmed by its acetylation with acetylchloride to afford a diacetate **2**.

Alkaline hydrolysis of delstaphisinine [**1**] with 5% methanolic KOH solution gave a compound which was identical with senbusine A [**3**] by ^{1}H-, ^{13}C-nmr, and mass spectra (11). Senbusine A had been recently isolated from *Aconitum carmichaeli* (11).

1-Acetyldelphisine [**5**] was isolated in a crystalline form, mp 151–153°, $[\alpha]^{25}D$ −8.8 (c=0.63, $CHCl_3$). This compound proved to be identical with a synthetic sample of 1-acetyldelphisine by tlc behavior, mp, mmp, ir, mass, ^{1}H-, and ^{13}C-nmr spectra. 1-Acetyldelphisine has not previously been reported in nature.

Delstaphisine [**9**] had been recently isolated from the seeds of *D. staphisagria* (8), and its structure had been determined on the basis of its spectral data only.

Delstaphisine [**9**] was reisolated (60 mg) and, when acetylated with Ac_2O and pyridine, afforded compound **10**. The ^{1}H-nmr spectrum exhibited the presence of four acetates: 2 singlets (3H each) at δ 1.99 and 2.02 and 1 singlet (6H) at δ 2.05. Also, the presence of four acetates was proved from its ^{13}C-nmr data (Table 1). This result confirms the presence of two free hydroxyls in delstaphisine [**9**].

Alkaline hydrolysis of delstaphisine [**9**] with 5% methanolic KOH solution gave

11, with a molecular formula $C_{23}H_{37}NO_6$ as shown by $[M]^+ = 423$ and ^{13}C-nmr data. The ^{1}H-nmr spectrum exhibited the following signals: δ 1.12 (3H, t, $J = 7$ Hz, N-CH_2-CH_3), 3.33 and 3.34 (3H each, s, OCH_3). The noise-decoupled ^{13}C-nmr spectrum of **11** exhibited 20 signals for the 23 carbon atoms of the molecule (Table 1). The spectral data for the acetylation [**10**] and hydrolysis product [**11**] confirm the previously suggested structure for delstaphisine [**9**] (8).

Table 1 summarizes the ^{13}C chemical shifts and assignments for delstaphisinine [**1**], delstaphisinine 1,6-diacetate [**2**], senbusine A [**3**], 1-acetyldelphisine [**5**], delstaphisine [**9**], delstaphisine 1,16-diacetate [**10**], and delstaphisine 8,14-deacetate [**11**].

EXPERIMENTAL

GENERAL EXPERIMENTAL PROCEDURES.—Melting points are corrected and were taken on a Thomas-Kofler hot stage equipped with a microscope and a polarizer. Optical rotations were measured on a Perkin-Elmer model 141 polarimeter. Ir spectra were taken on a Perkin-Elmer model 1420 spectrophotometer. ^{1}H- and ^{13}C-nmr spectra were recorded on JEOL FT model FX-60 and FX-90 Q spectrometers in $CDCl_3$. Mass spectra were determined on a Finnegan Quadrupole 4023 instrument. For chromatographic separations on a Chromatotron (14,15) rotors were coated with a 1-mm-thick layer of aluminum oxide 60 HF 254 + 365, basic (type E, EM Reagents, Cat. No. 1094), or Si gel PF 254 + 365 (EM Reagents, Cat. No. 7741); for separation by vacuum liquid chromatography (vlc) (16), Si gel HR (EM Reagents, Cat. No. 7744) and aluminum oxide 60 HF 254, basic (type E, EM Reagents, Cat. No. 1094) were used. For preparative tlc, Si gel PF-254 (EM Reagent, Cat. No. 7747) was employed.

FRACTIONATION OF MOTHER LIQUORS OF *D. STAPHISAGRIA*.—The amorphous fraction (106 g) of mother liquors of *D. staphisagria* (obtained from S.B. Penick, New York, NY) (9) was separated into 6 fractions by gradient pH extraction techniques (17): fraction 1 (neutral, 36.17 g), fraction 2 (neutral, 24.11 g), fraction 3 (pH 4.5, 20.61 g), fraction 4 (pH 8, 20.02 g), fraction 5 (pH 10, 1.32 g), and fraction 6 (pH 12, 0.21 g).

ISOLATION OF 1-ACETYLDELPHISINE [**5**] FROM FRACTION 3 (pH 4.5).—Part of fraction 3 (17.64 g, pH 4.5) was chromatographed (vlc) (16) on Si gel to get 7.345 g of delphisine [**4**] (mp 122–123°) and 186 mg of the alkaloid delstaphidine (mp 192.5–194.5°) (10). The mother liquors, after separation of delphisine and delstaphidine, were combined and chromatographed (vlc) on silica. Elution was performed with hexane/$CHCl_3$ mixtures of increasing polarity. Fractions eluted with hexane-$CHCl_3$ (80:20) and hexane-$CHCl_3$ (70:30) were similar on tlc plates and were combined (73 mg). The combined fraction was chromatographed (preparative tlc) over 2 plates of silica, using $CHCl_3$-MeOH (96:4) as an eluent. The major zone was extracted to give 41 mg residue which crystallized from Me_2CO/hexane mixture to give 28 mg of 1-acetyldelphisine [**5**]: mp 151–153°; $[\alpha]^{25}D$ −8.8 ($c = 0.63$, $CHCl_3$); ir (nujol) 1743 and 1727 cm^{-1} (C=O); ^{1}H nmr δ 1.09 (3H, t, $J = 7$ Hz, N-CH_2-CH_3), 1.96, 2.02 and 2.06 (3H each, s, $OCOCH_3$), 3.24, 3.27, 3.30 (3H each, s, OMe), 4.07 (1H, dd, $J_1 \sim 1$ Hz, $J_2 = 7$ Hz, H-6β), 4.75 (1H, dd, $J_1 = J_2 = 4.5$ Hz, H-14β); eims *m/z* (%) $[M-59]^+$ 504 (0.7), 444 (0.6), 91 (6), 71 (8), 58 (17), 43 (100); ^{13}C-nmr see Table 1. This compound proved to be identical with a sample of 1-acetyldelphisine (2) prepared by treatment with Ac_2O and pyridine, by tlc behavior, mp, mmp, ir, mass, ^{1}H-, and ^{13}C-nmr spectra.

ISOLATION OF DELSTAPHISININE [**1**] AND DELSTAPHISINE [**9**] FROM FRACTION 4 (pH 8).—This fraction (19.96 g) (pH 8) was chromatographed (vlc) (16) on Si gel. Elution was performed with hexane, hexane/$CHCl_3$, then $CHCl_3$/MeOH mixtures of increasing polarity. Fractions eluted with hexane-$CHCl_3$ (50:50) were crystallized to give 1.091 g of delphisine [**4**], mp 122–124°. Fractions eluted with hexane-$CHCl_3$ (25:75) and $CHCl_3$ were purified on a silica rotor of a Chromatotron to give 0.293 g of delphinine (mp 191.5–193.5°), and the mother liquors were combined and purified twice on an alumina rotor of a chromatotron to get 137 mg of delstaphisagrine [**7**]. Fractions eluted with $CHCl_3$ and $CHCl_3$-MeOH (99:1) gave the recently isolated alkaloid neolinine [**8**] (10), mp 226.5–228.5° (Me_2CO).

All the mother liquors, after the separation of the above alkaloids, were combined. Re-extraction with dilute H_2SO_4 and basification gave an alkaloid fraction that was chromatographed (vlc) (16) on Si gel. The collected fractions were fractionated several times on both alumina and silica rotors of a Chromatotron to obtain 13 mg of crystalline delstaphisinine [**1**], 60 mg of crystalline delstaphisine [**9**], and 91 mg of neoline [**6**], crystalline from Et_2O, mp 157–159°.

DELSTAPHISININE [**1**].—The properties found for **1** were mp 158–160° (Et_2O/hexane);

$[\alpha]^{25}D$ −14.1 (c = 0.15, $CHCl_3$); eims m/z (%) $[M]^+$ $C_{27}H_{41}NO_8$, 507 (0.1), 490 (0.1), 448 (0.3), 447 (0.5), 432 (0.1), 430 (0.1), 404 (0.3), 389 (0.4), 388 (2), 376 (0.2), 342 (0.6), 237 (3), 236 (2), 224 (3), 208 (1), 192 (2), 191 (3), 190 (5), 179 (2), 178 (4), 164 (2), 149 (2), 148 (4), 147 (6), 146 (1), 122 (2), 121 (3), 109 (3), 105 (3), 91 (6), 71 (7), 58 (21), 45 (29), 44 (8), 43 (100).

ACETYLATION OF DELSTAPHISININE [**1**].—Acetyl chloride (0.5 ml) was added to delstaphisinine [**1**] (5 mg), and the resulting solution was stirred continuously at 25° for 3 days. The resulting mixture was evaporated to dryness in vacuo, and the residue was crystallized from Et_2O to give 3.5 mg of pure delstaphisinine 1,6-diacetate [**2**]: mp 178–180°; $[\alpha]^{25}D$ +36.4 (c = 0.17, $CHCl_3$); ^1H nmr δ 1.13 (3H, t, J = 7 Hz, N-CH_2-CH_3), 1.90 and 2.01 (3H each, s, OCOCH_3), 2.04 (6H, s, 2 × OCOCH_3), 3.22 and 3.31 (3H each, s, OMe); ^{13}C-nmr see Table 1.

HYDROLYSIS OF DELSTAPHISININE [**1**].—To 8 mg of delstaphisinine [**1**] in 2.5 ml MeOH was added 2.5 ml of 5% methanolic KOH. The mixture was stirred at room temperature for 18 h. MeOH was distilled, and 10 ml of H_2O was added. The solution was extracted with 4 × 10 ml of $CHCl_3$. The $CHCl_3$ extract was dried over anhydrous Na_2SO_4, and the solvent was removed under reduced pressure to give 6 mg of senbusine A [**3**]. ^1H nmr δ 1.18 (3H, t, J = 7 Hz, N-CH_2-CH_3), 3.34 and 3.35 (3H each, s, OCH_3); eims m/z (%) $[M]^+$, $C_{23}H_{37}NO_6$, 423 (0.03), $[M-OH]^+$ 406 (0.2), 390 (0.05), 213 (0.1), 205 (0.1), 71 (35), 57 (32), 43 (58), 41 (100); ^{13}C-nmr see Table 1.

DELSTAPHISINE [**9**].—Delstaphisine was obtained in a crystalline form from Et_2O/hexane: mp 193.5–195.5°; $[\alpha]^{24.5}D$ −10.7 (c = 0.27, absolute EtOH), and its molecular formula $C_{27}H_{41}NO_8$ was deduced from the ms and ^{13}C-nmr data. ^1H nmr δ 1.12 (3H, t, J = 7 Hz, N-CH_2-CH_3), 1.97 and 2.05 (3H each, s, OCOCH_3), 3.25 and 3.31 (3H each, s, OCH_3), 4.03 (1H, dd, J_1 = 1 Hz, J_2 = 7 Hz, H-6β), 4.86 (1H, dd, J_1 = J_2 = 4.5 Hz, H-14β); ir (Nujol): 3500 and 3170 cm^{-1} (OH), 1740 and 1725 cm^{-1} (C=O); eims m/z (%) $[M]^+$, $C_{27}H_{41}NO_8$, 507 (0.5), $[M-Me]^+$ 492 (1), $[M-OH]^+$ 490 (4), $[M-59]^+$ 448 (4), 447 (1), 430 (1), 420 (1), 404 (2), 388 (1), 342 (2), 237 (6), 236 (4), 224 (7), 71 (8), 60 (7), 58 (60), 56 (12), 55 (11), 45 (41), 44 (14), 43 (100); ^{13}C-nmr see Table 1.

ACETYLATION OF DELSTAPHISINE [**9**].—Ac_2O-pyridine (1:1) (2 ml) was added to 15 mg of delstaphisine [**9**] and left at 25° for 3 days. Iced H_2O (15 ml) was added, and the reaction was rendered alkaline with $NaHCO_3$. The mixture was extracted with 4 × 15 ml of $CHCl_3$. The combined extracts were dried over anhydrous Na_2SO_4 and evaporated in vacuo to give 16 mg of delstaphisine 1,16-diacetate [**10**]: $[\alpha]^{26}D$ −4.2 (c = 0.26, $CHCl_3$); ir (Nujol) 1735 and 1730 cm^{-1} (C=O); ^1H nmr δ 1.11 (3H, t, J = 7 Hz, N-CH_2-CH_3), 1.99 and 2.02 (3H each, s, OCOCH_3), 2.05 (6H, s, 2 × OCOCH_3), 3.25 and 3.28 (3H each, s, OCH_3), 4.06 (1H, dd, J_1 = 1 Hz, J_2 = 7 Hz, H-6β), 4.80 (1H, dd, J_1 = J_2 = 4.5 Hz, H-14β); eims m/z (%) $[M-CH_3]^+$ 576 (0.01), $[M-58]^+$ 533 (5), $[M-59]^+$ 532 (16), 472 (3), 412 (3), 236 (1), 75 (8), 71 (10), 58 (33), 56 (14), 54 (37), 43 (100); ^{13}C nmr see Table 1.

HYDROLYSIS OF DELSTAPHISINE [**9**].—To 15 mg of delstaphisine [**9**] in 1 ml MeOH was added 1 ml of 5% methanolic KOH solution. The mixture was left at room temperature in dark for 18 h. MeOH was distilled, and 5 ml of H_2O was added. The solution was extracted with 5 × 10 ml of $CHCl_3$. The $CHCl_3$ extract was dried over anhydrous Na_2SO_4, and the solvent was removed under reduced pressure to give 11 mg of delstaphisine 8,14-deacetate [**11**]. ^1H nmr δ 1.12 (3H, t, J = 7 Hz, N-CH_2-CH_3), 3.33 and 3.34 (3H each, s, OCH_3); eims m/z (%) $[M]^+$, $C_{23}H_{37}NO_6$, 423 (4), $[M-H]^+$ 422 (1), $[M-Me]^+$ 408 (10), $[M-OH]^+$ 406 (40), $[M-H_2O]^+$ 405 (1), $[M-OMe]^+$ 392 (1), 390 (3), 374 (4), 336 (5), 305 (4), 236 (2), 178 (4), 129 (11), 128 (17), 122 (17), 108 (13), 96 (36), 91 (25), 71 (43), 58 (93), 55 (52), 45 (100), 43 (66); ^{13}C-nmr see Table 1.

ACKNOWLEDGMENTS

We acknowledge with gratitude financial support of this work by American Cyanamid Company. We thank Dr. H.K. Desai for the ^{13}C-nmr spectra, Mr Courtney Pape for mass spectra, and Dr. J.T. Etse for certain ^1H-nmr spectra.

LITERATURE CITED

1. W.A. Jacobs and L.C. Craig, *J. Biol. Chem.*, **127**, 36 (1939).
2. S.W. Pelletier, Z. Djarmati, S. Lajsic, and W.H. DeCamp, *J. Am. Chem. Soc.*, **98**, 2617 (1976).
3. S.W. Pelletier, J.K. Thakkar, N.V. Mody, Z. Djarmati, and J. Bhattacharyya, *Phytochemistry*, **16**, 404 (1977).
4. S.W. Pelletier and J. Bhattacharyya, *Tetrahedron Lett.*, 4679 (1976).
5. W.A. Jacobs and L.C. Craig, *J. Biol. Chem.*, **141**, 67 (1941).
6. S.W. Pelletier, N.V. Mody, Z. Djarmati, I.V. Micovic, and J.K. Thakkar, *Tetrahedron Lett.*, 1955 (1976).

7. S.W. Pelletier, Z. Djarmati, and N.V. Mody, *Tetrahedron Lett.*, 1749 (1976).
8. S.W. Pelletier and M.M. Badawi, *Heterocycles*, **23**, 2873 (1985).
9. S.W. Pelletier and M.M. Badawi, *J. Nat. Prod.*, **50**, 381 (1987).
10. S.A. Ross, H.K. Desai, and S.W. Pelletier, *Heterocycles*, **26**, 2895 (1987).
11. C. Konno, M. Shirasaka, and H. Hikino, *J. Nat. Prod.*, **45**, 128 (1982).
12. S.W. Pelletier and Z. Djarmati, *J. Am. Chem. Soc.*, **98**, 2626 (1976).
13. S.W. Pelletier, C.Z. Ying, B.S. Joshi, and H.K. Desai, *J. Nat. Prod.*, **47**, 474 (1984).
14. H.K. Desai, B.S. Joshi, A.M. Panu, and S.W. Pelletier, *J. Chromatogr.*, **322**, 223 (1985).
15. H.K. Desai, E.R. Trumbull, and S.W. Pelletier, *J. Chromatogr.*, **366**, 439 (1986).
16. S.W. Pelletier, H.P. Chokshi, and H.K. Desai, *J. Nat. Prod.*, **49**, 892 (1986).
17. S.W. Pelletier, B.S. Joshi, and H.K. Desai, in: "Advances in Medicinal Plant Research." Ed. by A.J. Vlietinck and R.A. Dommisse, Wissenschaftliche Verlagsgesellschaft, Stuttgart, 1985, pp. 153–196.

Received 14 December 1987