acetyl-2-methoxyphenyl 4'-acetylphenyl ether with 5-(β-aminoethyl)-2,3-dimethoxyphenyl 4'-(β-aminoethyl)-2'-methoxyphenyl ether.

LITERATURE CITED

1. E. P. Nakova and O. N. Tolkachev, Khim. Prir. Soedin., 86 (1985) [in this issue].
2. E. P. Nakova, O. N. Tolkachev, and R. P. Evstigneeva, in: Vth Indo–Soviet Symposium on the Chemistry of Natural Compounds. Abstracts of Lectures [in Russian], Erevan (1978), p. 62.
3. E. P. Nakova, O. N. Tolkachev, and R. P. Evstigneeva, Zh. Org. Khim., 17, 637 (1981).
4. E. P. Nakova, O. N. Tolkachev, and R. P. Evstigneeva, in: IInd Symposium with International Participation on the Structure and Reactivity of Organic Compounds. Manuscripts of Contributed Papers, Burgas, Bulgaria (1975), p. 45.
5. O. N. Tolkachev, E. P. Nakova, and R. P. Evstigneeva, in: IUPAC IInd International Symposium on the Chemistry of Natural Products. Symposium Papers, Vol. 3, Synthesis of Natural Products, Golden Sands, Bulgaria (1978), p. 47.
6. E. P. Nakova, O. N. Tolkachev, and R. P. Evstigneeva, in: First International Conference on the Chemistry and Biotechnology of Biologically Active Natural Products, Varna, Bulgaria, September 21-26, 1981. Short communications on Synthesis and Enzymatic Transformations and Biosyntheses, Vol. 3, No. 2 (1981), p. 570.
7. E. P. Nakova, O. N. Tolkachev, and R. P. Evstigneeva, Khim. Prir. Soedin., 457 (1981).
8. T. Kametani, H. Iida, S. Kano, S. Tanaka, K. Fukumoto, S. Shibuya, and H. Yagi, J. Heterocyclic Chem., 4, 85 (1967).
9. E. P. Nakova, Bulgarian Patent No. 26, 438 (1979).
10. S. M. Kupchan and H. W. Atland, J. Med. Chem., 16, 913 (1973).

CORUMDEPHINE — A NEW ALKALOID FROM *Delphinium corumbosum*

B. T. Salimov, M. S. Yunusov,
N. D. Abdullaev, and Z. M. Vaisov

UDC 547.944/945

The epigeal part of *Delphinium corumbosum* Rgl., collected in the flowering phase in the environs of Pokatilovka (Dzhungarian Ala-Tau) has yielded — in addition to the known alkaloids methyllycaconitine, lycoctonine, delcorine, deoxydelcorine, delcoridine, dehydrodelcorine, dephatine, browniine, dictysine, and dictysine acetonide — a new diterpene alkaloid with the composition $C_{25}H_{39}NO_6$ (I), which has been called corumdephine. The structure of corumdephine has been established on the basis of a passage from (I) to deoxydelcorine and spectral characteristics.

We have studied the epigeal part of *Delphinium corumbosum* Rgl. collected in the flowering phase in the environs of the village of Pokaitilovka (Dzhungarian Ala-Tau). The alkaloids methyllycaconitine, delcorine, and deoxydelcorine have been isolated previously from the epigeal part of this plant collected in the budding period in the upper reaches of the R. Baskan (Dzhungarian Ala-Tau) [1]. Chloroform extraction yielded 0.56% of combined alkaloids, from which methyllycaconitine, delcorine, deoxydelcorine, lycoctonine [2], delphatine [3], browniine [4], dictysine and dictysine acetonide [5], delcorine [6], dehydrodelcorine [7], and a new base $C_{25}H_{39}NO_6$ (I), which has been called corumdephine, were isolated.

The IR spectrum of (I) showed absorption bands at 3500 cm^{-1} (hydroxy group) and 1100 cm^{-1} (ether C–O bonds). In the PMR spectrum there were the signals of a N–CH_2CH_3 group (1.00 ppm, triplet with J = 7 Hz, 3 H), of three methoxy groups (3.14, 3.18, and 3.39 ppm, singlets, 3 H each), and of a methylenedioxy group (4.80 and 4.90 ppm, singlets, 1 H each). The mass spectrum of (I) contained the peaks of ions with m/z 449 (M^+), 434, 419, 418 (100%).

Institute of the Chemistry of Plant Substances, Academy of Sciences of the Uzbek SSR, Tashkent.

Translated from Khimiya Prirodnykh Soedinenii, No. 1, pp. 95-98, January-February, 1985. Original article submitted April 19, 1984.

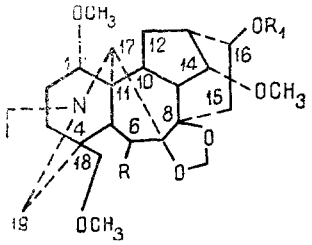
0009-3130/85/2101-0091$09.50

The facts given above permit (I) to be assigned to the diterpene alkaloids with a lycoctonine skeleton and the developed formula of corumdephine to be given as

$$C_{19}H_{21}(N-C_2H_5)(OCH_3)_3(OH)(CH_2O_2).$$

The comparison of the developed formulas of corumdephine and deoxydelcorine (II) [1, 8] showed that (I) differed from (II) only by the presence of one hydroxy group in place of a methoxy group. The methylation of (I) with methyl iodide in dioxane in the presence of sodium hydride led to a product the perchlorate of which proved to be identical with that of deoxydelcorine. The correlation performed confirmed the presence of a lycotonine skeleton in (I) and indicated the position and configuration of the substituents while, leaving open the question of their relative arrangement.

In the mass spectrum of (I), the maximum peak is that of the M − 31 ion, which shows the presence of a methoxy group at C_1 [9]. The acetylation of (I) with acetic anhydride in pyridine gave the monoacetate (III). The signal of the proton geminal to the acetoxy group appeared in the PMR spectrum of (III) at 4.66 ppm in the form of a one-proton quartet with ^3J = 10 and 7 Hz. In view of the facts that a methoxy group was located at C_1 and the signal of the gem-hydroxylic β-proton in C_{14} in the PMR spectra of alkaloids containing no substituents at C_9 and C_{13} appears in the form of a triplet with $^3J \approx 5$ Hz [10], it was possible to conclude that the only position remaining for the hydroxy group was position 16, and that corumdephine has the structure (I).



I. R=R₁=H;

II. R=H, R₁=CH₃;

III. R=H, R₁=COCH₃;

IV. R=OH, R₁=CH₃

The spin–spin coupling constants of the signal of the gem-hydroxylic proton given above agree well with the β-orientation of the hydroxy group at C_{16}. The dihedral angles between the α-proton at C_{16} and the C_{13}–β-H, C_{15}–α-H and C_{15}–β-H protons are, respectively, ~90-100°, 20-30°, and ~140-150°, which correspond to coupling constants of ~0, ~7-8, and ~10 Hz.

The ^{13}C NMR spectrum of corumdephine agrees well with the structure (I). The values of the chemical shifts of the signals of the carbon atoms are given in Table 1. The assignment of the signals were made on the basis of an analysis of the nature of the splitting of the resonance lines in spectra with incomplete decoupling from protons, and a comparison of the values of the chemical shifts of the carbon atoms of corumdephine (I), deoxydelcorine (II), and delcorine (IV) [11]. The most substantial difference in the spectra of (I), (II), and (IV) (see Table 1) was observed in the values of the chemical shifts of C_{16} signals. The replacement of a methoxy group at C_{16} by a hydroxy group led to an upfield shift of the C_{16} signal in corumdephine by about 10 ppm.

EXPERIMENTAL

The homogeneity of the substances was chekced by chromatography in a thin layer of type KSK silica gel in the benzene–methanol (4:1) and chloroform–methanol (20:1) systems and of alumina of "for chromatography" grade in the chloroform–methanol (50:1) and ether–hexane (3:1) systems. The IR spectrum was taken on a UR-20 instrument in a film; the PMR spectra, on a JNM-4H-100/100 MHz spectrometer (δ, ppm, $CDCl_3$, HMDS); ^{13}C NMR spectra, on WM-250 (Bruker) and CFT-20 (Varian) spectrometers in $CDCl_3$ with TMS as internal standard; and mass spectra, on an MKh-1310 instrument fitted with a system for direct introduction into the ion source.

Isolation and Separation of the Combined Alkaloids. The chloroform extraction of 21.5 kg of the air-dry epigeal part of the plant gave 103.2 g of an ether fraction and 17.2 g of a chloroform fraction of the alkaloids. On treatment with acetone, the ether fraction yielded 25.9 g of a crystalline mixture of alkaloids which, after recrystallization from methanol, gave 23.5 g of delcorine. The mother liquor (2.4 g) from the recrystallization of the delcorine was chromatographed on a column of silica gel (1:40). The alkaloids were eluted with chloroform (fractions 1-41) and with chloroform–methanol (20:1) (fractions 42-53), 100-ml fractions being collected. On being treated with acetone, fractions 4-10 yielded 0.49 g of

TABLE 1. Details of the ^{13}C NMR Spectra (δ, ppm) of Corumdephine (I), Deoxydelcorine (II), and Delcorine (IV) in $CDCl_3$

C-atom	I	II	IV [11]	C-atom	I	II	IV [11]
1	83.8[a]	83.1	83.1	16	72.0	81.9	81.8
2	26.2	26.6	26.4	17	62.3	61.8	63.9
3	31.9	32.2	31.8	18	78.9	79.0	78.9
4	38.4	38.1	38.1	19	52.6	52.6	53.7
5	44.0	44.5	52.6	$N-CH_2$	50.7	50.4	50.7
6	32.5	32.2	78.9	|			
7	92.1	90.5	92.7	CH_3	14.0	13.8	14.0
8	79.7	81.7	83.9	$O-CH_2-O$	93.4	93.3	92.9
9	47.8	47.8	48.1	1′	55.9	55.4	55.5
10	42.3	43.6	40.3	14′	58.1	57.6	57.8
11	50.3	50.8	50.2	16′	—	56.1	56.3
12	26.9	28.0	28.1	18′	59.4	59.3	59.6
13	39.9	38.3	37.9				
14	84.7[a]	83.5	82.5				
15	36.2	33.1	33.3				

*a — Assignments mutually ambiguous.

delcorine. The mother liquor after the separation of the delcorine was dissolved in ethanol and the solution was acidified with a 10% ethanolic solution of perchloric acid, which gave 0.16 g of deoxydelcorine perchlorate with mp 200-201°C. On acidification with a 10% ethanolic solution of perchloric acid, fractions 17-26 gave 0.29 g of delcoridine perchlorate with mp 222-223°C (foaming, ethanol), and fractions 43-51 gave 0.24 g of delphatine perchlorate.

The mother liquor after the separation of the 25.9 g of crystalline mixture of alkaloids was dissolved in ethanol, and the solution was acidified with a 10% ethanolic solution of perchloric acid. After 24 h, 24.4 g of methyllycaconitine perchlorate had separated out. The mother liquor after the separation of the methyllycaconitine perchlorate was evaporated, the residue was dissolved in water, and the solution was made alkaline with sodium carbonate and was extracted with ether and with chloroform. This gave 45.2 g of ether fraction and 5.2 g of chloroform fraction of the mother liquor. The ether fraction of the mother liquor was chromatographed on a column of alumina (20:1). The alkaloids were eluted with ether (fractions 1-10), with chloroform (fractions 11-20), and then with chloroform–methanol (25:1) (fractions 21-29), 500-ml fractions being collected. The acidification of fraction 2 with a 10% ethanolic solution of perchloric acid led to the isolation of 1.49 g of deoxydelcorine perchlorate. On treatment with acetone, fraction 3 yielded 2.0 g of delcorine. The mother liquor after the separation of the delcorine was evaporated, the residue was dissolved in ethanol, the solution was acidified with 10% ethanolic perchloric acid, and 3.7 g of deoxydelcorine perchlorate was separated. The treatment of fraction 4 with acetone yielded 1.1 g of delcorine. Acidification of the mother liquor with ethanolic perchloric acid gave 1.0 of delphatine perchlorate. On acidification with 10% ethanolic perchloric acid, fractions 13-16 gave 1.96 g of delcoridine perchlorate. On treatment with acetone, fractions 19-21 yielded 0.04 g of lycoctonine. The treatment of fractions 23-25 with acetone gave 0.66 g of dictysine.

The alcohol-soluble part of the perchlorates of fraction 3 after the separation of 3.7 g of deoxydelcorine perchlorate was evaporated to dryness, the residue was dissolved in water, and the solution was made alkaline with sodium carbonate and was extracted with chloroform. The solvent was evaporated off, and the residue (8.5 g) was chromatographed on a column of alumina (1:50). The alkaloids were eluted with hexane–ether (10:1) (fractions 1-40), (5:1) (fractions 41-80), (5:2) (fractions 81-116), (5:3) (fractions 117-137), and (1:1) (fractions 138-171), and then with ether (fractions 172-200), 100-ml fractions being collected. The treatment of fractions 22-32 with hexane yielded 0.07 g of dictysine acetonide, and fractions 58-65 gave 0.61 g of deoxydelcorine. Fractions 92-104 were rechromatographed on a column of silica gel (1:40). The substances were eluted with chloroform, 3-ml fractions being collected. The first three fractions yielded 0.07 g of dehydrodelcorine with mp 138-140°C (hexane), and the last fractions gave 0.085 g of chromatographically homogeneous pulverulent corumdephine. Fractions 187-200 were dissolved in ethanol and the solution was acidified with 10% ethanolic perchloric acid, giving 0.53 g of browniine perchlorate.

Acetylation of Corumdephine. A mixture of 0.035 g of the base, 2 ml of acetic anhydride, and 0.5 ml of pyridine was left at room temperature for 4 days. After the usual working up, 0.035 g of a chromatographically homogeneous substance with M^+ 491 was obtained. PMR spectrum: 1.96 ppm ($OCOCH_3$).

Methylation of Corumdephine. A mixture of 0.04 g of the base, 5 ml of dioxane, 2 ml of methyl iodide, and 0.04 g of sodium hydride was heated in the water bath with stirring for 7 h. The sodium hydride was separated off and the filtrate was evaporated to dryness. The residue was dissolved in 5% sulfuric acid. The acid solution was washed with ether, made alkaline with sodium carbonate, and shaken out with ether. The ethereal extracts were dried over sodium sulfate. The residue after the elimination of the ether was dissolved in ethanol and the solution was acidified with 10% ethanolic perchloric acid to give 0.007 g of deoxydelcorine perchlorate with mp 198-199°C, shown to be identical with an authentic sample by R_f values and a mixed melting point.

SUMMARY

The epigeal part of *Delphinium corumbosum* Rgl. collected in the flowering period in the environs of the village Pokatilovka (Dzhungarian Ala-Tau) has been studied. In addition to the known alkaloids, methyllycaconitine, lycotonine, delcorine, deoxydelcorine, delcoridine, dehydrodelcorine, delphatine, browniine, dictysine, and dictysine acetonide, a new base has been isolated — corumdephine — and its structure has been established.

LITERATURE CITED

1. A. S. Narzullaev, M. S. Yunusov, and S. Yu. Yunusov, Khim. Prir. Soedin. 497 (1973).
2. O. E. Edwards and M. Przybylska, Can. J. Chem., 60, 2261 (1982).
3. M. S. Yunusov and S. Yu. Yunusov, Khim. Prir. Soedin., 334 (1970).
4. M. H. Benn, M. A. M. Cameron, and O. E. Edwards, Can. J. Chem., 41, 477 (1963).
5. B. T. Salimov, B. Tashkhodzhaev, and M. S. Yunusov, Khim. Prir. Soedin., 86 (1982).
6. B. T. Salimov, M. G. Zhamierashvili, and M. S. Yunusov, Khim. Prir. Soedin., 621 (1981).
7. M. G. Zhamierashvili, V. A. Tel'nov, M. S. Yunusov, and S. Yu. Yunusov, Khim. Prir. Soedin., 836 (1977).
8. A. S. Narzullaev, M. S. Yunusov, and S. Yu. Yunusov, Khim. Prir. Soedin., 412 (1974).
9. M. S. Yunusov, Ya. V. Rashkes, V. A. Tel'nov, and S. Yu. Yunusov, Khim. Prir. Soedin., 515 (1969).
10. S. W. Pelletier, L. H. Keith, and P. C. Parthasarathy, J. Am. Chem. Soc., 89, 4146 (1967).
11. S. W. Pelletier, N. V. Mody, and O. D. Dailey, Can. J. Chem., 58, 1875 (1980).