contents were stirred for 0.75 h at ambient temperature, TLC system B. The reaction was terminated by dilution with Et_2O (27 mL) and the addition of H_2O. The layers were separated, and the organic phase was washed with H_2O and brine and dried over Na_2SO_4. The crude product was plug filtered through a pad of silica gel and eluted with ethyl acetate. The solvent was removed in vacuo which afforded an oil that was flash chromatographed on 60–200 mesh deactivated silica gel with 20% (v/v) ethyl acetate in hexane. Concentration in vacuo afforded 79 mg of **27** as a white foam (78%): ^1H NMR (partial of stereomeric mixture in a ratio of approximately 1:3) δ 7.88 (d, 2 H, J = 7.2 Hz), 7.80 (d, 2 H, J = 7.4 Hz), 7.62 (d, 1 H, J = 7.0 Hz), 7.55 (t, 2 H, J = 7.8 Hz), 4.31 (d, 1 H, J = 6.3 Hz), 3.89 (d, 1 H, J = 3.4 Hz), 3.17 (m, 1 H), 1.68 (s, 3 H), 1.39 (s, 3 H), 1.35 (s, 3 H), 1.10 (d, 3 H, J = 7.1 Hz); ^{13}C NMR (peaks of stereomeric mixture) δ 138.50 (e), 133.58 (o), 130.89 (o), 129.69 (o), 129.02 (o), 128.72 (o), 106.75 (e), 82.85 (o), 81.40 (e), 78.15 (e), 74.87 (o), 50.70 (o), 33.92 (e), 30.15 (e), 28.61 (o), 26.90 (o), 19.99 (o), 18.43 (o); IR ($CDCl_3$) R-*OH* 2.70–3.23 μm, exact mass (CI) calculated for $C_{20}H_{28}O_5S$ 381.1735, found 381.1727.

Reductive Elimination of β-Hydroxy Sulfone 27 to Alkene 28 Using 6% Na(Hg). A solution of alcohol **27** (51 mg, 0.134 mmol) in methanol (13.4 mL, 0.01 M) was treated with solid Na_2HPO_4 (76 mg, 0.537 mmol), 6% Na(Hg) (650 mg, 3.22 mmol) at ambient temperature, and then warmed to reflux for 2.2 h, TLC system B. The reaction was terminated by cooling the reaction contents to ambient temperature, then dilution with Et_2O (13 mL), and then careful addition of H_2O. The heterogeneous layers were separated, and the organic phase was washed (×2) with aqueous portions of saturated NH_4Cl and brine and dried over Na_2SO_4. The crude product was plug filtered through a pad of silica gel and eluted with Et_2O. The solvent was removed in vacuo which afforded an oil that was flash chromatographed on 60–200 mesh silica gel and eluted with pentanes and then CH_2Cl_2. Concentration in vacuo afforded 21 mg of **28** as an oil (70%): ^1H NMR δ 5.24 (br, 1 H), 3.66 (d, 1 H, J = 3.2 Hz), 2.87 (br, 1 H), 2.30 (m, 3 H), 1.95 (m, 3 H), 1.75 (m, 1 H), 1.52 (s, 3 H), 1.36 (s, 3 H), 1.13 (d, 3 H, J = 7.1 Hz), 1.11 (s, 3 H); ^{13}C NMR δ 171.79 (e), 143.10 (e), 121.23 (o), 84.70 (o), 76.58 (e), 52.02 (o), 32.97 (o), 32.23 (e), 30.92 (e), 28.56 (o), 27.13 (o), 23.01 (e), 18.30 (o), 17.66 (o); IR ($CDCl_3$) 6.85 (C=C, w), 3.31 μm (C=C*H*, m), exact mass (EI) calculated for $C_{14}H_{22}O_2$ 222.1619, found 222.1614.

Acknowledgment. We thank the National Institute of Health (GM 32693) for their generous support of this work. Thanks also to the Purdue University Magnetic Resonance Laboratory (RR 01077) for access to the 300-MHz high-field spectrometer. We are grateful to K. V. Wood and A. Rothwell for supplying mass spectra and helpful discussions about the fragmentations of α-silyl sulfones. Thanks to Gilbert Emeric for a 200 MHz 2-D NOE ^1H NMR of compound **24b**.

Registry No. (±)-8, 123538-62-5; (±)-**9b** (isomer 1), 123567-93-1; (±)-**9b** (isomer 2), 123670-07-5; (±)-**9c** (isomer 1), 123568-10-5; (±)-**9c** (isomer 2), 123670-08-6; (±)-**9d** (isomer 1), 123568-11-6; (±)-**9d** (isomer 2), 123670-09-7; (±)-**10** (isomer 1), 123567-94-2; (±)-**10** (isomer 2), 123670-17-7; (±)-**10** (isomer 3), 123670-18-8; (±)-**10** (isomer 4), 123670-19-9; (±)-**11** (isomer 1), 123567-95-3; (±)-**11** (isomer 2), 123670-11-1; (±)-**12** (isomer 1), 123567-96-4; (±)-**12** (isomer 2), 123670-10-0; **13a**, 123567-97-5; **13b**, 123568-12-7; (±)-**14**, 123567-98-6; (±)-**15** (isomer 1), 123567-99-7; (±)-**15** (isomer 2), 123670-12-2; (±)-**17** (isomer 1), 123568-00-3; (±)-**17** (isomer 2), 123670-13-3; (±)-**18** (isomer 1), 123568-01-4; (±)-**18** (isomer 2), 123568-13-8; (±)-**19** (isomer 1), 123568-02-5; (±)-**19** (isomer 2), 123568-15-0; (±)-**20** (isomer 1), 123568-03-6; (±)-**20** (isomer 2), 123670-14-4; (±)-**22** (isomer 1), 123568-04-7; (±)-**22** (isomer 2), 123670-15-5; (±)-**23**, 82769-83-3; (±)-**24a**, 123568-05-8; (±)-**24b**, 123568-14-9; (±)-**25**, 123568-06-9; (±)-**26**, 123568-07-0; (±)-**27** (isomer 1), 123568-08-1; (±)-**27** (isomer 2), 123670-16-6; (±)-**28**, 123568-09-2; $Sn(CH_2CH{=}CH_2)_4$, 7393-43-3.

Supplementary Material Available: Experimental procedures including NMR, IR, and mass spectroscopy data for compounds **9–22** (15 pages). Ordering information is given on any current masthead page.

Notes

The Structures of Cardionine and 11-Acetylcardionine, New C_{20}-Diterpenoid Alkaloids, from the Selective INAPT NMR Technique

Gabriel de la Fuente,* José A. Gavín, Matías Reina, and Rafael D. Acosta

Centro de Productos Naturales Orgánicos "Antonio González", CSIC-Universidad de La Laguna, La Laguna, Tenerife, Spain

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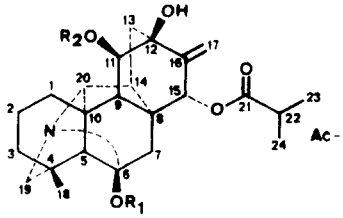
Discussion

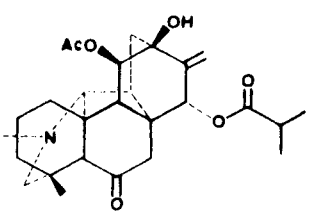
Plants of the *Aconitum*, *Delphinium*, and *Consolida* genera are recognized as rich sources of biologically active and structurally complex diterpenoid alkaloids.[1] In this paper we report on the structure of cardionine (**1**) and 11-acetylcardionine (**2**), isolated from *Delphinium cardiopetalum* DC[2,3] and *D. gracile* DC,[4] respectively.



1 R_1=H, R_2=H

2 R_1=H, R_2=Ac

3 R_1=R_2=Ac



4

11-Acetylcardionine (**2**) had a molecular formula $C_{26}H_{35}NO_6$ determined by HREIMS. Its ^1H and ^{13}C NMR spectra, among other characteristic features of a C_{20}-diterpenoid alkaloid with a hetisine-type skeleton,[2,5-8]

(1) Benn, M. H.; Jacyno, J. M. In *Alkaloids. Chemical and Biological Perspectives*; Pelletier, S. W., Ed.; J. Wiley: New York, 1983; Vol. I, Chapter 4.

(2) González, A. G.; de la Fuente, G.; Reina, M.; Jones, P. G.; Raithby, P. R. *Tetrahedron Lett.* **1983**, *24*, 3765.

(3) González, A. G.; de la Fuente, G.; Reina, M.; Díaz-Acosta, R. *Heterocycles* **1986**, *24*, 1513.

(4) González, A. G.; Díaz-Acosta, R.; Gavín, J. A.; de la Fuente, G. *Heterocycles* **1986**, *24*, 2753.

(5) González, A. G.; de la Fuente, G.; Reina, Mm.; Díaz, R.; Timón, I. *Phytochemistry* **1986**, *25*, 1971.

0022-3263/90/1955-0342$02.50/0

Table I. ^{13}C NMR Assignments for 11-Acetylcardionine (2), Cardionine (1), and Their Derivatives 3 and 4[a]

C	2	1	3	4
1	35.6	35.7	35.5	41.9
2	19.4	19.6	19.6	21.4
3	27.7	27.7	27.6	40.5
4	38.2	38.3	37.4	35.5
5	61.3 (1.56)	60.9	60.4	60.4
6	99.0	99.0	103.1	209.7
7	39.6	38.8	34.5	50.8
8	45.8	45.8	45.5	42.5
9	56.3 (1.65)	58.2	55.6	54.0
10	50.4		50.8	43.9
11	76.3 (4.99)	71.9	76.5	73.3
12	73.1	74.6	73.3	72.5
13	36.2	35.8	36.1	35.1
14	40.9 (2.32)	41.1	40.8	51.3
15	71.1 (5.68)	71.1	71.2	74.5
16	148.0	148.6	148.2	146.0
17	109.4 (5.01, 5.04)	110.3	109.7	111.6
18	30.6 (1.33)	30.4	29.9	27.5
19	60.3 (2.37, 3.08)	59.5	61.7	52.4
20	73.4 (2.59)	72.8	72.2	67.9
21	177.1	177.9	176.9	177.0
22	34.3 (2.63)	34.7	34.4	34.3
23	19.2 (1.20)	19.5	19.1	19.0
24	19.3	19.5	19.2	19.1
OAc			169.7	170.9*
			22.5	22.9*
OAc	172.2		172.4	171.3
	21.4 (2.04)		21.4	21.3

[a] Chemical shifts in ppm downfield from TMS. Solvent $CDCl_3$, except for 1 taken in $CDCl_3$–CD_3OD (1:1). Multiplicities were determined by DEPT data. In parentheses, one-bond connectivities observed in an HETCORR experiment. (*) Signals for the NAc group.

presented signals at δ 1.33 (s) and 30.6 (q), for a methyl group; 5.01 and 5.34 (each d), 109.4 (t) and 148.0 (s), for an exocyclic methylene; 1.20 (d), 2.63 (sept), 19.2 and 19.3 (each q), 34.3 (d) and 171.1 (s), for an isobutyryloxy group; 2.04 (s), 21.4 (q), and 172.2 (s), for an acetyloxy group; 73.1 (s) for a carbon bearing a tertiary hydroxyl group; and 99.0 (s) for a carbinolamine carbon. Signals owing to methoxy, *N*-methyl, or *N*-ethyl groups, frequent in C_{19}-diterpenoid alkaloids, were not observed.

The structure of 11-acetylcardionine (**2**) was established from chemical and spectroscopical evidence with the use of decoupling, NOE difference, DEPT, HETCORR 2D, and INAPT 1D NMR experiments. The ^{13}C assignments listed in Table I were also made taking into account those reported for related C_{20}-diterpenoid alkaloids.[5,7]

The INAPT experiment was developed recently and provides crucial information since by selecting the length of the pulse delay three-bond ^1H–^{13}C connectivity can be established from a highly simplified spectrum.[9] It has been used successfully for determining the structure of natural products.[10-12]

In order to obtain a suitable separation of ~20 Hz between the proton signals to be irradiated, the INAPT experiments with 11-acetylcardionine were carried out using $CDCl_3$–C_6D_6 (2:1) as solvent. When H-17e and H-17z signals at δ 5.00 and 5.30, respectively, were irradiated, three-bond connectivities were observed with C-12 (72.5 ppm, s) and C-15 (70.5 ppm, d) in both cases, allowing a tertiary hydroxyl group to be situated at C-12 and an ester group at C-15. The present of such a function at C-15 was also inferred by the fact that in the HETCORR 2D NMR spectrum the C-15 was correlated with the signal at δ 5.68 (H-15), which in turn was shown to be coupled with the C-17 protons signal, by a decoupling experiment.

On the other hand, in the INAPT experiment, irradiation of the signal at δ 4.86 (s) gave enhancement of C-8, C-10, C-16, and CH_3CO carbon resonances at 45.4 (s), 49.5 (s), 147.5 (s), and 171.7 ppm (s), respectively, which fitted with the presence of an acetyloxy group at C-11 in the molecule. In consequence with the preceding observation, the isobutyryloxy group was placed at C-15. Since the H-11 signal was a singlet the acetate was arranged in the β-configuration according to the dihedral angle between the H-11 and H-9.

The ^1H NMR signals at δ 1.65 (d) and 2.32 (br d), with a long-range coupling (2 Hz) typical of a *W* relationship, were assigned to H-9 and H-14, respectively, on account of the one-bond correlation with its corresponding carbon resonances at 56.3 (d) and 40.9 ppm (d) observed in the HETCORR 2D NMR spectrum. Irradiation of H-15 at δ 5.68 enhanced the H-9 signal in a NOE difference experiment; therefore, both protons are in an axial (β) configuration and the C-15 isobutyryloxy group must be situated in an α-position.

In the ^1H NMR spectrum of hetisine-type alkaloids, the H-6 appears as a broad singlet between 3.00 and 3.70 ppm and the C-18 methyl group at about 1.00 ppm.[8,13,14] The H-6 signal was not observed in the spectrum of 11-acetylcardionine, and the quaternary methyl group shifted downfield 0.33 ppm, hence the other tertiary hydroxyl group was located at C-6.[6,15,16]

Treatment of 11-acetylcardionine with acetic anhydride in pyridine yielded the basic and neutral diacetates **3** and **4**, in agreement with the presence of a tertiary hydroxyl group at C-6.[15,16] Compound **3** gave NMR signals at δ 1.03 and 103.1 ppm for the angular methyl group and the C-6, respectively. The *N*-acetyl nature of **4** was shown by its IR absorption at 1615 cm^{-1} and the ^1H NMR signal at δ 2.14 (3 H, s). The C-6 ketone group was inferred from the new carbonyl carbon resonance at 209.3 ppm (s) and because the C-18 methyl shifted upfield to δ 1.08, as in **3**.

The MS and ^1H and ^{13}C NMR spectra of cardionine (**1**) were very similar to those of **2** and, taking into account its molecular formula $C_{24}H_{35}NO_5$, alkaloid **2** was considered to be an acetate of cardionine. The secondary hydroxyl group at C-11β in **1** was evident from the H-11 signal at 3.86 (s) in its ^1H NMR spectrum. Also from compound **1** to **2** the characteristic α- and β-effects produced upon the introduction of an acetate group were observed in the ^{13}C NMR spectra. The structure of cardionine (**1**) was confirmed by its acetylation with acetic anhydride in pyridine, which afforded the same diacetates **3** and **4** as did 11-acetylcardionine (**2**).

To our knowledge the compounds reported here are the first examples of hetisine-type alkaloids bearing a tertiary hydroxyl group at C-12 and with an oxygen function at C-15 in α-configuration.

(6) Grina, J. A.; Schroeder, D. R.; Wydallis, E. T.; Stermitz, F. R. *J. Org. Chem.* **1986**, *51*, 390.
(7) Sun, F.; Liang, X. T.; Yu, D. Q. *J. Nat. Prod.* **1988**, *51*, 50.
(8) Glinski, J. A.; Joshi, B. S.; Jiang, Q. P.; Pelletier, S. W. *Heterocycles* **1988**, *27*, 185.
(9) Bax, A. *J. Magn. Reson.* **1984**, *57*, 314.
(10) Lin, L.-J.; Cordell, K. A. *J. Chem. Soc., Chem. Commun.* **1986**, 377.
(11) Kim. J.; Kinghorn, A. D. *Tetrahedron Lett.* **1987**, *28*, 3655.
(12) de la Fuente, G.; Reina, M.; Muñoz, O.; San Martin, A.; Girault, J. P. *Heterocycles* **1988**, *27*, 1887.
(13) Jiang, Q.; Pelletier, S. W. *Tetrahedron Lett.* **1988**, *29*, 1875.
(14) Sun, F.; Yu, D. Q. *Acta Pharm. Sinica* **1985**, *20*, 913.
(15) Goto, G.; Sasaki, K.; Sakabe, N.; Hirata, Y. *Tetrahedron Lett.* **1968**, 1369.
(16) Gotz, M.; Wiesner, K. *Tetrahedron Lett.* **1969**, 5335.

Experimental Section

General. Infrared spectra were recorded on a Perkin-Elmer 681 spectrophotometer. Optical rotations were measured with a Perkin-Elmer 137 polarimeter. Melting points (uncorrected) were determined on a Reichert Thermovar apparatus. Exact mass measurements and EIMS were obtained on a VG Micromass ZAB-2F instrument. The NMR experiments were performed on a Brucker WP-200 SY spectrometer. The ^1H couplings were verified by double-resonance experiments. The programs used for DEPT, HETCORR, NOEDIFF, and INAPT (J = 5 Hz, for maximum sensitivity) experiments were those furnished in the Bruker manual. Alumina, Merck, Art. 1077, 5581, and 1092, was used for CC, TLC, and PTLC, respectively. Visualization was effected with Dragendorff's reagent. All solvents, except ethanol, were distilled from glass prior to use. The known reisolated alkaloids were identified by comparison with authentic samples (melting point, IR, MS, and ^1H NMR data).

Isolation of Cardionine (1). Above-ground parts of plants of *Delphinium cardiopetalum* DC[2,3] (2.25 kg) were extracted in 80% EtOH by percolation for 4 days. After removing the solvent under vacuum, the ethanolic extract (238 g) was treated with 0.5 M HCl. The acid solution, washed with $CHCl_3$ and basified with NH_4OH to pH 8, with $CHCl_3$ extraction, gave 14 g of crude alkaloid material. The aqueous phase was then led to pH 12 with 25% NaOH, and extracted with $CHCl_3$ to yield 4 g of additional crude alkaloid material.

The pH 12 alkaloid fraction was chromatographed over alumina with EtOAc and mixtures of EtOAc–MeOH (99:1 to 90:10) to give two main fractions, F_1 (140 mg) and F_2 (2.51 g). Further CC and PTLC, when necessary, yielded cardionine (72 mg) and atisinium chloride[17] (1.95 g) from F_1 and F_2, respectively.

Cardionine (1) had mp 235 °C dec, crystallized from EtOAc: $[\alpha]_D$ 4.68° (c 0.13, EtOH); M^+, m/z 415.2362 for $C_{24}H_{33}NO_5$, Δ −0.4 mmu; IR (KBr) 3340 (br), 2900, 1720, 1260, 1195, 1160, 910, and 860 cm^{-1}; ^1H NMR ($CDCl_3$–CD_3OD, 1:1) δ 1.22 (6 H, d, J = 7 Hz, H-23 and H-24), 1.39 (3 H, s, H-18), 1.62 (1 H, s, H-5), 1.66 (1 H, d, J = 1.7 Hz, H-9), 2.36 (1 H, br d, J = 10.7 Hz, $W_{1/2}$ = 7.5 Hz, H-14), 2.51 (1 H, d, J = 11.8 Hz, H-19α), 2.63 (1 H, sept, J = 7 Hz, H-22), 2.73 (1 H, s, H-20), 3.18 (1 H, d, J = 11.8 Hz, H-19β), 3.86 (1 H, s, H-11α), 5.07 (1 H, d, J = 2 Hz, H-17e), 5.36 (1 H, d, J = 2 Hz, H-17z), and 5.73 (1 H, t, J = 2 Hz, H-15β); MS m/z (relative intensity) 415 (100) M^+, 344 (13), 329 (13), 328 (55), 327 (21), 298 (13), 162 (18), 160 (10), 137 (22), 91 (10), 60 (15), 45 (20), 43 (39), and 41 (18).

Isolation of 11-Acetylcardionine (2). Following the procedure already described, the ethanolic extract (145 g) from the aerial parts of plants of *Delphinium gracile* DC (1.45 kg) yielded pH 8 (6.4 g) and pH 12 (2.6 g) alkaloid fractions. The pH 8 alkaloid fraction was chromatographed over alumina with mixtures of hexane–EtOAc (80:20 to 10:90) and EtOAc to give three main fractions, F_1 (162 mg), F_2 (343 mg), and F_3 (184 mg). Further CC and PTLC yielded gracinine[4] (35 mg) and gadesine[18] (45 mg) from F_1, 11-acetylcardionine (42 mg), nudicaulidine[19] (80 mg), and dihydrogadesine[20] (38 mg) from F_2, and 13-acetylhetisinone[21] (110 mg) from F_3, respectively.

11-Acetylcardionine (2), isolated as a gum, had the following properties: $[\alpha]_D$ −5.71° (c 0.14, $CHCl_3$); M^+, m/z 457.2463 for $C_{26}H_{35}NO_6$, Δ −0.1 mmu; IR ($CHCl_3$) 3540, 3380 (br), 2895, 1710, 1230, 1140, 1050, and 895 cm^{-1}; ^1H NMR ($CDCl_3$) δ 1.20 (6 H, d, J = 7 Hz, H-23 and H-24), 1.33 (3 H, s, H-18), 1.56 (1 H, s, H-5), 1.65 (1 H, d, J = 2 Hz, H-9), 2.04 (3 H, s, OAc), 2.32 (1 H, br d, J = 10.8 Hz, $W_{1/2}$ = 7.5 Hz, H-14), 2.37 (1 H, d, J = 12.2 Hz, H-19α), 2.59 (1 H, s, H-20), 2.63 (1 H, sept, J = 7 Hz, H-22), 3.08 (1 H, d, J = 12.2 Hz, H-19β), 4.99 (1 H, s, H-11α), 5.01 and 5.34 (1 H each, d, J = 2.5 Hz, H-17e and H-17z), and 5.68 (1 H, t, J = 2.2 Hz, H-15β); MS m/z (relative intensity) 457 (79) M^+, 414 (24), 397 (29), 370 (12), 369 (19), 326 (22), 310 (35), 309 (27), 308 (21), 298 (14), 188 (12), 163 (38), 162 (41), 161 (28), 160 (36), 137 (20), 105 (18), 91 (27), 79 (18), 77 (15), 71 (16), 55 (18), 43 (100), and 41 (46).

Derivatives 3 and 4. Cardionine (1) was treated with a mixture of dry pyridine and acetic anhydride (1 mL) for 12 h at 4 °C, toluene was added, and the solvent was removed under vacuum. The reaction mixture was chromatographed over alumina and eluted with EtOAc to give the neutral and basic diacetates 4 (12 mg) and 3 (13 mg), as resins. Analogous treatment of 11-acetylcardionine (15 mg) gave the same derivatives in similar yield.

The neutral diacetate (4): M^+, m/z 499.2554 for $C_{28}H_{37}NO_7$, Δ +1.6 mmu; IR ($CHCl_3$) 3280 (br), 2920, 1720, 1615, 1400, 1235, 1190, 1150, 1050, 1030, 980, and 920 cm^{-1}; ^1H NMR ($CDCl_3$) δ 1.08 (3 H, s, H-18), 1.14 (6 H, d, J = 7 Hz, H-23 and H-24), 1.67 (1 H, d, J = 3 Hz, H-9), 2.04 (3 H, s, OAc), 2.14 (3 H, s, NAc), 2.52 (1 H, sept, J = Hz, H-22), 2.99 and 3.31 (1 H each, d, J = 12.4 Hz, H-19α and H-19β), 3.97 (1 H, s, H-20), 5.16 (1 H, s, H-11α), 5.22 and 5.33 (1 H each, s, H-17e and H-17z), and 5.65 (1 H, s, H-15β); MS m/z (relative intensity) 499 (29) M^+, 458 (28), 457 (100), 456 (54), 414 (10), 369 (29), 368 (19), 326 (17), 310 (14), 309 (13), 308 (19), 291 (22), 162 (13), 161 (12), 160 (13), 711 (19), 69 (11), and 57 (21).

The basic diacetate (3): M^+, m/z 499.2550 for $C_{28}H_{37}NO_7$, Δ +2.0 mmu; IR (KBr), 3430 (br), 3170 (br), 2920, 1735, 1718, 1460, 1360, 1240, 1220, 1155, 1132, 1070, 1030, 970, and 900 cm^{-1}; ^1H NMR ($CDCl_3$) δ 1.03 (3 H, s, H-18), 1.17 (6 H, d, J = 7 Hz, H-23 and H-24), 2.01 and 2.04 (3 H each, s, 2 OAc), 2.32 (1 H, br d, J = 11 Hz, $W_{1/2}$ = 7.5 Hz, H-14), 2.34 (1 H, s, H-5), 2.43 (1 H, d, J = 12.6 Hz, H-7α), 2.43 (1 H, d, J = 12.5 Hz, H-19α), 2.54 (1 H, s, H-20), 2.57 (1 H, sept, J = 7 Hz, H-22), 2.96 (1 H, d, J = 12.5 Hz, H-19β), 4.95 (1 H, s, H-11α), 4.99 and 5.31 (1 H each, d, J = 2.5 Hz, H-17e and H-17z), 5.65 (1 H, t, J = 2 Hz, H-15β); MS m/z (relative intensity) 499 (29), 458 (28), 457 (100), 456 (54), 414 (10), 369 (29), 368 (19), 326 (17), 310 (14), 309 (13), 308 (19), 291 (22), 162 (13), 161 (12), 160 (13), 71 (19), 57 (21), and 55 (19).

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Registry No. 1, 123151-94-0; 2, 123151-95-1; 3, 123151-96-2; 4, 123151-97-3; atisinium chloride, 4758-99-0; gracinine, 107040-83-5; gadesine, 70420-60-9; nudicaulidine, 99815-81-3; dihydrogagesine, 70420-63-2; 13-acetylhetisinone, 82209-94-7.

(17) Pelletier, S. W.; Aneja, R.; Gopinath, K. W. *Phytochemistry* **1968**, *7*, 625.
(18) González, A. G.; de la Fuente, G.; Díaz, R.; Fayos, J.; Martínez-Ripoll, M. *Tetrahedron Lett.* **1979**, 79.
(19) Kulanthaivel, P.; Benn, M. *Heterocycles* **1985**, *23*, 2515.
(20) González, A. G.; de la Fuente, G.; Díaz, R. *Phytochemistry* **1982**, *21*, 1781.
(21) González, A. G.; de la Fuente, G.; Reina, M. *An. Quím.* **1981**, *77C*, 171.

Synthesis and Structure of *as*-Triazinoquinazolines. 3[1,2]

Mohamed A. Badawy, Sayed A. Abdel-Hady, Ahamed H. Mahmoud, and Yehia A. Ibrahim*

Department of Chemistry, Faculty of Science, Cairo University, Giza, A. R. Egypt

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Recently, we reported the synthesis and structure of two isomeric *as*-triazinoquinazoline derivatives, viz., *as*-triazino[3,2-*b*]quinazolines and *as*-triazino[3,4-*b*]-quinazolines.[1,2] The present investigation reports our attempts to construct new *as*-triazino[4,3-*a*]quinazolines ring system. A convenient starting point in the synthetic pathway toward compound of type A depends on our recent findings that heterocyclic compounds containing an *N*-amino amide moiety ($CONNH_2$) can serve as a potential protecting group for obtaining certain isomeric condensed

(1) Abdel-Hady, S. A. L.; Badawy, M. A.; Ibrahim, Y. A.; Pfleiderer, W. *Chem. Ber.* **1984**, *117*, 1077.
(2) Badawy, M. A.; Abdel-Hady, S. A. L.; Eid, M. M.; Ibrahim, Y. A. *Chem. Ber.* **1984**, *117*, 1083.

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