Solanum Alkaloids, 139[1]

Photolysis of *N*-Chlorospirosolanes

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UV irradiation of *N*-chlorosoladulcidine (**2**) in trifluoroacetic acid, followed by separation and hydrolysis of the obtained 3-*O*-trifluoroacetates affords (23*R*)-23-chlorosoladulcidine (**5**) and 23,23-dichlorosoladulcidine (**7**). Similar treatment of *N*-chlorotomatidine (**9**) affords 23,23-dichloro-22-isotomatidine (**12**).

In the course of our former work on the syntheses of steroidal *Solanum* alkaloids from total-synthetically available nitrogen-containing pregnane and cholestane derivatives[2], we used reactions involving remote intramolecular free-radical functionalization such as the photochemically induced Hofmann-Löffler-Freytag cyclization of suitably substituted *N*-chloroamines[3]. Thereby, (22*R*,25*S*)- and (22*S*,25*R*)-*N*-chloro-22,26-epimino-5α-cholestan-3β-ol afforded, as expected, the solanidane alkaloid demissidine and its 22,25 stereoisomer, respectively[4]. In contrast, for stereochemical reasons the corresponding 22*S*,25*S* and 22*R*,25*R* stereoisomers were unable to undergo the necessary 16 → *N*-hydrogen abstraction, but gave by C-20/C-22 photofragmentation a mixture of the (20*R*)- and (20*S*)-20-chloro-5α-pregnan-3β-ols[5,6a]. The same type of photofragmentation was observed with the 16-substituted *N*-chloro-22,26-epimino-5α-cholestane-3β,16β-diols possessing different stereochemistry at C-22 and C-25, which represent the ring E opened dihydro compounds of the spirosolane alkaloids soladulcidine (**1**) and tomatidine (**8**)[2]. These were converted into the (20*R*)- and (20*S*)-20-chloro-5α-pregnane-3β,16β-diols[6]. Under the same conditions, the 20-hydroxylated (20*R*)-*N*-chloro-22,26-epimino-5α-cholestane-3β,20-diols and their 16α- and 16β-hydroxy derivatives yielded 3β-hydroxy- and 3β,16α-dihydroxy-5α-pregnan-20-one and 3β-hydroxy-5α-pregn-16-en-20-one, respectively[7].

In this paper we report on the photolysis of the *N*-chlorospirosolane alkaloids themselves. Thus, UV irradiation of *N*-chlorosoladulcidine[8] (**2**) in trifluoroacetic acid, followed by flash-chromatographic separation and alkaline hydrolysis of the obtained 3-*O*-trifluoroacetates **3**, **4** and **6** afforded besides a 54% yield of soladulcidine[2] (**1**) the *C*-chlorospirosolanes (23*R*)-23-chlorosoladulcidine (**5**) and 23,23-dichlorosoladulcidine (**7**) in yields of 2% and 11%, respectively. In the same manner, photolysis of *N*-chlorotomatidine[8,9] (**9**) gave besides 41% of tomatidine[2] (**8**) 23,23-dichloro-22-isotomatidine (**12**) in 14% yield. Since relatively large amounts of the starting spirosolane alkaloids **1** and **8** are recovered, the actual yields of compounds **5**, **7** and **12**, calculated on the basis of the actually consumed alkaloids, are much higher, i.e. 4% in the case of **5** and 24% in the cases of **7** and **12**.

According to HRMS, compound **5** possesses the elemental composition $C_{27}H_{44}ClNO_2$, showing in its EIMS the diagnostic fragment ions typical for spirosolanes[2] as doublets (1 chlorine) at *m/z* = 148/150 and 172/174 with the elemental compositions $C_6H_{11}ClNO$ and $C_9H_{15}ClN$, respectively. On the other hand, the compounds **7** and **12** exhibit the elemental compositions $C_{27}H_{43}Cl_2NO_2$ and gave only one of the typical spirosolane fragment ions as a triplet (2 chlorines) at *m/z* = 206/208/210 in low relative abundance, with the elemental composition $C_9H_{14}Cl_2N$. These results indicate that one and two chlorine atoms, respectively, must be located at the positions C-20 to C-27 of **5**, **7** and **12**. On the basis of the later discusses NMR data of **5**, **7** and **12**, these fragment ions are assigned the structures **a** and **b** (in the case of **5**) or **c** (in the case of **7** and **12**). Other prominent MS fragment ions are those at *m/z* = 413 [M^+ − HCl] (in the case of **5**) or 411 [M^+ − 2 HCl] (in the case of **7** and **12**), 387 [$C_{25}H_{41}NO_2^+ = M^+ - C_2H_3Cl$ (in the case of **5**) or $M^+ - C_2H_2Cl_2$ (in the case of **7** and **12**), respectively], 273 [$C_{19}H_{29}O^+$] and 152 [$C_9H_{14}NO^+$]. The results indicate that the fragmentation pattern of the 23-mono- and 23,23-dichloro derivatives differs considerably compared to that of the unsubstituted alkaloids soladulcidine (**1**) and tomatidine (**8**).

The ^{13}C-NMR spectra of **1**, **5** and **7** (soladulcidine series) as well as of **8** and **12** (tomatidine series) demonstrate convincingly (Table 1) that the introduced chlorine atom in **5** and the two introduced chlorine atoms in **7** and **12** must be located at C-23. Thus, the signal for C-23 of soladulcidine (**1**) at δ = 34.1 is shifted to lower field in the monochloro compound **5** (δ = 65.1) and further still in the dichloro derivative **7** (δ = 94.3). In the case of the dichloro com-

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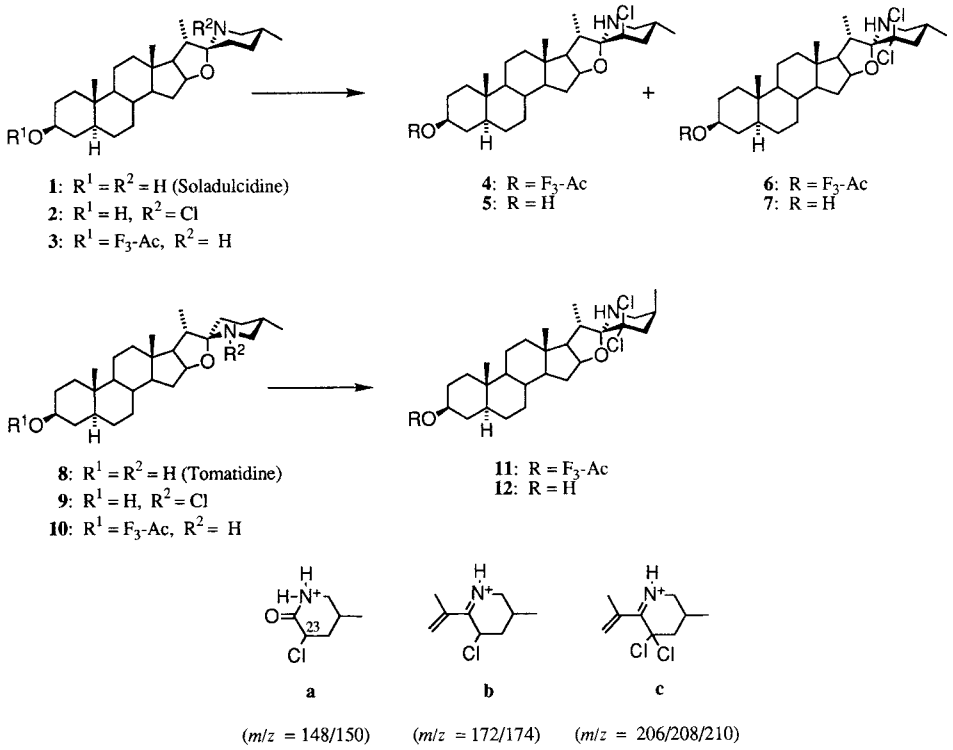


pound **12** this signal appears at δ = 93.3 compared to δ = 26.7 in the starting tomatidine (**8**). In a parallel manner, the corresponding signals of the neighbouring C-24 are also shifted to lower field from δ = 30.3 (**1**) to δ = 41.1 (**5**) and δ = 50.8 (**7**) and from δ = 28.7 (**8**) to δ = 48.3 (**12**), respectively.

Table 1. ^{13}C-NMR chemical shifts (δ values) of compounds **1**, **5**, **7**, **8** and **12** in $CDCl_3$

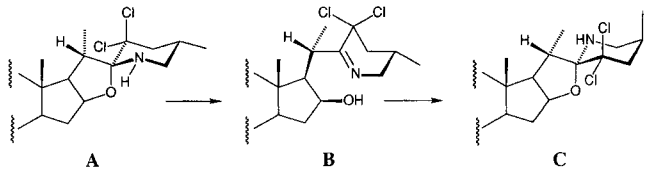
C	1	5	7	8	12	C	1	5	7	8	12
1	37.0	37.0	37.0	37.1	37.0	15	32.1	31.8	31.8	32.8	32.3
2	31.5	31.5	31.5	31.6	31.6	16	78.8	80.3	80.7	78.6	81.0
3	71.3	71.2	71.3	71.3	71.3	17	62.9	63.1	64.2	62.1	64.2
4	38.2	38.2	38.2	38.3	38.3	18	16.7	16.4	16.6	17.1	16.7
5	44.9	44.8	44.8	44.9	44.9	19	12.4	12.3	12.3	12.5	12.4
6	28.7	28.6	28.6	28.7	28.7	20	41.3	40.3	37.6	43.1	43.5
7	32.3	32.2	32.2	32.4	31.9	21	15.3	17.4	17.4	16.0	17.8
8	35.1	35.2	35.0	35.1	35.1	22	98.2	98.2	99.3	99.4	99.8
9	54.4	54.3	54.3	54.5	54.5	23	34.1	65.1	94.3	26.7	93.3
10	35.6	35.5	35.6	35.7	35.7	24	30.3	41.1	50.8	28.7	48.3
11	21.1	21.0	21.0	21.2	21.1	25	31.4	29.7	31.0	31.2	29.8
12	40.3	40.0	40.3	40.3	40.3	26	47.7	46.9	45.5	50.3	48.3
13	40.9	41.2	41.7	41.0	41.8	27	19.4	18.5	17.7	19.4	19.4
14	56.4	56.4	56.2	55.9	56.3						

The ^{1}H-NMR signal for 23-H of the 23-monochloro compound **5** was shown to be a double doublet at δ = 4.06 (J = 3.0 and 4.0 Hz), demonstrating the axial position of the chlorine (23*R* configuration).

Contrary to expectations, the dichloro compounds **11** and **12** of the tomatidine series show optical rotation values ($[\alpha]_D$ = −66.8 and −64.9, respectively) of almost the same magnitude as those of the 23,23-dichloro derivatives **6** and **7** of the soladulcidine series ($[\alpha]_D$ = −58.9 and −60.8, respectively). From this it can be assumed that **11** and **12** possess the same 22α*N* stereochemistry as the soladulcidine derivatives **6** and **7**, since the configuration at this centre of chirality has a pronounced effect on the optical rotation of spirosolanes differing only in the stereochemistry at C-22 and/or C-25 (molecular rotation contribution $\Delta[\Phi]_D$(22α*N* → 22β*N*) ≈ +300, in comparison to $\Delta[\Phi]_D$(25*R* → 25*S*) ≈ −40)[10]. This presumed inversion of configuration at C-22 in **11** and **12** (22-isotomatidine structure) puts the originally equatorially oriented 25-methyl group (C-27) in an axial position. This is confirmed by the ^{1}H-NMR spectrum with δ = 1.28 for an axial 27-H_3 in **12** instead of δ = 0.85 for the equatorial one in tomatidine (**8**) as well as by the equatorial/axial and equatorial/equatorial coupling of the 25_{eq}-H with the 26_{ax}-H at δ = 2.34 and the 26_{eq}-H at δ = 2.88, respectively, in the case of **12**.

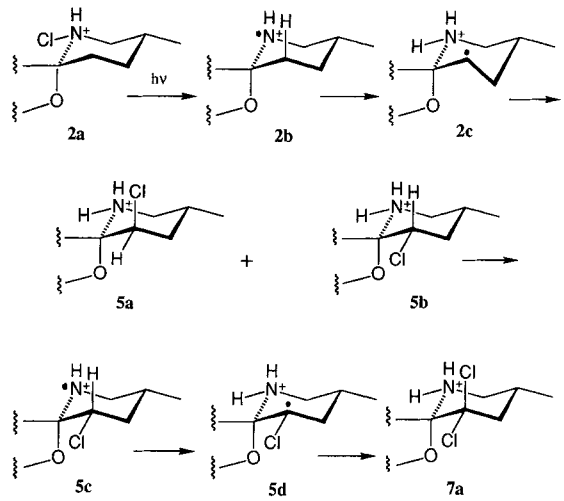
As suggested previously for the native spirosolane alkaloids[10,11], the inversion of the configuration at C-22 in the compounds **11** and **12** can be explained by a ring-chain tautomerism (**A** → **C**), proceeding via the corresponding ring E opened azomethine **B**. **B** recyclizes under thermodynamic control to the 22-iso compound **C** owing to the strong steric hindrance between the dichloro-substituted C-23 and the 20-methyl group (C-21). An analogous inversion of the configuration at C-22 has been reported for (23*S*)-acetoxy-substituted tomatidine, which also adopts the (23*S*)-23-acetoxy-22-isotomatidine structure [(23*S*,25*S*)-23-acetoxy-5α,22α*N*-spirosolan-3β-ol][12].

The formation of (23*R*)-23-chloro- (**5**) and 23,23-dichlorosoladulcidine (**7**) from *N*-chlorosoladulcidine (**2**) can be explained in terms of a photochemical radical chain mechanism (see ref.[3]). Thus, UV-induced homolysis of the



A B C

N–Cl bond of the chloroammonium ion **2a** leads to the aminium radical ion **2b**, which then undergoes intramolecular hydrogen abstraction via a six-membered cyclic transition state to give the trigonal C(23) radical ion **2c**. Recombination with chlorine radicals affords the 23-chloroammonium ions **5a** (23*R* configuration) and **5b** (23*S* configuration). Generation of the aminium radical ion **5c** from **5b**, a second hydrogen abstraction to give the C radical ion **5d**, and subsequent recombination lead to the 23,23-dichloroammonium ion **7a**. The conversion of *N*-chlorotomatidine (**9**) into 23,23-dichloro-22-isotomatidine (**12**) may be explained analogously, although a 23-monochloro compound could not be isolated in this case.



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Experimental Section

Melting points (corrected): Micro melting point apparatus PHMK-05 (Wägetechnik Rapido) with digital thermometer DTM 2110 (Thermometerwerk Geraberg). – Optical rotations: Zeiss Polamat A, solvent chloroform. – IR spectra: Zeiss Specord 75 IR. – ^{1}H-NMR (499.84 MHz) and ^{13}C-NMR spectra (125.70 MHz): Varian Unity 500, $CDCl_3$ as solvent and TMS as internal standard. The signals were assigned by ^{1}H-^{1}H DQF-COSY, HMBC and HMQC techniques. – Mass spectra (70 eV): Double focussing mass spectrometer AMD 402. – Flash chromatography: Silica gel 60, 0.040–0.063 mm (Merck). – Analytical TLC: DC-Alufolien Kieselgel 60 F_{254}(Merck), elution with chloroform/methanol (9:1), detection with concentrated sulfuric acid at 110°C and UV fluorescence or with iodine vapour. – The photolysis was carried out in a photoreactor fitted with a round-bottomed silica flask and with a ThU 500 high-pressure mercury lamp (Thelta Elektroapparate Zella-Mehlis) with a broad-band output (maximum 254 nm) under argon at room temperature.

Photolysis of N-Chlorosoladulcidine [(25*R*)-*N*-Chloro-5α,22α*N*-spirosolan-3β-ol, **2**]: A solution of 225 mg (0.5 mmol) of freshly prepared **2**[3] in 6 ml of trifluoroacetic acid was irradiated for 15 min (disappearance of the spot of **2** in the TLC, active chlorine was no longer detectable by potassium iodide/starch solution). The reaction mixture was concentrated in vacuo, the residue was treated with 20 ml of a saturated solution of potassium hydrogen carbonate and then extracted with chloroform (3 × 25 ml). The extract was washed with water (2 × 7 ml) and concentrated in vacuo. The residue (235 mg) was subjected to flash chromatography on 24 g of silica gel (column 40 cm, ∅ 2 cm), elution with *n*-hexane/ethyl acetate (98:2 → 45:55, total volume 1.2 l, 10-ml fractions), leading to the isolation of the following compounds: From fractions 22–41 26 mg (9%) of 23,23-dichlorosoladulcidine 3-*O*-trifluoroacetate (**6**), from fractions 42–60 42 mg of a mixture of (23*R*)-23-chlorosoladulcidine 3-*O*-trifluoroacetate (**4**) with compounds **3** and **6**, from fractions 61–81 98 mg (38%) of soladulcidine 3-*O*-trifluoroacetate (**3**), and from fractions 100–120 25 mg (12%) of soladulcidine (**1**). The above-mentioned mixture of the compounds **3**, **4** and **6** was subjected to flash chromatography once more (same conditions) and yielded an additional 19 mg (7%) of **6** (overall yield 16%), 9 mg (3%) of the monochloro compound **4** and 12 mg (12%) of **3** (overall yield 50%).

23,23-Dichlorosoladulcidine 3-O-Trifluoroacetate [(25*R*)-23,23-Dichloro-3β-trifluoroacetoxy-5α,22α*N*-spirosolane, **6**]: Colourless plates from acetone/*n*-hexane with m.p. 206–208°C, $[\alpha]_D^{22} = -58.9$ (c = 0.016), R_f = 0.93. – IR (KBr): $\tilde{\nu}$ = 1765 cm^{-1} (F_3-AcO), 1215, 1165 and 1130 (F_3C). – MS: *m/z* (%) = 579/581/583 (28/21/4) [M$^+$], 507 (11) [M$^+$ – 2 HCl], 483 (100) [M$^+$ – $C_2H_2Cl_2$], 468 (8) [483 – CH_3], 369 (15) [483 – F_3-AcOH], 206/208/210 (5/3/1) [$C_9H_{14}Cl_2N^+$ = **c**], 152 (24) [$C_9H_{14}NO^+$].

(23R)-23-Chlorosoladulcidine 3-O-Trifluoroacetate [(23*R*,25*R*)-23-Chloro-3β-trifluoroacetoxy-5α,22α*N*-spirosolane, **4**]: From acetone/methanol colourless needles with m.p. 163–166°C (the MS showed the product to be contaminated with a small amount of compound **6**), R_f = 0.90. – IR (KBr): $\tilde{\nu}$ = 1760 cm^{-1} (F_3-AcO), 1210, 1165 and 1125 (F_3C). – MS: *m/z* (%) = 545/547 (39/13) [M$^+$], 530/532 (3/1.2) [M$^+$ – CH_3], 509 (68) [M$^+$ – HCl], 483 (100) [M$^+$ – C_2H_3Cl], 486 (13) [483 – CH_3], 369 (30) [468 – F_3-AcOH], 172/174 (52/17) [$C_9H_{15}ClN^+$] = **b**], 152 (61) [$C_9H_{14}NO^+$], 148/150 (23/7) [$C_6H_{11}ClNO^+$ = **a**].

Soladulcidine 3-O-Trifluoroacetate [(25*R*)-3β-Trifluoroacetoxy-5α,22α*N*-spirosolane, **3**]: From acetone colourless plates with m.p. 173°C, $[\alpha]_D^{22} = -52.2$ (c = 0.025), R_f = 0.45. – IR (KBr): $\tilde{\nu}$ = 1764 cm^{-1} (F_3-AcO), 1214, 1166 and 1128 (F_3C). – MS: *m/z* (%) = 511 (34) [M$^+$], 496 (13) [M$^+$ – CH_3], 414 (7) [M$^+$ – F_3-Ac], 397 (6) [M$^+$ – F_3-AcOH], 138 (100) [$C_9H_{16}N^+$], 114 (83) [$C_6H_{12}NO^+$].

23,23-Dichlorosoladulcidine [(25*R*)-23,23-Dichloro-5α,22α*N*-spirosolan-3β-ol, **7**]: 20 mg (0.034 mmol) of compound **6** was shaken with 3 ml of a 2% methanolic solution of potassium hydroxide at room temp. for 30 min. The solvent was then evaporated in vacuo, 10 ml of water was added, and the mixture was extracted with chloroform (3 × 10 ml). The extract was washed with water, dried with anhydrous sodium sulfate, and concentrated in vacuo. The residue was crystallized from acetone, affording 11.9 mg (71%) of colourless needles with m.p. 179–183°C, $[\alpha]_D^{22} = -60.8$ (c = 0.010), R_f = 0.60. – ^{1}H NMR: δ = 0.64 (m, 1H, 9-H), 0.82 (s, 3H, 19-H_3), 0.85 (d, J = 6.8 Hz, 3H, 27-H_3), 0.96 (s, 3H, 18-H_3), 1.18 (d, J = 6.8 Hz, 3H, 21-H_3), 1.38 (m, 1H, 15β-H), 1.76 (m, 1H, 17-H), 1.97 (m, 1H, 15α-H), 2.07 (m, 1H, 25-H), 2.38 (m, 2H, 24-H_2), 2.61

(m, 1H, 26_{eq}-H), 2.67 (m, 1H, 26_{ax}-H), 2.80 (dd, J = 6.8 and 6.8 Hz, 1H, 20-H), 3.58 (m, 1H, 3α-H), 4.40 (m, 1H, 16α-H). – ^{13}C NMR: See Table 1. – MS: *m/z* (%) = 487 (3) [M^+ = $C_{27}H_{43}{}^{37}Cl_2NO_2{}^+$]: calcd. 487.2612, found 487.2614], 485 (20) [M^+ = $C_{27}H_{43}{}^{35}Cl^{37}ClNO_2{}^+$: calcd. 485.2641, found 485.2656], 483 (34) [M^+ = $C_{27}H_{43}{}^{35}Cl_2NO_2{}^+$: calcd. 483.2671, found 483.2665], 411 (17) [M^+ – 2 HCl = $C_{27}H_{41}NO_2{}^+$: calcd. 411.3137, found 411.3190], 387 (100) [M^+ – $C_2H_2Cl_2$ = $C_{25}H_{41}NO_2{}^+$: calcd. 387.3137, found 387.3105], 273 (9) [$C_{19}H_{29}O^+$: calcd. 273.2218, found 273.2201], 210 (0.5) [$C_9H_{14}{}^{37}Cl_2N^+$], 208 (2) [$C_9H_{14}{}^{35}Cl^{37}ClN^+$], 206 (4) [$C_9H_{14}{}^{35}Cl_2N^+$ = **c**: calcd. 206.0503, found 206.0546], 164 (6) [$C_{10}H_{14}NO^+$: calcd. 164.1075, found 164.1073], 152 (29) [$C_9H_{14}NO^+$: calcd. 152.1075, found 152.1053].

(23R)-23-Chlorosoladulcidine [(23*R*,25*R*)-23-Chloro-5α,22α*N*-spirosolan-3β-ol, **5**]: Obtained by alkaline hydrolysis of 5 mg of compound **4** as described for the preparation of compound **7** (yield 70%). Amorphous (the MS showed the product to be still contaminated with a trace of compound **7**), R_f = 0.52. – ^{1}H NMR: δ = 0.64 (m, 1H, 9-H), 0.82 (s, 3H, 19-H_3), 0.82 (d, J = 6.6 Hz, 3H, 27-H_3), 0.96 (s, 3H, 18-H_3), 1.18 (d, J = 6.7 Hz, 3H, 21-H_3), 1.70 (m, 1H, 17-H), 2.06 (m, 1H, 25-H), 2.60 (dd, J = 11.2 and 10.0 Hz, 1H, 26_{ax}-H), 2.70 (dd, J = 11.2 and 3.6 Hz, 1H, 26_{eq}-H), 3.58 (m, 1H, 3α-H), 4.06 (dd, J = 3.0 and 4.0 Hz, 1H, 23_{eq}-H), 4.40 (m, 1H, 16α-H). – ^{13}C NMR: See Table 1. – MS: *m/z* (%) = 451 (6) [M^+ = $C_{27}H_{44}{}^{37}ClNO_2{}^+$: calcd. 451.3031, found 451.3034], 449 (17) [M^+ = $C_{27}H_{44}{}^{35}ClNO_2{}^+$: calcd. 449.3061, found 449.3060], 413 (46) [M^+ – HCl], 387 (74) [M^+ – C_2H_3Cl], 273 (16) [$C_{19}H_{29}O^+$], 172/174 (42/14) [$C_9H_{15}ClN^+$ = **b**], 164 (66) [$C_{10}H_{14}NO^+$], 152 (100) [$C_9H_{14}NO^+$], 148/150 (36/12) [$C_6H_{11}ClNO^+$ = **a**].

Soladulcidine [(25*R*)-5α,22α*N*-Spirosolan-3β-ol, **1**]: The soladulcidine, R_f = 0.40, isolated by the above-mentioned flash chromatography and by alkaline hydrolysis of 10 mg of compound **3** (as described for the preparation of compound **7**, yield 85%), was shown to be identical in every respect with an authentic sample[2]. – ^{13}C NMR: See Table 1.

Photolysis of N-Chlorotomatidine [(25*S*)-*N*-Chloro-5α,22β*N*-spirosolan-3β-ol, **9**]: A solution of 225 mg (0.5 mmol) of freshly prepared **9**[3,4] in 6 ml of trifluoroacetic acid was irradiated and worked-up as described above for the photolysis of **2**. Upon flash chromatography on silica gel the following compounds were isolated: From fractions 31-40 50 mg (17%) of 23,23-dichloro-22-isotomatidine 3-*O*-trifluoroacetate (**11**), from fractions 48–57 64 mg (25%) of tomatidine 3-*O*-trifluoroacetate (**10**) and from fractions 62–89 43 mg (21%) of tomatidine (**8**).

23,23-Dichloro-22-isotomatidine 3-O-Trifluoroacetate [(25*S*)-23,23-Dichloro-3β-trifluoroacetoxy-5α,22α*N*-spirosolane, **11**]: Colourless cubes from acetone with m.p. 180–183°C, $[\alpha]_D^{22}$ = –66.8 (c = 0.025), R_f = 0.95. – IR (KBr): $\tilde{\nu}$ = 1765 cm^{-1} (F_3-AcO), 1215, 1165 and 1130 (F_3C). – MS: *m/z* (%) = 579/581/583 (37/25/4) [M^+], 507 (77) [M^+ – 2 HCl], 483 (100) [M^+ – $C_2H_2Cl_2$], 468 (11) [483 – CH_3], 369 (27) [483 – F_3-AcOH], 206/208/210 (22/15/2) [$C_9H_{14}Cl_2N^+$ = **c**], 152 (69) [$C_9H_{14}NO^+$].

Tomatidine 3-O-Trifluoroacetate [(25*S*)-3β-Trifluoroacetoxy-5α,22β*N*-spirosolane, **10**]: From acetone colourless cubes with m.p. 161–163°C, $[\alpha]_D^{22}$ = ±0 (c = 0.025), R_f = 0.60. – IR (KBr): $\tilde{\nu}$ = 1764 cm^{-1} (F_3-AcO), 1214, 1166 and 1128 (F_3C). – MS: *m/z* (%) = 511 (42) [M^+], 496 (14) [M^+ – CH_3], 414 (2) [M^+ – F_3-Ac], 397 (5) [M^+ – F_3-AcOH], 138 (100) [$C_9H_{16}N^+$], 114 (71) [$C_6H_{12}NO^+$].

23,23-Dichloro-22-isotomatidine [(25*S*)-23,23-Dichloro-5α,22α*N*-spirosolan-3β-ol, **12**]: Obtained by alkaline hydrolysis of 21 mg of compound **11** and worked-up as described for the preparation of compound **7**. The residue was crystallized from chloroform/methanol affording 14 mg (80%) of colourless needles with m.p. 158–160°C, $[\alpha]_D^{22}$ = –64.9 (c = 0.039), R_f = 0.60. – ^{1}H NMR: δ = 0.64 (m, 1H, 9-H), 0.82 (s, 3H, 19-H_3), 0.97 (s, 3H, 18-H_3), 1.24 (d, J = 7.0 Hz, 3H, 21-H_3), 1.28 (d, J = 6.5 Hz, 3H, 27-H_3), 2.34 (dd, J = 11.3 and 2.0 Hz, 1H, 26_{ax}-H), 2.38 (m, 2H, 24-H_2), 2.80 (m, 1H, 20-H), 2.88 (dd, J = 11.3 and 3.3 Hz, 1H, 26_{eq}-H), 3.24 (m, 2H, 24-H_2), 3.58 (m, 1H, 3α-H), 4.46 (m, 1H, 16α-H). – ^{13}C NMR: See Table 1. – MS: *m/z* (%) = 487 (2.5) [M^+ = $C_{27}H_{43}{}^{37}Cl_2NO_2{}^+$], 485 (17) [$M^+$ = $C_{27}H_{43}{}^{35}Cl^{37}ClNO_2{}^+$], 483 (25) [$M^+$ = $C_{27}H_{43}{}^{35}Cl_2NO_2{}^+$: calcd. 483.2671, found 483.2633], 411 (100) [M^+ – 2 HCl = $C_{27}H_{41}NO_2{}^+$: calcd. 411.3137, found 411.3132], 396 (11) [411 – CH_3 = $C_{26}H_{38}NO_2{}^+$: calcd. 396.2903, found 396.2918], 387 (92) [M^+ – $C_2H_2Cl_2$ = $C_{25}H_{41}NO_2{}^+$: calcd. 387.3137, found 387.3149], 273 (13) [$C_{19}H_{29}O^+$: calcd. 273.2218, found 273.2243], 210 (0.5) [$C_9H_{14}{}^{37}Cl_2N^+$], 208 (3) [$C_9H_{14}{}^{35}Cl^{37}ClN^+$], 206 (5) [$C_9H_{14}{}^{35}Cl_2N^+$ = **c**: calcd. 206.0503, found 206.0494], 164 (27) [$C_{10}H_{14}NO^+$: calcd. 164.1075, found 164.1075], 152 (13) [$C_9H_{14}NO^+$: calcd. 152.1075, found 152.1081].

Tomatidine [(25*S*)-5α,22β*N*-Spirosolan-3β-ol, **8**]: The tomatidine, R_f = 0.59, isolated by the above-mentioned flash chromatography and by alkaline hydrolysis of 10 mg of compound **10** (as described for the preparation of compound **7**, yield 81%), was shown to be identical in every respect with an authentic sample[2]. – ^{13}C NMR: See Table 1.

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