Chemistry of Heterocyclic Compounds, Vol. 30, No. 3, 1994

SYNTHESIS AND CONVERSIONS OF POLYHEDRAL COMPOUNDS

20.* SYNTHESIS OF CERTAIN DERIVATIVES OF 3,7-DIAZABYCYCLO[3.3.1]NONANE

G. G. Minasyan, A. D. Arutyunyan, G. G. Adamyan, and Ts. E. Agadzhanyan

1,3-Diazaadamantanes containing hydrogen atoms or a hydroxyl or oxime group at $C_{(6)}$, under the action of 2 moles of aralkyl halides, are converted in alkaline aqueous media to 3,7-diaralkyl-3,7-diazabicyclo[3.3.1]nonanes containing the indicated groups at $C_{(9)}$. Analogously, quaternary salts of 1,3-diazaadamantanes containing hydrogen atoms or a hydroxyl group at $C_{(6)}$ are converted in an alkaline aqueous medium to the corresponding 3-alkyl-3,7-diazabicyclo[3.3.1]nonanes containing the indicated groups at $C_{(9)}$.

We have developed two alternative paths for the synthesis of 3,7-dialkyl derivatives of 3,7-diazabicyclo[3.3.1]nonanes V-VII containing hydrogen atoms or a hydroxyl or oxime group at $C_{(9)}$, from a single starting compound — 5,7-dimethyl-6-oxo-1,3-diazaadamantane (I). Path A comprises the reduction of the ketone group of the diazaadamantane I to hydroxyl [2] or to methylene [3], or the conversion of the ketone group to oxime [3] with subsequent conversion of the resulting derivatives of 1,3-diazaadamantane II-IV, using procedures that we had developed, to the corresponding derivatives of 3,7-diazabicyclo[3.3.1]nonane — 3,7-dibenzyl-6-hydroxy- (Va) and 3,7-diaralkyl-1,5-dimethyl-1,3-diazabicyclo[3.3.1]nonanes (VIa,b) — or the oxime of 3,7-dibenzyl-1,5-dimethyl-6-oxo-3,7-diazabicyclo[3.3.1]nonane (VII), respectively, under the action of 2 moles of an aralkyl halide under alkaline conditions.

Path B comprises the conversion of the diazaadamantane I to 3,7-dibenzyl-1,5-dimethyl-9-oxo-3,7-diazabicyclo[3.3.1]-nonane (VIII) [4], either followed by reduction of its ketone group to hydroxyl Va by lithium aluminum hydride or to methylene VIa by the Kishner reaction, or followed by conversion of the ketone group to oxime VII by the action of hydroxylamine hydrochloride in ethanol in the presence of pyridine.

Here we have established that 1,3-diazaadamantanes containing hydrogen atoms or a hydroxyl or oxime group at $C_{(6)}$, under the action of 2 moles of aralkyl halides in an alkaline aqueous medium, undergo rupture of N–C bonds of the methylenediamino fragment and are converted to 3,7-diaralkyl derivatives of 3,7-diazabicyclononane containing (respectively) hydrogen atoms or a hydroxyl or oxime group at $C_{(9)}$. Heating of the oxime VII in a mixture of glacial acetic acid and acetic anhydride with zinc dust leads to the formation of 9-acylamino-3,7-dibenzyl-1,5-dimethyl-3,7-diazabicyclo[3.3.1]nonane (IX).

We have also developed two paths of synthesis, starting with the diazaadamantane I, for the preparation of 3-alkyl derivatives of 3,7-diazabicyclononane containing hydrogens (XVa-e or a hydroxyl group XVI at $C_{(9)}$:

— Path A. By means of a procedure we have developed, quaternary salts of 5,7-dimethyl-1,3-diazaadamantane with a CH_2 (XIIIa-e) or CHOH group (XIV) in position 6 of the 1,3-diazaadamantane are converted to the corresponding derivatives of 3-alkyl-3,7-diazabicyclononane;

— Path B. A procedure that we had developed is used in the Kishner reduction to CH_2, through the corresponding hydrazone XII, of the ketone group of 3-benzyl-1,5-dimethyl-9-oxo-3,7-diazabicyclo[3.3.1]nonane (XI), which is obtained from the chlorobenzylate of 5,7-dimethyl-6-oxo-1,3-diazaadamantane (Xb) [4].

*For Communication 19, see [1].

A. L. Mndzhoyan Institute of Fine Organic Chemistry, National Academy of Sciences of the Republic of Armenia, Erevan 375014. Translated from Khimiya Geterotsiklicheskikh Soedinenii, No. 3, pp. 401-406, March, 1994. Original article submitted January 18, 1994.

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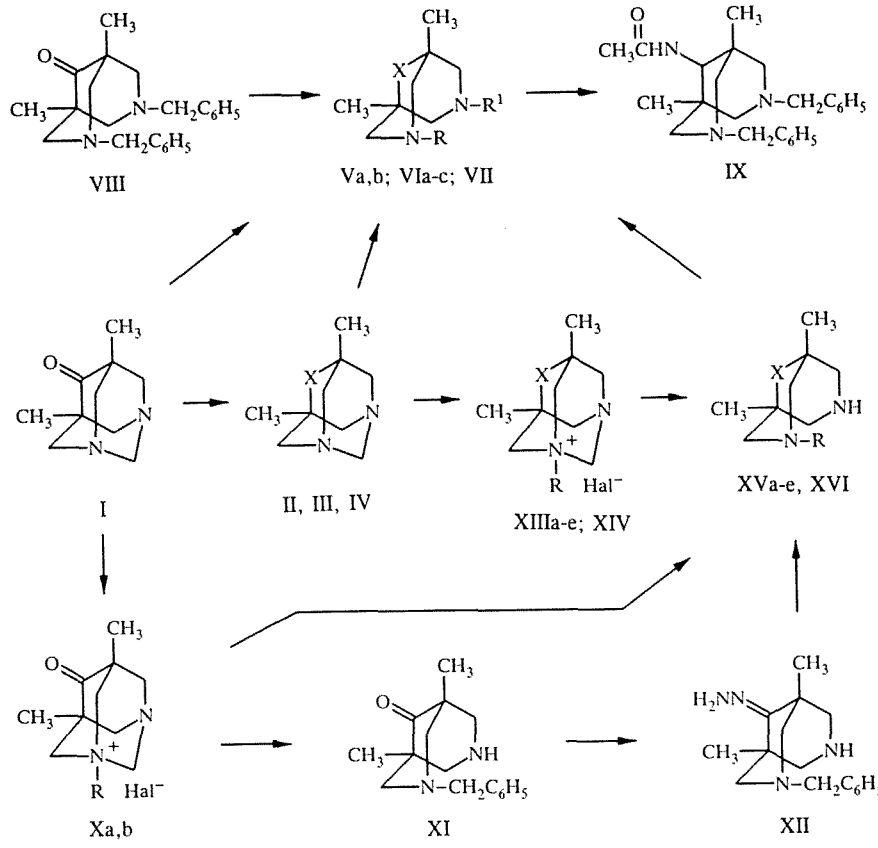

II, Va,b, XIV, XVI) X = CHOH; III, VIa-c, XIIIa-e, XVa-e) X = CH_2; IV, VII) X = C=NOH; Va, Xa, XIIIa, XIV, XVa, XVI) R = CH_3; Va, VIa,c, VII, Xb, XIIIb, XVb) R = $CH_2C_6H_5$; VIb, XIIIc, XVc) R = $CH_2C_6H_4Br$-*o*; XIIId, XVd) R = $CH_2C_6H_4Br$-*m*; XIIIe, XVe) R = $CH_2C_6H_4Br$-*p*; Va, VIa, VII) R^1 = $CH_2C_6H_5$; VIb) R^1 = $CH_2C_6H_4Br$-*o*; VIc) R^1 = $CH_2C_6H_4Br$-*p*; Vb) R^1 = $CH(C_6H_5)_2$

We have established that the quaternary salts of 1,3-diazaadamantanes containing hydrogen atoms or a hydroxyl group at $C_{(6)}$, in an alkaline aqueous medium, undergo rupture of N–C bonds of the methylenediamino fragment and are converted to 3-alkyl derivatives of 3,7-diazabicyclo[3.3.1]nonane containing (respectively) hydrogen atoms or a hydroxyl group at $C_{(9)}$.

At the same time, the iodomethylate of 5,7-dimethyl-6-oxo-1,3-diazaadamantane (Xa), upon heating in ethanol in the presence of KOH, undergoes, along with rupture of N–C bonds of the methylenediamino fragment, reduction of the ketone group to hydroxyl, forming 1,3,5-trimethyl-9-hydroxy-3,7-diazabicyclo[3.3.1]nonane (XVI). This product is identical to the compound that we obtained from the iodomethylate of 5,7-dimethyl-6-hydroxy-1,3-diazaadamantane (XIV) in an alkaline aqueous medium.

The 3-alkyldiazabicyclononanes XVb,e and XVI, under the action of aralkyl halides under alkaline conditions, are converted to 3,7-disubstituted 3,7-diazabicyclononanes with identical (VIa) or different (Vb, VIc) substituents on the nitrogen atoms.

A comparison of the two paths we have developed for obtaining 3-alkyl and 3,7-dialkyl derivatives of 3,7-diazabicyclononane in the example of synthesis of 3-benzyl- (XVb) and 3,7-dibenzyl-3,7-diazabicyclononanes (Va, VIa, VII), with due consideration for our data and literature information on the synthesis of the original compounds, indicates that path A is to be preferred for the synthesis of diazabicyclononanes with a methylene group at $C_{(9)}$ (VIa, XV). At the same time, for the synthesis of diazabicyclononanes with a hydroxyl or oxime group at $C_{(9)}$ (Va, VII), path B is preferred.

The molecular weights of the synthesized compounds, as determined by mass spectrometry, are in agreement with the calculated values. In the IR spectra of compounds Va, Vb, and XVI, there are absorption bands in the 3300-3450 cm^{-1} region (OH); in the spectra of compounds VII at 1670 cm^{-1} (C=NOH); IX at 1630 cm^{-1} (CO amide); XII at 1650 cm^{-1} (C=N) and at 1620, 3300, and 3365 cm^{-1} (NH).

In the PMR spectra of the 3,7-diaralkyldiazabicyclononanes VIa-c, which contain a methylene group at position IX, the protons of the diazabicyclononane skeleton are manifested in the form of a quartet of the AB-system. In the spectra of the

3,7-dibenzyldiazabicyclononanes Va and IX, which are substituted at $C_{(9)}$, and also the 3-monosubstituted XVa-e and XVI, regardless of the substituent at $C_{(9)}$, magnetic equivalence of the protons of the diazabicyclononane skeleton is disrupted, and the signals of these protons are manifested in the form of multiplets.

EXPERIMENTAL

IR spectra were taken in Specord and UR-20 spectrometers in white mineral oil. PMR spectra were taken in a Varian T-60 instrument in $CDCl_3$, internal standard TMS. Mass spectra were taken in an MKh-1320 mass spectrometer. The course of the reaction and the purity of the substances were monitored by TLC on Silufol-254 plates in the following systems: (A) *n*-propanol–water; (B) butanol–acetic acid–water, 3:1:1; (C) *n*-butanol and ammonia-saturated water.

Elemental analyses of the synthesized compounds for C, H, N, and Hal matched the calculated values.

3,7-Dibenzyl-1,5-dimethyl-9-hydroxy-3,7-diazabicyclo[3.3.1]nonane (Va, $C_{23}H_{30}N_2O$). A. A mixture of 1.9 g (0.05 mole) of $LiAlH_4$ in 100 ml of absolute ether was refluxed for 2 h. While continuing to heat the reaction mixture, a solution of 1.7 g (5 mmoles) of the diazabicyclononane VIII in 50 ml of ether was added dropwise over the course of 1 h. The mixture was refluxed for an additional 4 h and then chilled to 0°C, after which 10-15 ml of water was added dropwise while stirring vigorously. The ether layer was separated off, the aqueous layer was extracted twice with ether, and the ether solutions were combined and evaporated. The residue was triturated with water until crystallization took place and then recrystallized from ethanol, obtaining 1.4 g (82%) of compound Va, mp 111-112°C, R_f 0.47 (B). IR spectrum, cm^{-1}: 1580, 1600 (C=C arom.), 3450 (OH). PMR spectrum, ppm: 1.0 (6H, s, $2CH_3$); 1.77-2.77 (9H, m, $4CH_2$–N, CH); 3.4 (2H, s, $\underline{CH_2}C_6H_5$); 3.47 (2H, s, $\underline{CH_2}C_6H_5$); 4.4 (1H, br.s, OH); 7.3 ppm (10H, s, $2C_6H_5$). M^+ 350.

B. To a mixture of 0.9 g (5 mmoles) of the diazaadamantane II and 1.7 g (0.02 mole) of sodium bicarbonate in 50 ml of dioxane and 5 ml of water, 1.8 g (15 mmoles) of benzyl chloride in 10 ml of dioxane was added dropwise over the course of 30 min. The mixture was refluxed for 15 h, after which the solvent was driven off, water was added to the residue, and the mixture was triturated until crystallization took place, obtaining 1 g (49%) of compound Va, mp 111-112°C, R_f 0.47 (B).

7-Benzhydryl-9-hydroxy-1,3,5-trimethyl-3,7-diazabicyclo[3.3.1]nonane (VIb, $C_{23}H_{30}N_2O$). A mixture of 3.64 g (0.02 mole) of the diazabicyclononane XVI, 4.94 g (0.02 mole) of benzhydryl bromide, and 2.76 g (0.02 mole) of K_2CO_3 in 200 ml of methyl butyl ketone was heated while stirring for 20 h. The mixture was filtered, and the filtrate was vacuum-evaporated to one-fourth volume and then cooled. The resulting precipitate was filtered off and recrystallized from a 2:1 mixture of ethanol and water, obtaining 4.3 g (61.7%) of compound Vb, mp 140-142°C, R_f 0.52 (A). IR spectrum, cm^{-1}: 1620 (C=C arom.), 3300 (OH). M^+ 350.

3,7-Dibenzyl-1,5-dimethyl-3,7-diazabicyclo[3.3.1]nonane (VIa, $C_{23}H_{30}N_2$). A. To a solution of 16.6 g (0.1 mole) of the diazaadamantane III in 350 ml of dioxane, 25.2 g (0.2 mole) of benzyl chloride was added while refluxing and stirring, from time to time neutralizing the reaction medium with 30 g (0.3 mole) of triethylamine. The mixture was refluxed for another 2 h, cooled, and filtered. The filtrate was vacuum-evaporated to dryness. The residue was triturated with hexane (3 × 50 ml) and recrystallized twice from ethanol, obtaining 20.9 g (59.5%) of compound VIa, mp 91-92°C, R_f 0.44 (B). PMR spectrum, ppm (J in Hz): 0.77 (6H, s, $2CH_3$); 1.1 (2H, s, 9-CH_2); 1.83 (4H, d, J = 11 Hz, $4CH_e$-N); 3.4 (4H, s, $2\underline{CH_2}C_6H_5$); 7.17-7.6 ppm (10H, m, $2C_6H_5$). M^+ 334. Dihydrochloride ($C_{23}H_{30}N_2 \cdot 2HCl$), mp 236-240°C (from isopropanol).

B. A mixture of 2.44 g (0.01 mole) of the diazabicyclononane XVb, 1.3 g (0.01 mole) of benzyl chloride, and 2 g (0.023 mole) of Na_2CO_3 in 50 ml of butanol was refluxed and stirred for 11 h. After cooling, the mixture was filtered, and the filtrate was evaporated to dryness under vacuum. The residue was triturated with hexane (3 × 20 ml) and recrystallized from ethanol, obtaining 2.5 g (75%) of compound VIb, mp 91-92°C, R_f 0.44 (B).

C. A mixture of 2 g (5.7 mmoles) of compound VIII [4], 15 ml of triethylene glycol, 1.5 ml of 85% hydrazine hydrate, and 2 g (34 mmoles) of KOH was refluxed for 6 h. Then 20 ml of water was added, and the mixture was extracted with ether (100 ml). The ether solution was washed with water, dried with sodium sulfate, and evaporated. The residue was recrystallized twice from ethanol, obtaining 0.52 g (26.8%) of compound VIa, mp 91-92°C, R_f 0.44 (B).

3,7-bis(*o*-bromobenzyl)-1,5-dimethyl-3,7-diazabicyclo[3.3.1]nonane (VIb, $C_{23}H_{28}Br_2N_2$). This compound was obtained in the same general manner as VIa (method A) from 8.3 g (0.05 mole) of the diazaadamantane III, 27.5 g (0.11 mole) of *o*-bromobenzyl bromide, and 15 g (0.15 mole) of triethylamine in 200 ml of dioxane, over the course of 6 h. Yield of compound VIb 16.1 g (65.5), mp 129-130°C (from isopropanol), R_f 0.35 (B). PMR spectrum, ppm (J in Hz): 0.8 (6H, s,

$2CH_3$) 1.15 (2H, s, 9-CH_2); 1.93 (4H, d, J = 11, 4CH_a-N); 2.77 (4H, d, J = 11, 4CH_3-N); 3.52 (4H, s, 2$\underline{CH_2}C_6H_4$); 7.0-7.83 ppm (8H, m, 2C_6H_4). M^+ 490, 492, 494. Fumarate ($C_{23}H_{28}Br_2N_2 \cdot C_4H_4O_4$), mp 176-179°C.

3-Benzyl-7-(*p*-bromobenzyl)-1,5-dimethyl-3,7-diazabicyclo[3.3.1]nonane (VIc, $C_{23}H_{29}BrN_2$). A mixture of 3.23 g (0.01 mole) of the diazabicyclononane XVe, 1.57 g (12.4 mmoles) of benzyl chloride, and 3.2 g (0.03 mole) of Na_2CO_3 in 120 ml of butanol was refluxed and stirred for 9 h. The mixture was cooled and filtered, the filtrate was evaporated to dryness, and the residue was dissolved in 150 ml of ether. The ether solution was washed with water (4 × 50 ml), dried with sodium sulfate, and evaporated, obtaining 2.7 g (65%) of compound VIc (viscous oil), R_f 0.43 (B). PMR spectrum, ppm (J in Hz): 0.73 (6H, s, $2CH_3$); 1.07, (2H, s, 9-CH_2); 1.8 (4H, d, J = 12, 4CH_a-N); 3.65 (4H, d, J = 12, 4CH_e-N); 3.3 and 3.37 (each 2H, ss, $\underline{CH_2}C_6H_5$ and $\underline{CH_2}C_6H_4$); 7.25-7.87 (9H, m, arom. protons), M^+ 412, 414. Fumarate ($C_{23}H_{29}BrN_2 \cdot C_4H_4O_4$), mp 181-183°C (from isopropanol).

Oxime of 3,7-Dibenzyl-1,5-dimethyl-9-hydroxy-3,7-diazabicyclo[3.3.1]nonane (VII, $C_{23}H_{29}N_3O$). ***A***. A mixture of 0.5 g (1.4 mmoles) of the diazabicyclononane VIII, 0.2 g (2.8 mmoles) of hydroxylamine hydrochloride, 6 ml of pyridine, and 70 ml of absolute ethanol was heated for 8 h. After evaporation, the residue was washed with ethanol and recrystallized from a 1:1 mixture of ethanol and water, obtaining 0.4 g (78%) of compound VII, mp 265-266°C, R_f 0.66 (C). IR spectrum, cm^{-1}: 1620 (C=C arom.), 1670 (C=N−CH). M^+ 363.

B. A 1.95-g quantity (0.01 mole) of the diazaadamantane IV was dissolved in 150 ml of dioxane, with heating. Then 2.6 g (0.02 mole) of benzyl chloride in 30 ml of dioxane was added to the solution dropwise with stirring, after which 3 g (0.03 mole) of triethylamine was added, and the solution was heated for 4 h. The mixture was filtered and the dioxane was driven off from the filtrate; 15 ml of water was added to the residue, and this mixture was extracted with ether. The ether solution was washed with water, dried with sodium sulfate, and evaporated. The residue was recrystallized from a 1:1 mixture of ethanol and water, obtaining 1.2 g (33%) of compound VII, mp 265-266°C, R_f 0.66 (C).

9-Acetamino-3,7-dibenzyl-1,5-dimethyl-3,7-diazabicyclo[3.3.1]nonane (IX, $C_{25}H_{33}N_3O$). To a solution of 1.86 g (5 mmoles) of the oxime VII in 100 ml of acetic acid and 150 ml of freshly distilled acetic anhydride, 5 g of zinc powder was added in portions while stirring and heating, and the mixture was refluxed an additional 1 h. After cooling, the mixture was filtered, and the filtrate was vacuum-evaporated. The remaining oil was dissolved in 150 ml of 1:1 mixture of ethanol and water, boiled with activated carbon, filtered, and vacuum-evaporated. The residue was recrystallized from a 1:1 mixture of hexane and heptane, obtaining 2 g (89%) of compound IX, mp 254-255°C (decomp.), R_f 0.55 (A). IR spectrum, cm^{-1}: 1580, 1600 (C=C arom.), 1630 (C=O amide). PMR spectrum, ppm: 0.95 (3H, s, CH_3); 1.44 (3H, s, CH_3); 1.97 (3H, s, CH_3−CO); 2.2-3.73 (10H, m, 4CH_2−N, CH, NH); 3.83 (4H, s, 2$\underline{CH_2}C_6H_5$); 7.26 (10H, s, 2C_6H_5). M^+ 391.

Iodide of 5,7-Dimethyl-6-oxo-1-methylazoniaadamantane (Xa, $C_{11}H_{19}N_2OI$). To a solution of 7.2 g (0.04 mole) of the diazaadamantane I in 100 ml of absolute ethanol, 5.7 g (0.04 mole) of methyl iodide was added. The mixture was heated for 3 h at 70°C. The resulting precipitate was filtered off and washed with absolute ethanol, obtaining 9.5g (80%) of compound Xa, mp 240-241°C, R_f 0.21 (A).

Hydrazone of 3-Benzyl-1,5-dimethyl-9-oxo-3,7-diazabicyclo[3.3.1]nonane (XII, $C_{16}H_{24}N_4$). A mixture of 2.2 g (8 mmoles) of compound XI [4] and 5 g (0.1 mole) of 85% hydrazine hydrate was refluxed for 14 h. After cooling the mixture, the precipitate was filtered off, washed with 10 ml of hexane, and recrystallized from a 3:1 mixture of methanol and water, obtaining 1.5 g (64%) of compound XII, mp 227-229°C, R_f 0.4 (C). IR spectrum, cm^{-1}: 1590, 1610 (C=C arom.), 1650 (C=N), 1620, 3300, 3365 cm^{-1} (NH).

Quaternary Salts of 5,7-Dimethyl-1,3-diazaadamantane (XIIIa-e). To a solution of 16.6 g (0.01 mole) of the diazaadamantane III in 150 ml of absolute benzene and absolute ethanol (in the case of the methyl iodide), there was added 0.01 mole of an arylalkyl halide (benzyl chloride, *o*-, *m*-, *p*-bromobenzyl bromide) or methyl iodide, and the mixture was refluxed and stirred for 3-4 h. After cooling, the precipitate was filtered off, washed with 30-40 ml of solvent, and dried. Yield 86-98%.

XIIIa: mp 278-280°C (from absolute ethanol), R_f 0.64 (A). XIIIb: mp 230-232°C, R_f 0.32 (A). XIIIc: mp 223-225°C, R_f 0.53 (A). XIIId: mp 242-245°C, R_f 0.55 (A). XIIIe: mp 206-208°C, R_f 0.45 (A).

Iodide of 5,7-Dimethyl-6-hydroxy-1-methylazoniaadamantane (XIV, $C_1H_{21}N_2$). Obtained in the same manner as Xa from 0.54 g (3 mmoles) of the diazaadamantane II and 0.42 g (3 mmoles) of methyl iodide in 70 ml of ethanol. Yield 0.8 g (84%), mp 259-261°C, R_f 0.25 (A).

3-Benzyl-1,5-dimethyl-3,7-diazabicyclo[3.3.1]nonane (XVb, $C_{16}H_{24}N_2$). A. To a solution of 9.7 g (33 mmoles) of the quaternary salt XIIIb in 50 ml of ethanol and 10 ml of water, 9.3 g (0.17 mole) of KOH was added, and the mixture was stirred on a boiling water bath for 5 h. The mixture was evaporated under vacuum, and the residue was dissolved in 100 ml

of ether. The ether solution was washed with water (2 × 40 ml), dried with sodium sulfate, evaporated, and vacuum-distilled, obtaining 6.5 g (80%) of compound XVb, bp 163-165°C/1 mm, R_f 0.4 (B), n_D^{20} 1.5355. The substance crystallizes upon prolonged storage, mp 37°C. PMR spectrum, ppm: 0.67 (6H, s, $2CH_3$); 1.2 (2H, s, 9-CH_2); 1.7-2.83 (8H, m, $4CH_2N$); 3.25 (2H, s, $\underline{CH_2}C_6H_5$); 3.43 (1H, s, NH, $+CD_3OD$-disappears); 7.23 (5H, s, C_6H_5). M^+ 244.

Fumarate ($C_{16}H_{24}N_2 \cdot C_4H_4O_4$), mp 178-180°C (from absolute ethanol).

B. A melt of 0.55 g (2 mmoles) of the hydrazone XII and 1 g (18 mmoles) of KOH was held for 3 h at 220°C. After cooling, the mixture was extracted with boiling hexane (3 × 20 ml). The hexane solution was evaporated to dryness, obtaining 0.25 g (51.2%) of compound XVb in the form of an oil, R_f 0.4 (B), n_D^{20} 1.5355. The substance crystallizes upon prolonged storage, mp 37°C.

3-(*o*-Bromobenzyl)-1,5-dimethyl-3,7-diazabicyclo[3.3.1]nonane (XVc, $C_{16}H_{23}BrN_2$). Obtained in the same manner as compound XVb (method A), using 11 g (26.4 mmoles) of the quaternary salt XIIIc, 7.4 g (132 mmoles) of KOH, 70 ml of ethanol, and 20 ml of water. Yield 7.1 g (83.5%), bp 165-168°C/1 mm, R_f 0.41 (B), n_D^{17} 1.5597. The substance crystallizes upon prolonged storage, mp 46°C. PMR spectrum, ppm: 0.67 (6H, s, $2CH_3$); 1.2 (2H, s, 9-CH_2); 1.8-2.9 (8H, m, $4CH_2N$); 3.32 (2H, s, $\underline{CH_2}C_6H_4$); 3.73-4.0 (1H, br.s, NH); 7.0-7.63 (4H, m, C_6H_4), M^+ 322, 324.

Fumarate ($C_{16}H_{23}BrN_2 \cdot C_4H_4O_4$), mp 184-187°C (from ethanol).

3-(*m*-Bromobenzyl)-1,5-dimethyl-3,7-diazabicyclo[3.3.1]nonane (XVd, $C_{16}H_{23}BrN_2$). Obtained in the same manner as compound XVb (method A), using 25 g (0.06 mole) of the quaternary salt XIIId, 17 g (0.3 mole) of KOH, 200 ml of ethanol, and 100 ml of water. Yield 17.8 g (91.8%, bp 162-165°C/1 mm, R_f 0.34 (B), n_D^{27} 1.5522. PMR spectrum, ppm: 0.67 (6H, s, $2CH_3$); 1.2 (2H, s, 9-CH_2); 1.67-2.9 (8H, m, $4CH_2N$); 3.15-3.3 (3H, m, NH, $\underline{CH_2}C_6H_4$); 7.1-7.4 (4H, m, C_6H_4). M^+ 322, 324.

3-(*p*-Bromobenzyl)-1,5-dimethyl-3,7-diazabicyclo[3.3.1]nonane (XVe, $C_{16}H_{23}BrN_2$). Obtained in the same manner as compound XVb (method A), using 27 g (55 mmoles) of the quaternary salt XIIIe, 28.5 g (0.5 mole) of KOH, 200 ml of ethanol, and 100 ml of water. Yield 19 g (80.7%), bp 188-190°C/1 mm, R_f 0.31 (B), n_D^{18} 1.5599. PMR spectrum, ppm: 0.67 (6H, s, $2CH_3$); 1.2 (2H, s, 9-CH_2); 1.67-2.87 (8H, m, $4CH_2N$); 3.2 (1H, s, NH); 3.33 (2H, s, $\underline{CH_2}C_6H_4$); 7.0-7.6 (4H, m, C_6H_4). M^+ 322, 324.

Fumarate ($C_{16}H_{23}BrN_2 \cdot C_4H_4O_4$), mp 171-173°C (from absolute ethanol).

1,3,5-Trimethyl-3,7-diazabicyclo[3.3.1]nonane (XVa, $C_{10}H_{20}N_2$). Obtained in the same manner as compound XVb (method A), using 84 g (0.273 mole) of the quaternary salt XIIIa, 76.5 g (1.365 moles) of KOH, 700 ml of ethanol, and 150 ml of water. Yield 25 g (54.5%), bp 78-80°C/2.5 mm, R_f 0.3 (B), n_D^{20} 1.4810. The substance crystallizes upon prolonged storage, mp 35°C. PMR spectrum (CCl_4), ppm: 0.7 (6H, s, $2CH_3$); 1.2 (2H, m, 9-CH_2); 2.12 (3H, s, NCH_3); 1.67-3.0 (8H, m, $4CH_2N$); 3.67-3.82 (1H, br.s, NH).

Fumarate ($C_{10}H_{20}N_2 \cdot C_4H_4O_4$), mp 149-151°C (from absolute ethanol).

9-Hydroxy-1,3,5-trimethyl-3,7-diazabicyclo[3.3.1]nonane (XVI, $C_{10}H_{20}N_2O$). ***A***. To a solution of 7.5 g (23 mmoles) of the iodide Xa in 50 ml of ethanol, a solution of 6.5 g (115 mmoles) of KOH in 50 ml of ethanol was added. The solution was heated for 3 h and then vacuum-evaporated to dryness. The residue was dissolved in 50 ml of water and extracted with ether. The ether extract was dried with sodium sulfate and then evaporated; the residue was recrystallized from heptane, obtaining 2.5 g (60%) of compound XVI, mp 131-132°C, R_f 0.32 (C). IR spectrum, cm^{-1}: 1610, 3240 (NH), 3450 (OH). PMR spectrum: 0.7 (6H, s, $2CH_3$); 2.03 (3H, s, $N-CH_3$); 2.3-2.98 (9H, m, $4CH_2$, CH); 3.01 (1H, s, OH); 4.07 (1H, s, NH). M^+ 184.

B. Obtained in the same manner as in method A, from 0.5 g (1.5 mmoles) of the iodide XIV and 0.42 g (7.5 mmoles) of KOH in 70 ml of ethanol. Yield 0.1 g (40%), mp 131-132°C, R_f 0.32 (C).

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