^{1}H Nmr Structural Analysis of Azabicyclospirohydantoins

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Based on the data from ^{1}H nmr spectra, the structure and spatial configuration of the above mentioned hydantoins are established. In the 3-alkyl-3-azabicyclo[3.3.1]nonane-9-spiro-5'-hydantoins analyzed, we confirm the chair-chair configuration and the presence of only one stereoisomer at the spiro carbon atom (with the C_4'=O group axial with regard to the piperidine ring). In the 3,7-dialkyl-3,7-diazabicyclo[3.3.1]nonane-9-spiro-5'-hydantoins analyzed, we also confirm the chair-chair configuration and we calculate the percentage of the two stereoisomers when they exist.

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Introduction.

The preferred conformation of the bicyclo[3.3.1]-nonane system has been the subject of considerable investigation (2-7). Now we wish to report the structural analysis of a new series of spirohydantoins (compounds **1-14**) listed in Table I.

Several methods have been described for syntheses of 3,7-diazabicyclo[3.3.1]nonan-9-ones, related to the classical Robinson-Schopf reaction, but the heterocycles obtained were substituted on both bridge-head carbon atoms. J. E. Douglass, *et al.* (8), obtained the 3,7-diazabicyclo-[3.3.1]nonane system without said substituents by a choice of reaction conditions. The same conditions have been used by us in the syntheses of 3,7-dialkyl-3,7-diazabicyclo[3.3.1]nonan-9-ones (**8A-14A**, Table I).

Methods reported for syntheses of 3-azabicyclo[3.3.1]-nonan-9-ones are rather complicated and give poor yields (9-12). Therefore, it occurred to us to obtain these ketones (**1A-7A**, Table I) by the same method used for the diazabicyclo system mentioned above. The spirohydantoins were obtained from the corresponding aza and diazabicyclanones by the Bucherer-Bergs reaction (13).

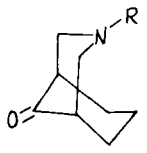
In interpreting the experimental data obtained by ^{1}H nmr, we have kept in mind the conclusions drawn by several authors in similar, simpler systems such as 3-methyl-3-azabicyclo[3.3.1]nonan-9-one (**1A**) (9), 9-methoxy-3-methyl-3-azabicyclo[3.3.1]nonane (14), 3-cyano-9β-methoxy-9α-phenyl-3-azabicyclo[3.3.1]nonane and 3-cyano-3β-hydroxy-9α-phenyl-3-azabicyclo[3.3.1]nonane (15), *N,N'*-dimethylbispidine (8), and several *N*-monoalkylbispidines and *N,N'*-dialkylbispidines (16).

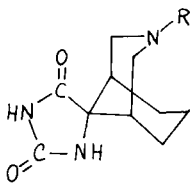
Results and Discussion.

Spriohydantoins **1-7** (Table I) have been obtained from 9-alkyl-9-azabicyclo[3.3.1]nonan-9-ones by reaction with ammonium carbonate and potassium cyanide (Bucherer-Bergs synthesis). Some of these ketones have been described for the first time. House, *et al.* (9), studied compounds **15**, **1A**, and **16** (Figure 1), and suggest for 3-methyl-3-azabicyclo[3.3.1]nonan-9-one (**1A**), on the basis of ir data, dipole moments and pK_a values, a chair-chair conformation and an equatorial position for the *N*-methyl group.

Table I

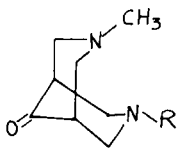
3-Alkyl-3-azabicyclo[3.3.1]-nonane-9-spiro-5'-hydantoins

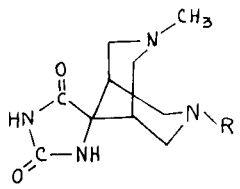




1A-7A R	**1-7** Compound
-CH_3	**1**
-CH_2-CH_3	**2**
-CH_2-CH_2-CH_3	**3**
-*i*-C_3H_7	**4**
-*sec*-C_4H_9	**5**
-*i*-C_4H_9	**6**
-CH_2-CH_2-C_6H_5	**7**

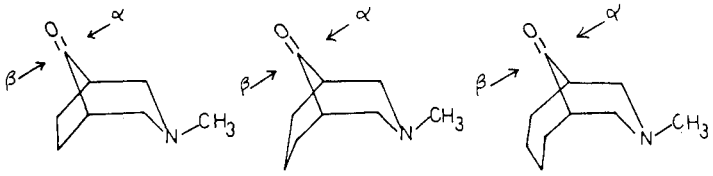
3-Methyl-7-alkyl-3,7-diazabicyclo-[3.3.1]nonane-9-spiro-5'-hydantoins





8A-14A R	**8-14** Compound
-CH_3	**8**
-CH_2-CH_3	**9**
-CH_2-CH_2-CH_3	**10**
-*i*-C_3H_7	**11**
-*n*-C_4H_9	**12**
-CH_2-CH_2OH	**13**
-CH_2-CH_2-C_6H_5	**14**

Figure 1

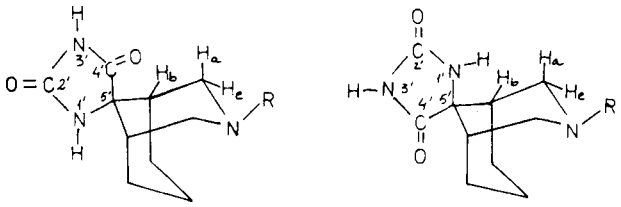


15 **1A** **16**

Furthermore, the chair-chair conformation, which is typical for most bicyclo[3.3.1]nonane systems, has been confirmed in 3-azabicyclo[3.3.1]nonane by x-ray diffraction studies (17).

From the ketones **1A-7A** we can expect two stereoisomer hydantoins **A** and **B** (Figure 2).

Figure 2



A B

From the results obtained by reduction of compounds **15**, **1A** and **16** studied by House, *et al.* (18), it is clear that the major factor determining the stereochemistry of the reduction of these aminoketones is the bulk and the conformation of the polymethylen chain. For aminoketone **16**, the polymetylen chain serves to shield the carbonyl function from attack by a reducing agent in the direction labeled β (Figure 1), being the α attack the predominate mode of reaction, but for aminoketone **15**, the β attack is the predominate mode of reaction indicating that addition to the carbonyl function is less hindered by the two carbon methylen chain. The reductions of aminoketone **1A** are intermediate between these two extremes, indicating that the α attack is slightly favored in respect to the β attack in this system. These results show that the nitrogen atom has a slight influence in the stereochemistry of the attack.

The stereochemical results obtained by addition of organometallic reagents to aminoketones **15**, **1A** and **16** (10) conform rather closely to the above mentioned reductions.

From these results, we could assume that the Bucherer-Bergs reaction, whose mechanistic considerations have been studied by Edward, *et al.* (19), when applied to the aminoketones **1A-7A**, had to yield a mixture of the two stereoisomer hydantoins **A** and **B** (Figure 2).

However, the ^{1}H nmr data of spirohydantoins **1-7** obtained by us point out that the Bucherer-Bergs synthesis yields the stereoisomer **A**.

The ^{1}H nmr spectra of compounds **1-7** were obtained in deuteriochloroform since the solubility in deuterium oxide was too small (Table II).

The chemical shift assigned to H_a in compound **1** is δ 3.15 (Table II), while H_a in *N,N'*-dimethylbispidine (in benzene) has a chemical shift δ 2.22 (8). The difference of 0.93 ppm can only be attributed to the field effect due to the magnetic anisotropy of the C_4'=O group, which is only possible in the stereoisomer **A**. H_e, on the contrary, have very close chemical shifts (2.74 in **1** and 2.62 in *N,N'*-dimethylbispidine). The clearness of the signals is uncompatible with the presence of two stereoisomers.

For the hydrochloride of **1** (in deuterium oxide), the value of the chemical shift of H_a is δ 3.96, which assumes a downfield shift of 0.81 ppm, as compared with the hydantoin base, ascribable to the inductive effect of the protonated nitrogen atom, and of 1.74 ppm, as compared with this hydrogen atom in *N,N'*-dimethylbispidine.

Table II

Chemical Shifts of Compounds **1-7** in Deuteriochloroform (δ Values, TMS as Internal Reference)

	1	**2**	**3**	**4**	**5**	**6**	**7**	**1** Hydrochloride (1)
H_a	3.15	3.14	3.14	3.36	3.35 3.52	2.80	3.22	3.96
H_e	2.74	2.81	2.80	2.72	2.63	2.40	2.82	3.67
H_b	1.87	1.88	1.87	1.87	1.88	1.97		
$N^{1'}$-H	6.16	6.37	6.44	6.68	6.91	6.46	6.40	
$N^{3'}$-H	7.56	7.72	7.87	8.11	8.39	7.83	7.86	
CHα	2.24	2.41	2.32	2.74	2.51	2.47		2.93
CHβ		1.05	1.49	1.04	1.41 0.99	1.09		
CHγ			0.91		0.90	0.89		

(1) In deuterium oxide.

Table III

Compound	Solvent	δH_b	δH_a	δH_e	$\delta H_a'$	$\delta H_e'$	δN-CH$_3$	δN'-CH$_3$'
N,N'-Dimethylbispidine	trifluoroacetic acid(a)	2.68	3.42	3.97	3.42	3.97	3.07	3.07
N,N'-Dimethylbispidine perchlorate	deuterium oxide	2.32	2.92	3.50	2.92	3.50	2.42	2.42
8	deuterium oxide	2.14	4.06	3.47	2.73	3.12	2.76	2.31

(a) Spectrum determined under conditions which should ensure protonation of both nitrogen atoms.

The chair-chair conformation is confirmed by the values of the coupling constants J_{ab} and J_{eb} of approximately 3 Hz. This value is very similar to that found in *N,N'*-dimethylbispidine (8) and to the series studied below. Although the two vicinal coupling constants J_{ab} and J_{eb} cannot be correlated reliably with dihedral angles, and hence with conformation, since the flattened chair-chair conformation for *N,N'*-dimethylbispidine has been determined by different methods (5,8), we can reasonably think on the same conformation.

The presence of only one stereoisomer in compounds **1-7** is an interesting fact which we hope to study in the future. At the moment we have found that the Bucherer-Bergs reaction on compounds **15** and **16** yields hydantoins whose structures (studied by ^{1}H nmr and x-ray diffraction) (20) agree with the stereochemical results of the reactions mentioned above.

The ^{1}H nmr spectra of compounds **8-14** have been registered in deuterium oxide. In the ^{1}H nmr spectrum of **8** (3,7-dimethyl-3,7-diazabicyclo[3.3.1]nonane-9-spiro-5'-hydantoin), we indicate the signals corresponding to the different protons (Figure 3).

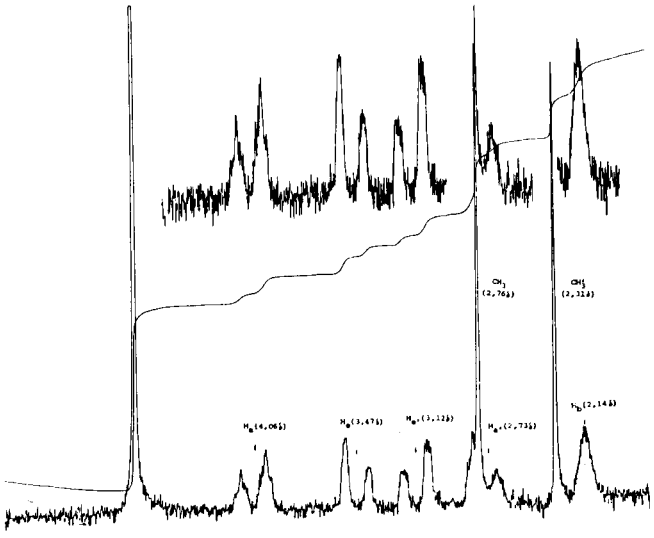


Figure 3. ^{1}H Nmr spectrum of **8** in deuterium oxide (δ values, DSS as internal reference).

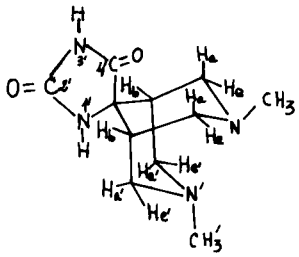


Figure 4. Nomenclature of the different protons of **8**.

The nomenclature of these protons corresponds to that set forth in Figure 4.

In Table III we summarize the chemical shifts of the different protons of *N,N'*-dimethylbispidine perchlorate (in deuterium oxide), *N,N'*-dimethylbispidine in trifluoroacetic acid (8) and compound **8** (in deuterium oxide). For *N,N'*-dimethylbispidine perchlorate, Douglas, *et al.* (8), proposed an adamantane like structure (Figure 5).

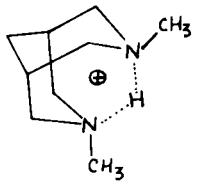
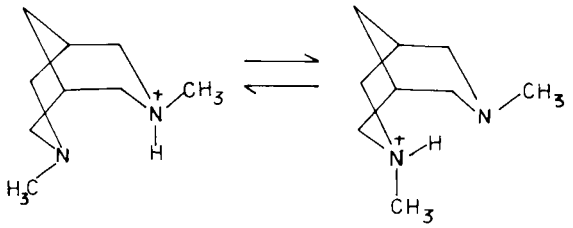


Figure 5

Support for this structure was derived from the position of the *N*-methyl resonance. The observed shift is some 0.6 ppm further upfield than is commonly found when the nitrogen atom carries a full positive charge (as we suppose to be the case in trifluoroacetic acid). However, the same authors admit that this fact does not constitute proof for said adamantane like structure for this cation, since rapid exchange *intra-* or *inter*molecularly will give an average effect for the *N*-methyl and the *N*-methyl signals (Figure 6).

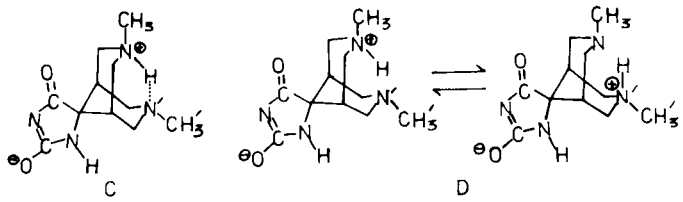
The observed chemical shifts of the *N*-CH$_3$ and *N'*-CH$_3$' protons of **8** in deuterium oxide (*p*H = 10), clearly suggest that both nitrogen atoms carry between them a positive charge. The values for the chemical shifts of CH$_3$ and

Figure 6



CH_3' in compound **8** at *p*H = 1 (conditions in which both nitrogen atoms should be protonated) are: δ_{CH_3} = 2.94 and $\delta_{CH_3'}$ = 2.73. The chemical shifts observed for **8** in deuterium oxide (*p*H = 10) are: δ_{CH_3} = 2.76 and $\delta_{CH_3'}$ = 2.31. These values can be applied to both an adamantane like structure (Figure 8, **C**) or a monoprotonated compound where rapid exchange would give an average effect for N-CH_3 and $\overset{+}{N}$-CH_3 and for N'-CH_3' and $\overset{+}{N}'$-CH_3' (Figure 7, **D**).

Figure 7



C D

The hybrid ion shown in Figure 7 also appears when *N*-alkylgranatanine-3-spiro-5'-hydantoins are dissolved in deuterium oxide (21).

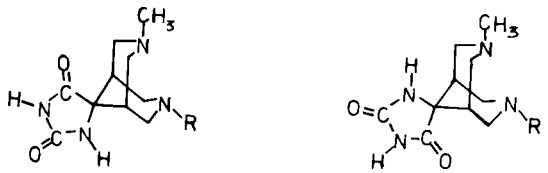
The chemical shift of the H_e proton of **8** is consistent with nitrogen atoms so charged. This proton has a very close chemical shift with respect to the relative proton in *N,N'*-dimethylbispidine perchlorate: δ = 3.5 in this compound and δ = 3.4 in **8**. The remarkable downfield shift of the H_a proton in comparison to the relative protons in *N,N'*-dimethylbispidine perchlorate ($\simeq$ 1 ppm) can only be attributed to the additional field effect due to the magnetic anisotropy of the C_4'=O group.

According to what we have stated up to now, compound **8** in aqueous solution has a hybrid ionic structure (form **C** or **D**, Figure 7).

When H_b is irradiated we observe, besides the geminal couplings (J_{ae} = 13 Hz), a long range coupling ($J_{aa'} \simeq$ 3 Hz). This result clearly suggests a zig-zag disposition which confirms the chair-chair conformation of both rings. Support for this conformation was derived from J_{ab} and J_{eb} values ($\simeq$ 3 Hz). The long range coupling mentioned above identifies the couple H_a,H_a' from H_e,H_e'.

The ^{1}H nmr spectra of compounds **9-14** have been registered using deuterium oxide solutions. The data obtained show total agreement with data obtained from compound **8** in deuterium oxide, studied above, showing that the nitrogen atoms carry a positive charge between

Figure 8

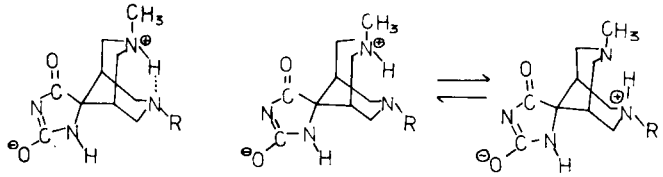


E F

them (Table IV). From these data we can point out the presence of two stereoisomeric hydantoins **E** and **F** (Figure 8).

If we had only one stereoisomer (**E**, for example), the N-CH_3 group would give only one signal, that we could assign to an adamantane like structure (Figure 9, **G**) or a monoprotonated species in rapid exchange (Figure 9, **H**).

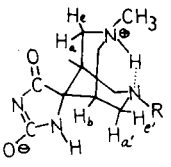
Figure 9



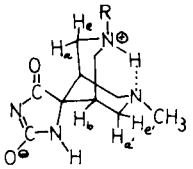
G H

Table IV

Chemical Shifts of Compounds **8-14** (Deuterium Oxide, 0.02 *M* Solution; Values, DSS as Internal Reference)



a)



b)

		8	**9**	**10**	**11**	**12**	**13**	**14**
(a)	H_a	4.06	4.05	4.05	4.07	4.02	4.16	3.97
	H_e	3.47	3.46	3.44	3.45	3.42	3.56	3.20
	H_a'	2.73	2.74	2.73	2.91	2.81	3.36	2.73
	H_e'	3.12	3.21	3.22	3.18	3.10	2.96	3.20
(b)	H_a	4.06	4.08	4.09	4.25	4.08	3.88	
	H_e	3.47	3.50	3.50	3.38	3.51	3.56	
	H_a'	2.73	2.74	2.73	2.72	2.71	3.30	
	H_e'	3.12	3.10	3.13	3.09	3.09	2.96	
	H_b	2.14	2.15	2.15	2.15	2.15	2.19	2.05
(a)	CH_3	2.76	2.74	2.75	2.72	2.74	2.84	2.32
(b)	CH_3	2.31	2.29	2.30	2.28	2.31	2.53	2.00
(a)	CHα	2.31	2.57	2.50	2.99	2.54	2.61	
	CHβ		1.10	1.57	1.09		3.74	
	CHγ			0.84				
(b)	CHα	2.76	3.10	2.91	3.40	3.02	2.96	
	CHβ		1.30	1.74	1.31		3.84	
	CHγ			0.88				
	CHδ					2.93		
% Form a):			56	50	56	47	64	78

Since we have two signals for the N-CH_3 group, these have to be due to the presence of said stereoisomer hydantoins **E** and **F**. From the relative intensities of these two signals we can calculate the percentage of the two stereoisomer forms. This percentage appears to be influenced to a certain extent by the nature of R, as is shown in the *N*-phenetylderivative (Table IV).

The values of the chemical shifts of **8** to the different *p*H values are indicated in Table V. After studying these data and the electrotitration curve of **8**, we can draw the following conclusions: (a) Three critical p*K* values seem to exist (12, 8 and 4 approximately). (b) H_a, H_e and CH_3 are mainly affected at p*K* = 12 (*p*H = 10 → *p*H = 14, Table V). The moment corresponds to the monoprotonation process of the nitrogen atom of the diazabicyclo system at the expense of the acidic proton of the hydantoin ring (p*K* of *N*,*N*'-dimethylbispidine = 11.9) (8). (Figure 10, **a** ⇌ **b**). (In this Figure we only work with the

Table V

Chemical Shifts of **8** as a Function of *p*H Values (δ Values, DSS as Internal Reference)

	*p*H 1	*p*H 6	*p*H 7	*p*H 10	*p*H 14
			Chemical Shifts		
H_a	4.03	3.92	3.95	4.06	3.79
H_e	3.74	3.58	3.52	3.47	3.26
H_a'	3.19	2.84	2.75	2.73	2.66
H_e'	3.58	3.21	3.15	3.12	3.04
H_b	2.64	2.49	2.31	2.14	2.02
CH_3	2.94	2.79	2.77	2.76	2.57
CH_3'	2.73	2.49	2.33	2.31	2.26

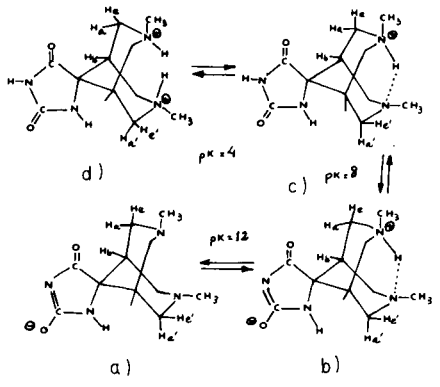


Figure 10. Structure of **8** as a function of p*K* values.

adamantane like structure of the monoprotonated species). (c) We only observe a slight variation in H_a and H_b at p*K* = 8 (*p*H = 10 → *p*H = 6, Table V). The moment corresponds, probably, to the protonation process of the anionic oxygen atom of the hydantoin ring (p*K* of the hydantoin and 5,5-dimethylhydantoin = 8.3) (22). (See Figure 10, **b** ⇌ **c**). (d) We observe a significant variation in H_a', H_e' and CH_3' at p*K* = 4 (*p*H = 6 → *p*H = 1, Table V). This fact clearly indicates the protonation process of the nitrogen atom *N*'.

EXPERIMENTAL

All melting points were taken in open capillary tubes and are uncorrected. Infrared spectra were determined using a Perkin-Elmer 577 spectrophotometer. The ^{1}H nmr spectra have been recorded using a Bruker HX 90E spectrometer, operating at 90 MHz, in the following conditions: 2.5 μ seconds width of pulsation, 600 Hz of spectral width, "16 K" memory points, 1.4 second time of repetition and 64 accumulations, at room temperature. The mass spectra were made in a Hitachi Perkin-Elmer RMU-6M spectrometer.

N-Alkyl-3-azabicyclo[3.3.1]nonan-9-ones (**1A-7A**).

A solution of 15.6 ml. (0.15 mole) of cyclohexanone in 100 ml. of methanol was transferred to a dropping funnel attached to a 500 ml. flask which was also equipped with a mechanical stirrer and a reflux condenser. Alkylamine (13.6 g., 0.15 mole), 0.15 mole of acetic acid (in R = CH_3, methylammonium acetate was used), 150 ml. of methanol and 10 g. (0.33 mole) of paraformaldehyde were added to the flask. After bringing the mixture to 50°, the solution in the funnel was added with stirring over a period of about 0.5 hours, the mixture was heated at the same temperature for an additional 6 hours after the addition was complete. The mixture was kept under an atmosphere of nitrogen throughout the course of the reaction. The solution was allowed to cool to room temperature and stand overnight.

The viscous residue which was left after stripping off most of the solvent on the rotary evaporator was made strongly alkaline by the slow addition of a solution of 40% aqueous potassium hydroxide. An ice bath was used to keep the temperature of the solution below 20°. The organic layer was separated with three 25 ml. portions of chloroform. The combined organic material was dried over anhydrous sodium sulfate. After removing the solvent on the rotary evaporator, the residue was distilled under reduced pressure as rapidly as possible using a short-path still; following a small forerum of cyclohexanone, the aminoketone was collected.

N-Methyl-3-azabicyclo[3.3.1]nonan-9-one (**1A**).

This compound was obtained in a yield of 34%, b.p. (0.3 mm Hg) 65-70°; ir (liquid film): 1710 and 1730 (C=O) cm^{-1}.

N-Ethyl-3-azabicyclo[3.3.1]nonan-9-one (**2A**).

This compound was obtained in a yield of 34%, b.p. (0.4 mm Hg) 62-67°; ir (liquid film) 1705 and 1730 (C=O) cm^{-1}.

N-Propyl-3-azabicyclo[3.3.1]nonan-9-one (**3A**).

This compound was obtained in a yield of 30%, b.p. (0.4 mm. Hg) 72-75°; ir (liquid film): 1705 and 1730 (C=O) cm^{-1}.

N-Isopropyl-3-azabicyclo[3.3.1]nonan-9-one (**4A**).

This compound was obtained in a yield of 31%, b.p. (0.4 mm. 75-80°; ir (liquid film): 1695 and 1730 (C=O) cm^{-1}.

N-Secbutyl-3-azabicyclo[3.3.1]nonan-9-one (**5A**).

This compound was obtained in a yield of 39%, b.p. (0.3 mm. Hg) 87-92°; ir (liquid film): 1730 (C=O) cm^{-1}.

N-Isobutyl-3-azabicyclo[3.3.1]nonan-9-one (**6A**).

This compound was obtained in a yield of 30%, b.p. (0.3 mm. Hg) 95-100°; ir (liquid film): 1715 and 1740 (C=O) cm^{-1}.

N-Phenetyl-3-azabicyclo[3.3.1]nonan-9-one (**7A**).

This compound had a yield of 28%, m.p. 42-43°; ir: 1700 and 1725 (C=O) cm^{-1}.

N-Alkyl-3-azabicyclo[3.3.1]nonan-9-spiro-5′-hydantoins (**1-7**).

A solution of 0.024 mole of aminoketone, potassium cyanide (0.036 mole), and ammonium carbonate (0.072 mole) in ethanol (10 ml.) and water (30 ml.) was heated 70-75° in a sealed flask for 24 hours. After cooling, the precipitated solid was filtered off and recrystallized.

N-Methyl-3-azabicyclo[3.3.1]nonane-9-spiro-5′-hydantoin (**1**).

This compound was obtained in a yield of 58%, m.p. 267-269° (from methanol); ir (potassium bromide): 1725 and 1755 (C=O) cm^{-1}. The mass spectrum of the product had a molecular ion peak at m/e 223 with abundant fragment peaks at m/e 222, 154, 84, 58, 57, 44 and 42.

Anal. Calcd. for $C_{11}H_{17}N_3O_2$: C, 59.17; H, 7.67; N, 18.82. Found: C, 58.87; H, 7.69; N, 18.60.

N-Ethyl-3-azabicyclo[3.3.1]nonane-9-spiro-5′-hydantoin (**2**).

This compound was obtained in a yield of 54%, m.p. 256-258° (from ethanol); ir (potassium bromide): 1690, 1720 and 1761 (C=O) cm^{-1}. The mass spectrum of the product had a molecular ion peak at m/e 237 with abundant fragment peaks at m/e 236, 222, 208, 168, 71, 58 and 42.

Anal. Calcd. for $C_{12}H_{19}N_3O_2$: C, 60.73; H, 8.07; N, 17.71. Found: C, 60.94; H, 7.83; N, 17.90.

N-Propyl-3-azabicyclo[3.3.1]nonane-9-spiro-5′-hydantoin (**3**).

This compound was obtained in a yield of 47%, m.p. 248-250° (from ethanol); ir (potassium bromide): 1690, 1720 and 1760 (C=O) cm^{-1}. The mass spectrum of the product had a molecular ion peak at m/e 251 with abundant fragment peaks at m/e 250, 223, 222, 179, 108, 93, 84, 81, 72, 68, 58, 54, 42 and 41.

Anal. Calcd. for $C_{13}H_{21}N_3O_2$: C, 62.12; H, 8.42; N, 16.72. Found: C, 62.20; H, 8.42; N, 16.44.

N-Isopropyl-3-azabicyclo[3.3.1]nonane-9-spiro-5′-hydantoin (**4**).

This compound was obtained in a yield of 42%, m.p. 254-256° (from ethanol); ir (potassium bromide): 1690, 1720 and 1760 (C=O) cm^{-1}. The mass spectrum had a molecular ion peak at m/e 251 with abundant fragment peaks at m/e 250, 237, 236, 208, 108, 93, 72, 68, 56, 43, 42 and 41.

Anal. Calcd. for $C_{13}H_{21}N_3O_2$: C, 62.12; H, 8.42; N, 16.72. Found: C, 61.90; H, 8.61; N, 16.42.

N-Secbutyl-3-azabicyclo[3.3.1]nonane-9-spiro-5′-hydantoin (**5**).

This compound was obtained in a yield of 33%, m.p. 232-234° (from ethanol); ir (potassium bromide): 1685, 1720 and 1760 (C=O) cm^{-1}. The mass psectrum of the product had a molecular ion peak at m/e 265 with abundant fragment peaks at m/e 264, 250, 237, 236, 208, 136, 108, 93, 84, 82, 70, 68, 67, 58, 56, 54, 44, 42 and 41.

Anal. Calcd. for $C_{14}H_{23}N_3O_2$: C, 63.36; H, 8.74; N, 15.83. Found: C, 63.65; H, 8.51; N, 15.54.

N-Isobutyl-3-azabicyclo[3.3.1]nonane-9-spiro-5′-hydantoin (**6**).

This compound was obtained in a yield of 42%, m.p. 262-264° (from ethanol); ir (potassium bromide): 1720 and 1770 (C=O) cm^{-1}. The mass spectrum of the product had a molecular ion peak at m/e 265 with abundant fragment peaks at m/e 264, 224, 223, 179, 108, 107, 93, 70, 58, 44, 42 and 41.

Anal. Calcd. for $C_{14}H_{23}N_3O_2$: C, 63.36; H, 8.74; N, 15.78. Found: C, 63.54; H, 8.46; N, 15.78.

N-Phenylethyl-3-azabicyclo[3.3.1]nonane-9-spiro-5′-hydantoin (**7**).

This compound was obtained in a yield of 30%, m.p. 187-189° (from ethanol); ir (potassium bromide): 1720 and 1760 (C=O) cm^{-1}.

Anal. Calcd. for $C_{18}H_{23}N_3O_2$: C, 68.98; H, 7.40; N, 13.40. Found: C, 69.15; H, 7.64; N, 13.13.

N-Methyl, *N*′-alkyl-3,7-diazabicyclo[3.3.1]nonan-9-ones (**8A-14A**).

These aminoketones were obtained following Douglas and Ratliff's method (8).

N-Methyl-*N*′-alkyl-3,7-diazabicyclo[3.3.1]nonane-9-spiro-5′-hydantoins (**8-14**).

These spirohydantoins were obtained following the same procedure described in compounds **1-7** (23).

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