

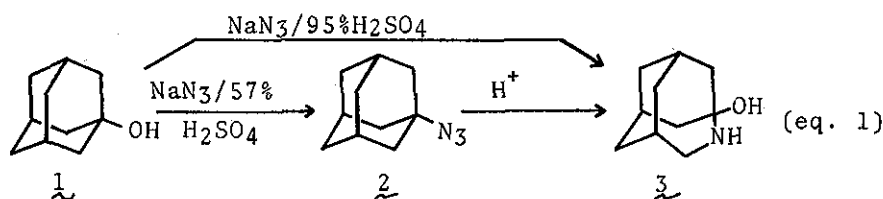
SYNTHESIS OF ADAMANTANE DERIVATIVES. 39.¹ SYNTHESIS AND
ACIDOLYSIS OF 2-AZIDOADAMANTANES. A FACILE ROUTE TO
4-AZAHOMOADAMANT-4-ENES

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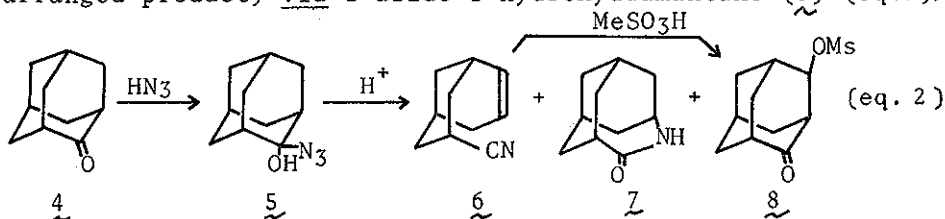
2-Azidoadamantanes 10b-f and 4-azahomoadamant-4-
enes 11a-e were obtained in good yields on treatment
of the corresponding alcohols 9a-f with NaN_3 in 57%-
 $\text{H}_2\text{SO}_4\text{-CH}_2\text{Cl}_2$ and in $\text{CH}_3\text{SO}_3\text{H-CHCl}_3$, respectively.
Azides 10a-e gave also 11a-e on decompositions in
 $\text{CH}_3\text{SO}_3\text{H-CHCl}_3$, while 10f afforded only adamant-
ylideneaniline.

We have recently reported an efficient and convenient
synthesis of 1-azidoadamantane (2) and 3-hydroxy-4-azahomo-
adamantane (3) from 1-hydroxyadamantane (1).² This
procedure consists of substitution of a hydroxyl group
with azide function via carbocation, followed by acidolysis
of the produced azides (eq.1).³ On the other hand, the



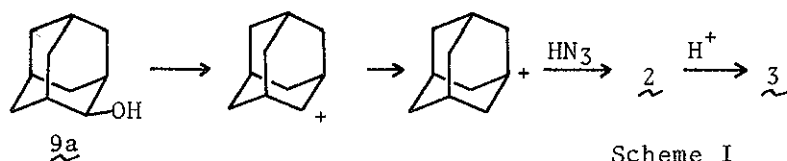
Schmidt reaction of adamantanone (4) is known to afford 6 or
8 (fragmentation and π -route cyclization products) and 7 (re-

arranged product) via 2-azido-2-hydroxyadamantane (5) (eq.2).⁴



In view of above interesting behaviors of azidoadamantanes on acidolysis, we have examined the reactions of 2-hydroxyadamantanes 9a-f with hydrazoic acid under acidic conditions.

Secondary alcohol 9a did not react with *in situ* generated hydrazoic acid (4-fold excess to 9a) in 57% H_2SO_4 - CH_2Cl_2 but in 97% H_2SO_4 - CHCl_3 , 9a afforded 3 in *ca.* 30% yield accompanied with several side products. The results could be rationalized by consideration of the well known intermolecular hydride transfer to afford 1-adamantylcation which reacted with HN_3 (Scheme I).^{2,5} However, when 9a was added to an

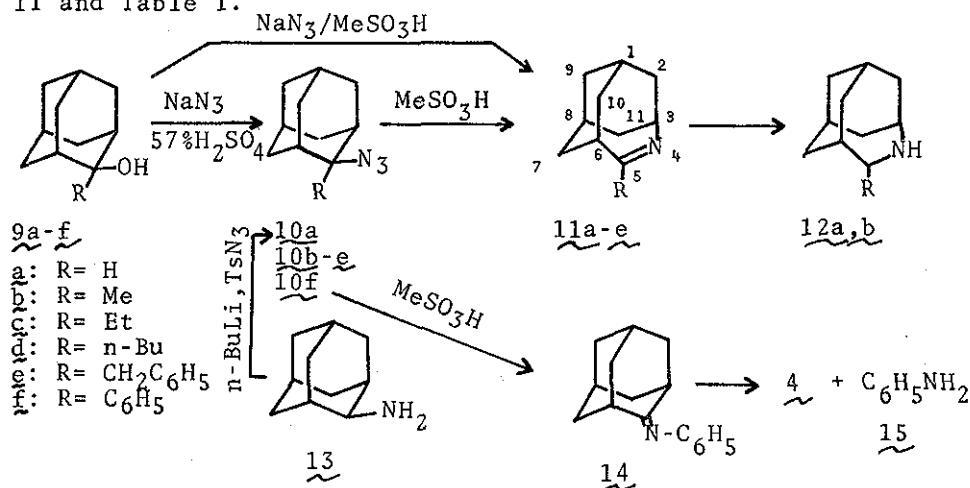


Scheme I

ice-cooled and stirred mixture of HN_3 (5-fold excess) in $\text{CH}_3\text{SO}_3\text{H}$ - CHCl_3 and the mixture was stirred for 5 hr at 20-25°, 4-azahomoadamant-4-ene (11a) was obtained as a very sublimable solid (61% yield). The structure was assigned on the basis of analysis, mass spectral molecular weight (m/e 149, M^+), ir and pmr spectral data (Table III) as well as NaBH_4 reduction to known 4-azahomoadamantane (12a)⁶ (Scheme II). Furthermore, 2-azidoadamantane (10a) was prepared in 32% yield from 2-aminoadamantane (13) by treatment with *n*-BuLi, followed by the reaction with *p*-toluenesulfonyl azide,³ and the decom-

position of 10a in $\text{CH}_3\text{SO}_3\text{H}-\text{CHCl}_3$ afforded also exclusively the imine 11a (Table II).

Tertiary alcohols 9b-f afforded azides 10b-f in good yields on treatment with NaN_3 in $57\%\text{H}_2\text{SO}_4-\text{CH}_2\text{Cl}_2$ as shown in Scheme II and Table I.



Scheme II

On decomposition in $\text{CH}_3\text{SO}_3\text{H}-\text{CHCl}_3$, azides 10b-e afforded also 5-alkyl-4-azahomoadamant-4-enes 11b-e in good yields as summarized in Table II. The structures of 11b-e were supported by analytical and spectral data (Table III) as well as reduction of 11b to 12b. Imine 11b, on refluxing with $\text{NaBH}_3(\text{OAc})$ in dioxane for 7 hr, gave 12b which was characterized as hydrochloride (46% yield): mp $295-8^\circ(\text{dec})$; $\text{ir}(\text{KBr})$ $3200-2400\text{ cm}^{-1}$; $\text{pmr}(\text{CDCl}_3-\text{D}_2\text{O})$ δ 4.0-3.3 (m, 2H), 2.66-1.30 (m, 16H) and 1.53 (d, $J=7.0\text{ Hz}$, 3H). Imines 11a-e gave the corresponding hydrochlorides, all of which revealed characteristic ir absorptions at $1675-1680\text{ cm}^{-1}$ due to $\nu_{\text{C}=\text{N}^+\text{H}}$ (Table III). Since the formation of 11a-e depends on the larger migratory aptitude of C_1-C_2 bond of adamantane nucleus than R group in 10a-e, decomposition of 10f, $\text{R}=\text{C}_6\text{H}_5$ is

Table I. Synthesis of 2-Azidoadamantanes 10a-f^a

Pre- cur- sor	Azide (Yield, %)	Mp, °C or n _D (temp, °C)	Ir (film) cm ⁻¹	Pmr (CDCl ₃ , 60MHz) δ	Formula	Analysis ^b		
						C	H	N
<u>13</u>	<u>10a</u> (32.7)	30-35	2100	3.79(s, 1), 2.5-0.5 (m, 14)	C ₁₀ H ₁₅ N ₃	F 67.76 C 67.76	8.71 8.53	23.53 23.71
<u>9b</u>	<u>10b</u> (92.4)	35-36	2120 2090	2.4-1.5 (m, 14), 1.46(s, 3)	C ₁₁ H ₁₇ N ₃	F 68.95 C 69.07	8.81 8.96	22.23 21.97
<u>9c</u>	<u>10c</u> (91.1)	1.5252 (30.0)	2090	2.4-1.2 (m, 16), 0.94(t, 7.5Hz, 3)	C ₁₂ H ₁₉ N ₃	F 70.36 C 70.20	9.29 9.33	20.34 20.47
<u>9d</u>	<u>10d</u> (75.0)	1.5172 (29.3)	2090	2.4-0.7 (m, 20), 0.95(t, 5.5Hz, 3)	C ₁₄ H ₂₃ N ₃	F 72.23 C 72.06	9.66 9.93	18.10 18.01
<u>9e</u>	<u>10e</u> (70.8)	1.5767 (23.2)	2100	7.17(s, 5), 3.05(s, 2), 2.4-1.3 (m, 14) ^c	C ₁₇ H ₂₁ N ₃	F 76.30 C 76.37	8.16 7.92	15.54 15.71
<u>9f</u>	<u>10f</u> (89.7)	44.5- 45.6	2090	7.8-7.3 (m, 5), 3.0-1.46 (m, 14)	C ₁₆ H ₁₉ N ₃	F 76.05 C 75.85	7.49 7.56	16.72 16.59

^a Azide 10a was prepared by the diazo-transfer method, while 10b-f were obtained by stirring 9b-f with NaN₃ (4-fold excess) in 57% H₂SO₄-CH₂Cl₂ (1:1, v/v) for 3-5 hr at 20-25°, followed by usual work-up and chromatography (silica gel, n-pentane-CH₂Cl₂).
^b F=Found and C=Calcd. In CCl₄.

Table II. Synthesis of 4-Azahomoadamant-4-enes 11a-e from 2-Hydroxyadamantanes 9a-e and Azides 10a-e

Pre- cur- sor	Mol. ratio of NaN ₃ to alcohols	CHCl ₃ : CH ₃ SO ₃ H (v/v)	React. time, hr	Imine	Yield, %	Purification Method
<u>9a</u>	5.0	1:1	5.0	<u>11a</u>	60.9	sublimation
<u>10a</u>	0	3:2	0.5	<u>11a</u>	65.0	(90°, 20 mm)
<u>9b</u>	4.0	1:1	1.5	<u>11b</u>	75.3	Kugel rohr distn.
<u>10b</u>	0	4:5	0.8	<u>11b</u>	68.8	(70-80°, 0.4 mm)
<u>9c</u>	4.0	1:1	4.0	<u>11c</u>	67.7	Kugel rohr distn.
<u>10c</u>	0	1:1	2.0	<u>11c</u>	81.8	(88-95°, 0.4 mm)
<u>9d</u>	10.0	1:2	20.0	<u>11d</u>	89.3	Kugel rohr distn.
<u>10d</u>	0	1:2	1.0	<u>11d</u>	74.5	(90-95°, 0.4 mm)
<u>9e</u>	10.0	1:2	19.0	<u>11e</u> ^a	44.6	chromatography
<u>10e</u>	0	1:2	2.0	<u>11e</u> ^a	46.9	(alumina, CH ₂ Cl ₂)

^a Adamantylidenebenzylamine was also produced in ca. 45% yield.

Table III. Physical and Analytical Data of Cyclic Imines 11a-e and Their Hydrochlorides

Imine (mp, °C or n _D , temp)	Ir, ^a cm ⁻¹	Pmr (CDCl ₃ , 60MHz), ^b δ	Formula	Analysis ^c		
				C	H	N
<u>11a</u> (215-8)	1650	8.07 (d, 6.0Hz, 1), 4.33-3.90 (m, 1), 3.0-2.4 (m, 1), 2.35-1.35 (m, 12)	C ₁₀ H ₁₅ N	F 80.34 C 80.48	10.03 10.13	9.63 9.39
<u>11aHCl</u> (276-9, dec)	3200- 2400, 1680	9.00 (d, 6.0Hz, 1), 4.5-4.15 (m, 1), 3.5-3.0 (m, 1), 2.5-1.4 (m, 12)	C ₁₀ H ₁₆ NC1	F 64.61 C 64.68	8.86 8.69	7.44 7.54
<u>11b</u> (1.5155, 22.0)	1660	3.97 (t, 4.0Hz, 1), 2.57 (t, 4.0Hz, 1), 2.00 (s, 3), 1.9-1.5 (m, 12)	C ₁₁ H ₁₇ N	F 81.20 C 80.92	10.33 10.50	8.47 8.58
<u>11bHCl</u> (278- 280, dec)	3200- 2400, 1680	4.27 (bs, 1), 2.92 (bs, 1), 2.75-1.5 (m, 15)	C ₁₁ H ₁₈ NC1	F 66.15 C 66.16	8.94 9.08	6.92 7.01
<u>11c</u> (1.5154, 29.5)	1665	4.2-3.8 (m, 1), 2.78-2.45 (m, 1), 2.23 (q, 7.0Hz, 2), 2.44-1.5 (m, 14), 1.07 (t, 7.0Hz, 3)	C ₁₂ H ₁₉ N	F 81.60 C 81.30	10.58 10.80	7.82 7.90
<u>11cHCl</u> (160-2)	3300- 2400, 1675	4.35 (bs, 1), 3.2-2.7 (m, 3), 2.5-1.5 (m, 12), 1.32 (t, 7.0Hz, 3)	C ₁₂ H ₂₀ NC1	F 67.61 C 67.43	9.65 9.43	6.42 6.55
<u>11d</u> (1.5074, 30.0)	1660	4.01 (t, 3.0Hz, 1), 2.62 (t, 3.0Hz, 1), 2.45-1.15 (m, 18), 0.95 (t, 5.3Hz, 3)	C ₁₄ H ₂₃ N	F 81.61 C 81.89	11.46 11.29	6.95 6.82
<u>11dHCl</u> (148- 153)	3200- 2400, 1680	4.31 (bs, 1), 2.94 (bs, 3), 2.5-0.8 (m, 19)	C ₁₄ H ₂₄ NC1	F 69.53 C 69.54	9.91 10.00	5.64 5.79
<u>11e</u> (84-8)	1660, 1600, 740,	8.2-7.1 (m, 5), 4.28 (t, 3.0Hz, 1), 3.32 (t, 3.0Hz, 1), 2.4-1.6 (m, 14)	C ₁₇ H ₂₁ N	F 85.61 C 85.31	8.59 8.84	6.14 6.85
<u>11eHCl</u> (167- 170)	3400- 2400, 1685, 1600, 750, 690	8.1-7.1 (m, 5), 4.60 (bs, 1), 3.11 (bs, 1), 2.5-1.5 (m, 14)	C ₁₇ H ₂₂ NC1	F 74.03 C 74.03	7.92 8.04	4.79 5.08

^a In KBr for solids and film for oils. ^b Hydrochlorides were measured in CDCl₃-D₂O, and bs = broad singlet. ^c F=Found and C=Calcd.

expected to afford a phenyl migration product rather than a ring-expanded product by considering the well known larger migratory tendency of a phenyl group.³ In fact, 10f decomposed in $\text{CH}_3\text{SO}_3\text{H}-\text{CHCl}_3$ to afford only adamantanone (4) and aniline (15), which indicated the formation of adamantylidene-aniline (14),⁸ the phenyl migration product. Also, in the decomposition of 10e, a considerable amount (ca.45%) of adamantylidenebenzylamine was produced as well as 11e.⁹

The imines 11b-e were obtained also directly from alcohols 9b-e on treatment with NaN_3 in $\text{CH}_3\text{SO}_3\text{H}-\text{CHCl}_3$ (Table II). Therefore, above described procedures provide facile synthesis of 2-alkyl- or 2-aryl-2-azidoadamantanes and 5-unsubstituted and 5-alkyl-4-azahomoadamant-4-enes.

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- 9 The structural analysis of 11e should be considered as tentative because of appearance of benzylic methylene at abnormally higher field in the pmr spectrum.

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