Anal. Calcd for $C_8H_{12}S$: C, 68.54; H, 8.63. Found: C, 68.63; H, 8.54.

Compound **12** had mp 140–143 °C (lit.[11b] mp 143–143.5 °C), and its IR and ^1H NMR spectra and GLC retention time were identical with those of an authentic sample prepared by $LiAlH_4$ reduction of 6-chloro-9-thiabicyclo[3.3.1]non-2-ene.[11b]

B. Thermal Decomposition of 10b without Solvent. The sodium salt **10b**, prepared as above from **10a** (300 mg, 0.925 mmol), was well mixed with Celite 535 (0.5 g) and heated at 155–180 °C under reduced pressure (100 mm) in a sublimation flask to afford the sublimed product (90 mg, 70%), which gave a 74:26 mixture of **11** and **12** as a colorless solid (70 mg, 54%) on resublimation.

9-Thianoradamantane 9,9-Dioxide (13). A mixture of 9-thianoradamantane (**11**) (20 mg, 0.14 mmol) and *m*-chloroperbenzoic acid (85% purity; 70 mg, 0.34 mmol) in chloroform (3 mL) was stirred at room temperature for 24 h. The mixture was washed with 5% aqueous sodium thiosulfate (2 mL) and 5% aqueous sodium bicarbonate (2 mL × 3) and dried (Na_2SO_4). Removal of the solvent and sublimation (130 °C, 18 mm) afforded **13** as a colorless solid (18 mg, 75%): mp >300 °C; IR (KBr) 2960, 1450, 1285, 1110, and 818 cm^{-1}; ^1H NMR ($CDCl_3$) δ 3.36 (broad s, 2 H), 2.80 (broad s, 2 H), and 2.52–1.67 (AB q type m, 8 H); ^{13}C NMR, see Table I; mass spectrum, *m/e* (relative intensity, %) 174 (1.4, M + 2), 171 (2.9, M + 1), 172 (10.5, M^+), 108 (100), 94 (30.2), 92 (68.4), 81 (99.5), 78 (67.0), 66 (63.6), 65 (46.5), 41 (93.0), and 39 (99.0).

Anal Calcd for $C_8H_{12}O_2S$: C, 55.78; H, 7.00. Found: C, 56.02; H, 6.76.

9-Methyl-9-thianoradamantanium (9-Methyl-9-thiatricyclo[3.3.1.0^{3,7}]nonanium) Iodide (14). A mixture of **11** (15 mg, 0.10 mmol) and methyl iodide (340 mg, 2.4 mmol) in chloroform (3 mL) was heated under reflux for 17 h to afford a precipitate, which was filtered off and dried to give **14** as colorless crystals (25 mg, 89%): mp 242–244 °C dec; IR (KBr) 2925, 1460, 1415, 1300, 1250, 1240, 1085, 960, and 710 cm^{-1}; ^1H NMR (D_2O–$CDCl_3$) δ 3.87 (broad s, 2 H), 2.84 (s, 3 H), and 3.0–1.8 (m, 10 H).

Anal. Calcd for $C_9H_{15}SI$: C, 38.31; H, 5.36. Found: C, 38.46; H, 5.21.

Acknowledgment. We gratefully acknowledge Takeda Chemical Industries Ltd. for obtaining the mass spectral data.

Registry No.—**5**, 1073-76-3; **10a**, 67194-75-6; **10b**, 67194-76-7; **12**, 13334-79-7; **14**, 67194-77-8.

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Synthesis of Adamantane Derivatives. 42.[1] Novel Synthesis of 5-Methylene-4-azahomoadamantane Derivatives from 2-Methyl-2-hydroxyadamantane and Their Carbon-13 Nuclear Magnetic Resonance Spectra

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5-Methyl-4-azahomoadamant-4-ene (**9**), readily obtainable from 2-methyl-2-hydroxyadamantane (**8**), was converted to 4-acyl-5-methylene-4-azahomoadamantanes **11a**, **11b**, and **11c** in good yields on acylation. The reaction of **9** with dichlorocarbene gave also 4-formyl-5-methylene-4-azahomoadamantane (**16**), while peracetic acid oxidation of **9** gave the corresponding oxaziridine **17**. 4,5-Dimethyl-4-azahomoadamantenium iodide (**18a**), the methiodide of **9**, gave 4-methyl-5-methylene-4-azahomoadamantane (**19**) on treatment with aqueous alkali. ^{13}C NMR data of the thus prepared 5-methylene-4-azahomoadamantane derivatives have been reported.

4-Azahomoadamantane derivatives are known as potentially biologically active compounds,[2] and several synthetic routes to this skeleton have been reported recently by many workers. The Beckmann rearrangement[3] and the Schmidt reaction[4] of the adamantanone system (**1**) are the simple routes to 4-azahomoadamantan-5-one (**2**), but these reactions are prone to suffer from side reactions such as fragmentations. The rearrangement of spirooxaziridine (**3**) is known also as a direct route to *N*-alkyl-4-azahomoadamantan-5-one (**2**).[5] On the other hand, rearrangements via 1-adamantylnitrenium ion type intermediates as in the **4** → **5**,[6] **6** → **5**,[7] and **7** → **5**[8] conversions are unique routes to 3-substituted 4-azahomoadamantanes. In this paper, we report a novel and facile synthesis of 5-methylene-4-azahomoadamantane derivatives via 5-methyl-4-azahomoadamant-4-ene (**9**) from 2-methyl-2-hydroxyadamantane (**8**).

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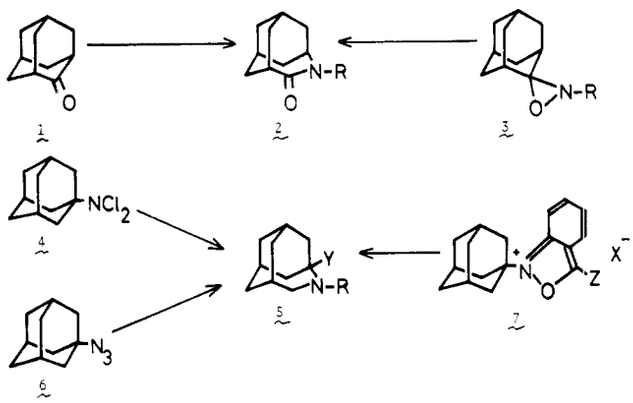
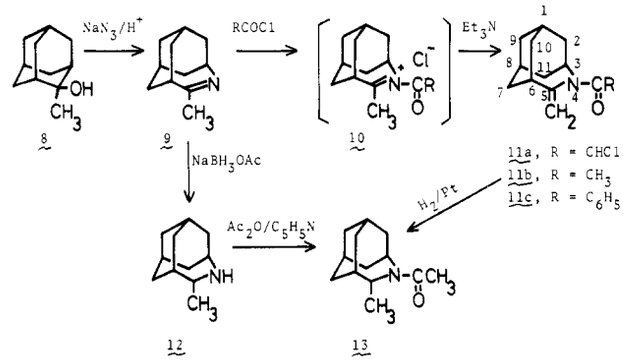
Table I. Chemical Shifts (δ) of 5-Methylene-4-azahomoadamantane Derivatives[a]

compd	$C_{1,8}$	$C_{2,11}$[b]	C_3	C_5	$=CH_2$	C_6	$C_{7,10}$[b]	C_9	C=O	other carbons
11a	26.4 (d)	33.6 (t)	49.9 (d)	153.3 (s)	108.0 (t)	37.6 (d)	36.3 (t)	35.1 (t)	163.3 (s)	64.1 (d)[c]
11b	26.7 (d)	34.2 (t)	48.3 (d)	153.6 (s)	107.4 (t)	38.1 (d)	36.6 (t)	35.4 (t)	169.5 (s)	23.8 (q)[d]
11c	26.6 (d)	34.6 (t)	48.2 (d)	152.2 (s)	109.5 (t)	37.8 (d)	36.7 (t)	35.3 (t)	169.3 (s)	138.2 (s) ($C_{1'}$)[e]
										128.9 (d) ($C_{4'}$)[e]
										127.7 (d) ($C_{2',3',5',6'}$)[e]
16	26.4 (d)	34.8 (t)[f]	46.5 (d)	153.2 (s)	98.2 (t)	38.2 (d)	36.2 (t)	34.8 (t)[f]	160.7 (s)	
19	26.3 (d)	36.4 (t)[f]	59.4 (d)	160.8 (s)	76.3 (t)	42.0 (d)	36.4 (t)[f]	35.2 (t)		40.4 (q)[g]

[a] Downfield from internal tetramethylsilane in $CDCl_3$, and see the structural formula for numbering of the carbon atoms. [b] See ref 13c. [c] $CHCl_2$. [d] CH_3. [e] Phenyl carbons. [f] Overlapped. [g] CH_3.



Scheme I



Results and Discussion

We have recently reported in a communication[9] that 2-alkyl-2-hydroxyadamantane can be converted in good yields to the corresponding 5-alkyl-4-azahomoadamant-4-ene by treatment with sodium azide in methanesulfonic acid. Thus, 5-methyl-4-azahomoadamant-4-ene (**9**) was obtained directly from 2-methyl-2-hydroxyadamantane (**8**)[10] in 79% yield simply by stirring **8** with a 4-fold excess of sodium azide in CH_3SO_3H–CH_2Cl_2, followed by the usual workup and distillation under reduced pressure. The imine **9** gave the corresponding hydrochloride with hydrogen chloride gas,[9] which was reconverted to free imine **9** with aqueous potassium hydroxide, indicating the considerable stability of **9** toward acid or base.

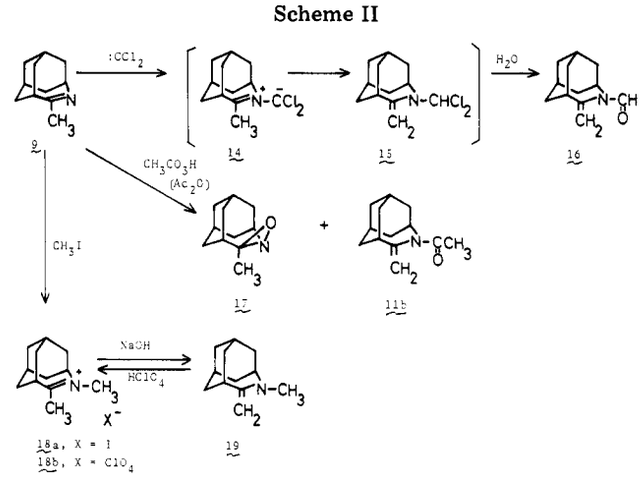
The additions of carbene and ketene to C=N double bonds are well known as simple routes to aziridines and azetidinones, respectively.[11,12] In order to examine the reactivity of the C=N double bond in **9**, **9** was treated with dichloroacetyl chloride in refluxing benzene containing triethylamine (the conditions for generation of dichloroketene) for 6 h. The usual workup and chromatography on an alumina column afforded an adduct **11a** in 55% yield as colorless crystals. This compound was not a dichloroketene adduct but was characterized as 4-dichloroacetyl-5-methylene-4-azahomoadamantane on the basis of analysis and spectral data. The IR (KBr) spectrum had strong absorptions at 1670 ($\nu_{C=O}$) and 1630 and 880 ($\nu_{C=CH_2}$) cm^{-1}. The ^1H NMR ($CDCl_3$) spectrum revealed signals at δ 6.90 (s, 1 H, $CHCl_2$), 5.00 and 4.82 (both s, each 1 H, $C=CH_2$), 4.77 (broad s, 1 H, C_3H), 3.00 (broad s, 1 H, C_6 H), and 2.2–1.4 (m, 12 H, other protons), supporting the assigned structure of **11a** (Scheme I). Furthermore, the ^{13}C NMR spectrum had ten lines (Table I), which were compatible with the given structure. The assignments (Table I) were based on the chemical shifts, peak intensities, and proton off-resonance spectral data.[13]

Treatment of **9** with acetyl chloride and benzoyl chloride in the presence of triethylamine also gave the corresponding 4-acyl-5-methylene-4-azahomoadamantanes **11b** and **11c** in 66 and 82% yields, respectively. The structures of **11b** and **11c** were supported by the spectral data (see Experimental Section and Table I). Furthermore, **11b** was converted to 4-acetyl-5-methyl-4-azahomoadamantane (**13**) quantitatively on catalytic hydrogenation. The structure of **13** was confirmed by an alternative preparation via 5-methyl-4-azahomoadamantane (**12**), which is readily obtainable from **9** as shown in Scheme I.

The yields of dichlorocarbene addition to C=N double bonds have been much improved recently by applying the phase-transfer technique.[14] Therefore, **9** was treated with dichlorocarbene generated from chloroform and 50% aqueous potassium hydroxide under the phase-transfer catalyzed conditions using benzyltriethylammonium chloride (BTAC) as a catalyst. The product obtained in 66% yield as an oil after chromatography was shown by spectral data to be 4-formyl-5-methylene-4-azahomoadamantane (**16**). The formation of **16** can be rationalized by the initial formation of N–C ylide **14**, followed by proton loss or H migration and hydrolysis of the N–$CHCl_2$ group as depicted in Scheme II.[15]

Oxidation of **9** with peracetic acid prepared in situ from 35% hydrogen peroxide, acetic anhydride, and sulfuric acid by the Emmons' procedure[16] gave oxaziridine **17**, mp 65–68 °C, and **11b** in 23 and 9.4% yields, respectively (Scheme II). The as-

Scheme II



signed structure of 17 was supported by analysis and spectral data. The formation of **11b** as the minor product is ascribable to the reaction of **9** with acetic anhydride. This was independently proven through the preparation of **11b** by treating 9 with acetic anhydride and sulfuric acid.

All of the above results indicate that the iminium salt of **9** can be converted to 4-acyl-5-methylene-4-azahomoadamantane derivatives. Furthermore, an example of enamine formation from bicyclic *N*-methyliminium iodide has been reported previously by Walker and Alkalay.[17a] Therefore, the 4-alkyliminium salt of **9** may be a promising precursor to 4-alkyl-5-methylene-4-azahomoadamantane. In fact, the reaction of aqueous sodium hydroxide with 4-methyliminium iodide **18a**, which was readily obtained from **9** and methyl iodide, afforded 4-methyl-5-methylene-4-azahomoadamantane (**19**) in 80% yield.[17b] The structure of **19** was supported by analysis and spectral data. The IR (film) spectrum had a strong absorption at 1600 cm^{-1}, and the ^1H NMR ($CDCl_3$) spectrum revealed signals at δ 3.7–2.95 (broad m, 3 H, C=CH_2 and C_3 H), 2.82 (s, 3 H, CH_3), 3.0–3.3 (broad m, 1 H, C_6 H), and 2.2–1.4 (m, 12 H, other protons). The appearance of the vinylic protons at characteristically higher field supported the assigned enamine structure **19**. In the ^{13}C NMR spectrum (Table I), one of the vinylic carbons (=CH_2) appeared also at considerably higher field (δ 76.3). The enamine **19** was converted to 4,5-dimethyl-4-azahomoadamant-4-enium perchlorate (**18b**) on treatment with perchloric acid (Scheme II).

Because 2-alkyl-2-hydroxyadamantanes such as **8** are readily obtainable from adamantanone and Grignard reagents or alkyllithium, the above facile formation of 4-acyl- and 4-alkyl-5-methylene-4-azahomoadamantanes via **9** may provide a novel and convenient route to 5-alkylidene-4-azahomoadamantane derivatives from adamantanone.

Experimental Section[18]

5-Methyl-4-azahomoadamant-4-ene (9). To a stirred and ice-cooled mixture of 98% methanesulfonic acid (15 mL) and dichloromethane (10 mL) was added solid sodium azide (0.52 g, 8.0 mmol) and then 2-methyl-2-hydroxyadamantane (**8**)[10] (1.00 g, 6.00 mmol). To the resulting mixture was added little by little sodium azide (1.04 g, 16.0 mmol) during 0.5 h. After the stirring was continued further for 8 h at 20–25 °C, the mixture was poured onto ice water (ca. 10 mL). The aqueous layer was separated, washed with CH_2Cl_2 (3 mL), basified with 50% aqueous KOH–ice, and extracted with CH_2Cl_2 (10 mL × 4). The combined extracts were dried (Na_2SO_4), and the solvent was removed to afford a brownish oil which was purified by Kugelrohr distillation (120 °C, 0.2 mm) to give **9** as a colorless oil (0.77 g, 79%): $n^{22}D$ 1.5155; IR (film) 2920, 2850, 1660, and 1440 cm^{-1}; ^1H NMR ($CDCl_3$) δ 3.97 (t, J = 4.0 Hz, 1 H, C_3 H), 2.57 (t, J = 4.0 Hz, 1 H, C_6 H), 2.00 (s, 3 H, CH_3), and 1.9–1.5 (m, 12 H).

Anal. Calcd for $C_{11}H_{17}N$: C, 80.92; H, 10.50; N, 8.58. Found: C, 81.20; H, 10.33; N, 8.47.

The hydrochloride of **9** was obtained on treatment with HCl gas in ether as a colorless precipitate, mp 278–280 °C dec.[9]

4-Dichloroacetyl-5-methylene-4-azahomoadamantane (11a). To a stirred and refluxing mixture of **9** (81 mg, 0.50 mmol) and triethylamine (101 mg, 1.00 mmol) in anhydrous benzene (6 mL) was added dichloroacetyl chloride (147 mg, 1.00 mmol) in benzene (3 mL) during 0.5 h under an argon atmosphere. After the refluxing was continued further for 6 h, the cooled mixture was washed with water and dried (Na_2SO_4). Removal of the solvent gave a brownish oil which was purified on an alumina column (Wako, basic, grade I) eluting with CH_2Cl_2 to afford **11a** as colorless crystals (76 mg, 55.4%): mp 61–63 °C (*n*-hexane); IR (KBr) 3040, 2920, 2850, 1670, 1630, 1450, 1405, 1190, and 880 cm^{-1}; ^1H and ^{13}C NMR, see text and Table I.

Anal. Calcd for $C_{13}H_{17}Cl_2NO$: C, 56.95; H, 6.25; N, 5.11. Found: C, 56.93; H, 6.10; N, 5.26.

The same reaction at −78 °C for 15 h and at 20–25 °C for 9 h in anhydrous ether as the solvent also gave **11a** in 55.3 and 54.3% yields, respectively.

4-Acetyl-5-methylene-4-azahomoadamantane (11b). A mixture of **9** (81 mg, 0.50 mmol) and triethylamine (76 mg, 0.75 mmol) in ether (3 mL) was treated with acetyl chloride (59 mg, 0.75 mmol) in ether (2 mL) at 20–25 °C for 1 day. Removal of the solvent gave the crude product, which was purified on an alumina column eluting with CH_2Cl_2 to afford **11b** as colorless crystals (68 mg, 66%): mp 37–40 °C (*n*-hexane); IR (KBr) 3120, 2920, 2850, 1640, 1630, 1450, 1395, 1320, and 870 cm^{-1}; ^1H NMR ($CHCl_3$) δ 4.90 (s, 1 H), 4.80 (broad s, 1 H), 4.60 (s, 1 H), 2.90 (broad s, 1 H), 2.20 (s, 3 H), and 2.1–1.3 (m, 12 H); ^{13}C NMR ($CDCl_3$), see Table I.

Anal. Calcd for $C_{13}H_{19}NO$: C, 76.06; H, 9.33; N, 6.82. Found: C, 76.36; H, 9.17; N, 6.91.

4-Benzoyl-5-methylene-4-azahomoadamantane (11c). A mixture of **9** (81 mg, 0.50 mmol) and triethylamine (76 mg, 0.75 mmol) in anhydrous ether (3 mL) was treated with benzoyl chloride (106 mg, 0.75 mmol) in ether (2 mL) as above for 2 h at 20–25 °C. Workup as above and chromatography on an alumina column eluting with CH_2Cl_2 afforded **11c** as colorless crystals (110 mg, 82.3%): mp 122–125 °C; IR (KBr) 3060, 2920, 2840, 1620, 1580, 1450, 1395, 1335, 870, and 690 cm^{-1}; ^1H NMR ($CDCl_3$) δ 7.6–7.1 (m, 5 H), 5.10 (broad s, 1 H), 4.52 (s, 1 H), 4.07 (s, 1 H), 2.90 (broad s, 1 H), and 2.3–1.5 (m, 12 H); ^{13}C NMR ($CDCl_3$), see Table I.

Anal. Calcd for $C_{18}H_{21}NO$: C, 80.86; H, 7.92; N, 5.24. Found: C, 80.86; H, 7.79; N, 5.37.

5-Methyl-4-azahomoadamantane (12). To a solution of **9** (50 mg, 0.31 mmol) in anhydrous dioxane (5 mL) was added sodium acetoxyborohydride[19] (294 mg, 3.00 mmol), and the mixture was heated under reflux for 7 h. The cooled mixture was diluted with water (20 mL) and extracted with chloroform (9 mL × 4). The combined extracts were washed with saturated aqueous sodium chloride solution, dried (Na_2SO_4), and concentrated to ca. 15 mL, which was diluted with ether (10 mL) and treated with HCl gas. Removal of the solvent gave a solid which was reprecipitated from CH_2Cl_2–*n*-hexane to afford the hydrochloride of **12** (29 mg, 46%): mp 295–298 °C dec; IR (KBr) 3200–2400 and 1585 cm^{-1}; ^1H NMR ($CDCl_3$–D_2O) δ 4.0–3.3 (m, 12 H), 2.66–1.3 (m, 13 H), and 1.53 (d, J = 7.0 Hz, 3 H).

Anal. Calcd for $C_{11}H_{20}NCl$: C, 65.49; H, 9.92; N, 6.92. Found: C, 65.58; H, 9.87; N, 6.88.

4-Acetyl-5-methyl-4-azahomoadamantane (13). A. From 11b. A mixture of **11b** (22 mg, 0.11 mmol) and Adams' catalyst (22 mg) in methanol was stirred under a hydrogen atmosphere for 48 h at room temperature. Removal of the catalyst by filtration and removal of the solvent gave **13** as colorless crystals (22 mg, 99%): mp 35–39 °C; IR (KBr) 2920, 2850, 1630, 1440, 1080, and 950 cm^{-1}; ^1H NMR ($CDCl_3$) δ 5.37–3.64 (m, 2 H), 2.20 and 2.14 (each s, 0.86 H and 2.14 H), 2.5–1.0 (m, 13 H), and 1.34 and 1.23 (each d, J = 6.7 Hz, 0.86 H and 2.14 H).[20]

Anal. Calcd for $C_{13}H_{21}NO$: C, 75.32; H, 10.21; N, 6.76. Found: C, 75.58; H, 9.98; N, 6.73.

B. From 12. A mixture of the hydrochloride of **12** (10 mg, 0.050 mmol) and acetic anhydride (108 mg, 1.1 mmol) in pyridine (0.5 mL) was stirred for 1 day at room temperature. The usual workup with sublimation gave **13** as a colorless solid (10 mg, 100%) which had the same IR and ^1H NMR spectra as the sample prepared from **11b**.

4-Formyl-5-methylene-4-azahomoadamantane (16). To a vigorously stirred mixture of **9** (160 mg, 1.0 mmol), benzyltriethylammonium chloride (7 mg), 50% aqueous KOH (2 mL), and benzene (2 mL) was added a mixture of chloroform (1.2 g, 10 mmol) and benzene (2 mL) during 1 h at room temperature, and the stirring was continued further for 6 h. The mixture was diluted with water (10 mL) and extracted with ether (6 mL × 3). The combined extracts were dried (Na_2SO_4). Removal of the solvent gave a brownish oil which was purified on an alumina column eluting with *n*-hexane–CH_2Cl_2 to afford **16** as a colorless oil (122 mg, 65.9%): $n^{19.5}D$ 1.5510; IR (film) 3100, 2920, 2850, 1660, 1620, 1440, 1380, 1270, and 850 cm^{-1}; ^1H NMR ($CDCl_3$) δ 8.47 (s, 1 H, CHO), 4.67 (broad s, 1 H, C_3 H), 4.48 and 4.52 (each s, 2 H, C=CH_2), 2.85 (broad s, 1 H, C_6H), and 2.4–1.3 (m, 12 H); ^{13}C NMR ($CDCl_3$), see Table I.

Anal. Calcd for $C_{12}H_{17}NO$: C, 75.35; H, 8.96; N, 7.32. Found: C, 75.12; H, 8.93; N, 7.33.

3′-Methyl-4-azahomoadamantano[4,5-*b*]oxaziridine (17). To a stirred and ice-cooled mixture of 35% aqueous H_2O_2 (0.08 mL, 0.82 mmol) and dichloromethane (2 mL) was added successively 97% H_2SO_4 (0.03 mL) and acetic anhydride (65 mg, 0.63 mmol), and the mixture was stirred for 15 min under ice cooling and 5 min at 20 °C. This peracetic acid solution was added to a stirred and ice-cooled solution of **9** (81 mg, 0.50 mmol) in CH_2Cl_2 (2 mL), and the stirring was continued for 15 h at 20–25 °C. The mixture was treated with 5% aqueous sodium thiosulfate and dried (Na_2SO_4). Removal of the solvent gave an oil which was purified by preparative TLC (alumina, CH_2Cl_2) to afford **11b** (10 mg, 9.7%) and **17** as colorless crystals (21 mg, 23%): mp 65–68 °C; IR (KBr) 3000, 2900, 2850, 1440, 1380, 1180, 1110, and 830 cm^{-1}; ^1H NMR ($CDCl_3$) δ 3.82 (broad s, 1 H, C_3H), 2.35 (broad s, 1 H, C_6 H), 2.2–1.5 (m, 12 H), and 1.47 (s, 3 H, CH_3).

Anal. Calcd for $C_{11}H_{17}NO$: C, 73.70; H, 9.56; N, 7.81. Found: C,

73.78; H, 9.42; N, 7.70.

The acetyl derivative **11b** was identified by comparison of its IR spectrum and R_f values on TLC with the sample prepared from **9** and acetyl chloride. Treatment of **9** with acetic anhydride in CH_2Cl_2 in the presence of a catalytic amount of sulfuric acid also gave **11b** (37%).

4,5-Dimethyl-4-azahomoadamant-4-enium Iodide (18a). A mixture of **9** (81 mg, 0.50 mmol) and methyl iodide (1.14 g, 8.0 mmol) in chloroform (3 mL) was heated under reflux for 1 day. Removal of the solvent and excess methyl iodide gave a brownish solid which was washed with acetone to afford **18a** as a colorless solid (130 mg, 85.5%): mp 277–280 °C dec; IR (KBr) 2920, 2850, 1660, 1450, and 800 cm^{-1}; ^1H NMR ($CDCl_3$) δ 4.25 (broad s, 1 H), 3.90 (s, 3 H), 3.19 (broad s, 1 H), 2.87 (s, 3 H), and 2.55–1.81 (m, 12 H).

Anal. Calcd for $C_{12}H_{20}NI$: C, 47.23; H, 6.61; N, 4.59. Found: C, 47.22; H, 6.32; N, 4.62.

The methiodide **18a** was also obtained in 65.5% overall yield from **8** (450 mg, 2.70 mmol) without isolation of **9** by the same procedure.

4-Methyl-5-methylene-4-azahomoadamantane (19) and 4,5-Dimethyl-4-azahomoadamant-4-enium Perchlorate (18b). A solution of **18a** (305 mg, 1.00 mmol) in methanol (10 mL) was poured onto ice-cooled 10% aqueous NaOH (60 mL), and the mixture was extracted with ether (15 mL × 4). The combined extracts were dried (Na_2SO_4–K_2CO_3), and removal of the solvent gave an oil which was purified by Kugelrohr distillation (120 °C, 0.2 mm) to afford the enamine **19** as a colorless oil (142 mg, 80.0%). **19** turned to a yellowish oil rapidly in the air: $n^{19}D$ 1.5487; IR (film) 3120, 2920, 2840, 1600, 1440, 1400, 1300, 1030, and 750 cm^{-1}; ^1H and ^{13}C NMR, see text and Table I.

Anal. Calcd for $C_{12}H_{19}N$: C, 81.30; H, 10.80; N, 7.90. Found: C, 81.50; H, 10.57; N, 7.93.

To a solution of **19** (78 mg, 0.44 mmol) in methanol (2 mL) and ether (10 mL) was added 70% aqueous perchloric acid (0.1 mL) to afford a colorless precipitate which was filtered off and washed with ether to give **18b** (122 mg, 100%): mp >300 °C; IR (KBr) 2920, 2870, 1667, 1450, and 1090 cm^{-1}; ^1H NMR [$CDCl_3$–D_2O–$(CD_3)_2SO$] δ 4.18 (broad s, 1 H), 3.70 (s, 3 H), 3.22 (s, 3 H), 3.4–3.0 (broad m, 1 H), and 2.75–1.50 (m, 12 H).

Anal. Calcd for $C_{12}H_{20}NO_4Cl$: C, 51.89; H, 7.26; N, 5.04. Found: C, 52.12; H, 7.01; N, 4.93.

Registry No.—**8,** 702-98-7; **9,** 65218-97-5; **11a,** 67180-43-2; **11b,** 67180-44-3; **11c,** 67180-45-4; **12** HCl, 65219-01-4; **13,** 67180-48-7; **16,** 67180-46-5; **17,** 67180-49-8; **18a,** 67180-50-1; **18b,** 67180-52-3; **19,** 67180-47-6; dichloroacetyl chloride, 79-36-7; acetyl chloride, 75-36-5; benzoyl chloride, 98-88-4; acetic anhydride, 108-24-7.

References and Notes

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(13) (a) L. F. Johnson and W. C. Jankowski, "Carbon-13 NMR Spectra", Wiley, New York, N.Y., 1972. (b) For 9-azabicyclo[3.3.1]nonane derivatives, see J. R. Wiseman and H. O. Krabbenhoft, *J. Org. Chem.,* **40,** 3222 (1975). (c) These assignments should be considered as tentative.
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Methano-Bridged 10π-Electron Aromatic Annulenes. 4-Methoxy-1,6-methanoisoquinoline

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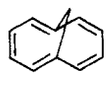
The synthesis of 4-methoxy-1,6-methanoisoquinoline (**2b**), a 10π-electron heterocyclic methano-bridged system, is described. The ring skeleton is generated via a Beckmann rearrangement of tricyclo[4.3.1.$0^{1,6}$]-2,4-decadien-8-one oxime (**3**). Aromatization of the resulting lactam is accomplished by introduction of a methylthio group, its oxidation to a sulfone, amide *O*-methylation, and elimination of methanesulfinic acid. Compound **2b** shows ^1H NMR chemical shifts indicative of a 10π-electron delocalized system.

There have been several examples of aromatic 10π- and 14π-electron methano-bridged systems since the synthesis of 1,6-methano[10]annulene[1] (**1**) but very few have been heterocyclic in nature.[2] Our present concern is with methano-bridged counterparts of indole, quinoline, isoquinoline, carbazole, and similar species from the viewpoint of aromaticity studies and modification of physiological activity in drugs containing such skeletons.



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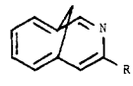

2 (a, R = H; b, R = OCH_3)

The skeletal unit of interest in this work is 1,6-methanoisoquinoline (**2a**), and the synthesis of one of its derivatives, 4-methoxy-1,6-methanoisoquinoline (**2b**) is described.

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