# BRIDGEHEAD BICYCLIC IMINIUM SALTS AND ENAMINES

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Abstract— The preparation of the novel bridgehead bicyclic iminium salts **3** and **4** and the transformation of **3** to the bridgehead bicyclic enamine **7** is described. Their structures are discussed in terms of Bredt's Rule.
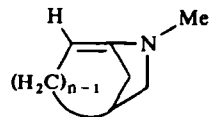
WE DESCRIBE here the formation of the bicyclic iminium salts **3** and **4** from the amino ketone perchlorate precursors **1** and **2** and the failure of **5** to undergo the corresponding transformation to the [4.2.1] bicycle **6**. These transformations, best brought about by heating in refluxing isopropanol (see below for other conditions), were

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1 n = 9	**3** n = 9	**7** n = 9
2 n = 5	**4** n = 5	**8** n = 5
5 n = 4	**6** n = 4	
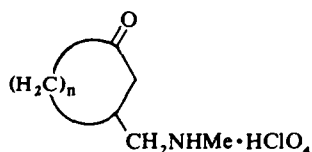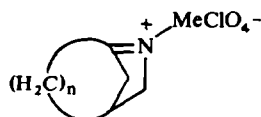
paralleled in the mass spectrometer, where **1** and **2** gave only molecular ions due to **3** minus $HClO_4$, and **4** minus $HClO_4$ whereas the molecular ion shown by **5** corresponded to **5** minus $HClO_4$.

We also found that **3** could be further transformed into the bicyclic enamine **7** by shaking with dilute base, conditions which led only to the hydrolytic cleavage of **4**.

These results bear on the delineation of the limits of Bredt's Rule as it applies to bicyclic bridgehead olefinic heterocycles and represent an extension of the recent elegant work by Marshall and Faubl[2] and Wiseman and Pletcher[1c] and Wiseman *et al.*[1d] on defining the limits of Bredt's Rule in bicyclic bridgehead olefinic carbocyclic systems. In this latter series, preparations of **9**,[1c, 2] and its isomer **10**[1d] the carbocycle analog of **6** was achieved.
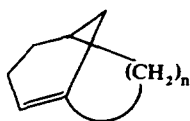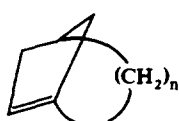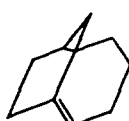
9 n = 3   **10** n = 4   **10a**   **11**

The failure of **5** to form **6**, the heterocyclic analog of **10** does not necessarily mean that **6** is incapable of existence, since the reaction conditions employed in its attempted formation were re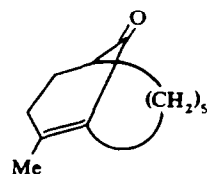versible. (see discussion of the mass spectrum of **5** below.) This is in contrast to the irreversible reactions used by Marshall (pyrolytic elimination of carbon dioxide) and Wiseman (pyrolysis of a quaternary ammonium hydroxide) for introducing the bridgehead double bond. It does, however, suggest that the strain in **6** precludes its isolation under reversible conditions.* A similar conclusion should be drawn from the failure of **4** to form the bicyclic enamine **8** under the reversible conditions employed.

The formation of **4** a [5.2.1] system represents the smallest bridgehead bicycle formed thus far under reversible conditions, a distinction previously held by the [5.3.1] bicycle **11** prepared by Prelog [1a,b] in his now classic study on the limitations of Bredt's Rule.

The formation of the iminium salts **3** and **4** rather than the isomeric protonated enamines (N-protonated **7** and **8**) under the equilibrium conditions described indicates that the iminium bicyclic structure is the more stable. This would be at variance with the conclusions of Wiseman et al.[1d] regarding the relative stabilities of the closely related carbocyclic systems **10** and **10a** based on their molecular model studies, but would be in accord with their experimental results. On the basis of the former Wiseman et al. concluded that **10a** is more stable and invoked a kinetic control argument to explain the predominant formation of **10** from the pyrolysis of a quaternary ammonium hydroxide precursor. If one could extrapolate from our findings, then **10** would be more stable than **10a** and would be expected to predominate on stability considerations alone.

The preparation of the amino ketones **1**, **2** and **5** was accomplished in a quite straight forward manner as outlined in the following equations. The required α, β-unsaturated ketones (A) were obtained by literature procedures (Experimental).

When the conversion of A, n = 4 to B, n = 4 was attempted in MeOH instead of aqueous THF, β-cyano ketone formation was accompanied by the formation of the bicyclic amide **12** with the latter predominating (ca. 65% as indicated by IR, experimental). **12** presumably forms via the indicated sequence.[3]

This same reaction accompanies the formation of B, n = 5 from A, n = 5 in MeOH. The 8-membered analog of **12** is formed in considerably lower relative yield (ca 35% by IR).

The conversion of **1** and **2** to **3** and **4** respectively was best accomplished by heating in i-PrOH. The iminium salts **3** and **4** precipitated directly and were easily isolated by filtration. The conversion of **1** to **3** also took place in ca 3 hr at room temperature in both i-PrOH and benzene. The 8-membered analog **2** was cyclized in i-PrOH at room temperature after 24 hr, but was recovered unchanged after this time in benzene.

The bridgehead bicyclic enamine **7** was formed by briefly shaking **3** in ether with dilute NaOH. Drying and evaporating the ethereal phase left a clear oil whose NMR spectrum showed a broad 1-proton signal at $3·95\,\delta$ due to the vinyl proton, which is within the general region for enamine vinyl proton absorption.[4a] Its mass spectrum showed the anticipated molecular ion at 207 atomic mass units (amu) and its IR spectrum showed a strong peak at $6·02\,\mu$ for the carbon-carbon double bond stretching

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*Experiments designed to detect its *formation* (e.g. NMR monitoring of the mixture) were not done.

1 n = 9
2 n = 5
5 n = 4
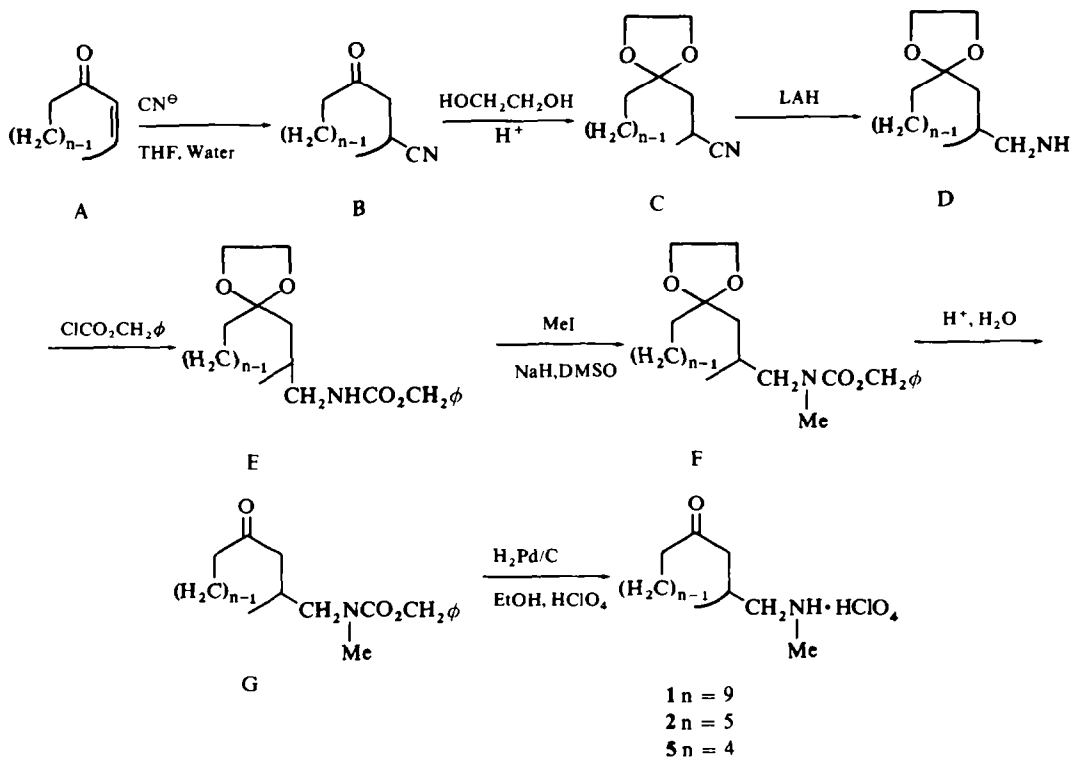
mode in accord with previous observations.[4b] Treatment of 7 in ether with an equivalent of 60% HClO₄ aq gave back 3.

Under the conditions described, 4 could not be transformed into the enamine 8. The product isolated showed a band at 5·9 μ and appeared identical by IR spectroscopy to the product obtained from treating 2 with base.

As already indicated above, the mass spectra of 1 and 2 showed only molecular ions corresponding to 3 minus HClO₄ and 4 minus HClO₄, i.e. the respective enamines 7 and 8. Thus, although 4 could not be transformed to 8 in solution, under the conditions of mass spectral measurement, where the compound is first vaporized into the ion source under high vacuum, the enamine 8 does apparently form.

On the other hand, the mass spectrum of 5 showed only a molecular ion due to 5 minus HClO₄; no molecular ion corresponding to the enamine 6 minus HClO₄ was present. The conditions employed in the mass spectrometric experiment would appear to approach irreversibility in that any water thermally split from 5 would be immediately removed from the reaction site, thus closely parallelling the irreversible

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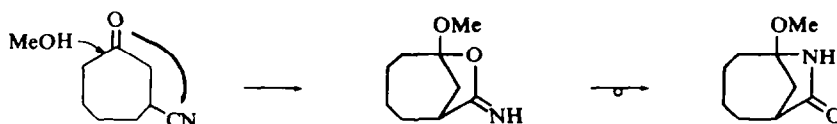
conditions employed by Marshall and Wiseman (especially those of Wiseman). On this basis, the inability of **5** to transform to **6** suggests a real difference in strain energy between the carbocyclic system **10** and its heterocyclic counterpart **6**, it being greater for the latter.

EXPERIMENTAL

M.ps are uncorrected. NMR spectra were determined on a Varian A-60 spectrometer using TMS as internal standard. Mass spectra were determined on an AEI MS-9 spectrometer at 70 eV. Samples were introduced directly into the source at *ca* 150°. MgSO₄ was used for drying. TLC's were run on phosphor containing silica gel plates (Anal., Tech., Newark, Delaware); thick layer chromatograms were run on 2 mm. silica gel plates (E. Merk Ag., Darmstadt, Germany; distributed by Brinkmann Instrument Inc., Westbury, N.Y.).

2-cycloheptanone[5] (A, n = 4). To a stirred soln of cycloheptanone (112 g, 1 mole) in one liter of ethylene glycol (dried over molecular sieves) was added 1·5 ml of Br₂. The bromine color disappeared within ten min. Then 160 g (1 mole) of bromine was added over 1·5 hour at such a rate that a faint yellow color was maintained. Occasional cooling kept the temperature between 25° and 28°. The mixture was poured into a stirred suspension of 250 g of anhyd. Na₂CO₃ in hexane (1l). After continuous stirring for ten min, water (1l) was added. The hexane layer was separated and the aqueous phase extracted thrice with hexane. The combined extracts, were dried and the solvent removed *in vacuo* to yield 198 g of crude 2-bromo-cyclo-heptanone ethylene ketal.

A solution of 197 g (0·84 mole) of crude ketal in 350 ml DMSO was cooled in ice and 136 g (2·52 mole) of NaOMe added over thirty min so that the temperature did not exceed 35°. The thick brown suspension was stirred at room temp, with occasional cooling to maintain below 35°. After four hr the mixture was cooled in ice, diluted with water (1l) and extracted four times with hexane. The combined extracts were dried and the solvent removed *in vacuo* to yield 113 g (0·73 mole) of crude 2-cycloheptenone ethylene ketal. This was dissolved in a mixture of 300 ml THF and 1N H₂SO₄ (40 ml) and stirred at room temp for one hr. After dilution with water (1l) the mixture was extracted four times with hexane. The combined hexane extracts were dried and the solvent removed *in vacuo* to yield 70·0 g (0·64 mole) of 2-cycloheptenone. This was used without further purification.

2-Cyclooctenone[5] (A, n = 5). Cyclooctanone (101 g 0·8 mole) treated in similar manner yielded 58·2 g of 2-cyclooctenone.

2-Cyclododecenol. 2-Cyclododecenol was prepared according to Nozaki *et al.*[6] from cyclododecane epoxide (Aldrich).

2-Cyclododecenone (A, n = 9). 2-Cyclododecenone was prepared from 2-cyclododecenol according to Nozaki *et al.*[6]

6-Methoxy-7-azabicyclo [4.2.1] *nonan-8-one* (**12**). A solution of KCN (520 mg, 8 mmole) in 2 ml water was added to a solution of 2-cycloheptenone (440 mg, 4 mmole) and glacial AcOH (240 mg, 4 mmole) in 15 ml of MeOH. After stirring overnight at room temp the mixture was diluted with water (50 ml) and extracted thrice with CHCl₃. The combined extracts were dried and concentrated *in vacuo* to a gummy solid. The IR spectrum showed a weak band at 4·5 μ, a band of moderate intensity at 5·9 μ and a strong band at 6·1 μ, indicative of a mixture of cyano-ketone and bicyclic lactam. Analytically pure 6-methoxy-7-azabicyclo [4.2.1]nonan-8-One (**12**) (235 mg, 43 %) was readily obtained by crystallization of the crude material from benzene (3 ml). The mass spectrum showed a molecular ion at 169 a.m.u. The IR spectrum showed a strong carbonyl band at 6·1 μ. (Calc. for C₉H₁₅NO₂(169·22): C, 63·88; H, 8·49; N, 8·28. Found: C, 64·01; H, 9·00; N, 8·26%).

7-Methoxy-8-azabicyclo[5.2.1]decan-9-one. A solution of KCN (9·12 g, 0·14 mole) in 13 ml of water was added to a soln of 2-cyclooctenone (8·68 g, 0·07 mole) and glacial AcOH (4·2 g, 0·07 mole) in 100 ml MeOH. After stirring overnight at room temp, the mixture was diluted with water (400 ml) and extracted with four 100 ml portions of CHCl₃. The combined extracts were dried and concentrated *in vacuo* to an orange oil. The IR spectrum showed a nitrile peak at 4·5 μ, a strong carbonyl peak at 5·9 μ and a peak of moderate intensity at 6·1 μ, indicating a mixture of the keto-nitrile and the bicyclic lactam. Upon standing, the oil deposited a small amount of crystalline material. The supernatant oil was decanted and the residual oily crystals pressed on a porous plate. Recrystallization from hexane gave 90 mg of analytically pure 7-methoxy-8-azabicyclo[5.2.1] decan-9-one as white crystals, m.p. 113–115°. The mass spectrum showed a

molecular ion at 183 a.m.u. and the IR spectrum exhibited a strong carbonyl peak at 6·1 μ (Calc. for $C_{10}H_{17}NO_2$ (183·24): C, 65·54; H, 9·35; N, 7·64. Found: C, 65·48; H, 9·45; N, 7·68%).

1·0 g of the total crude was subjected to thick layer chromatography on 2 mm silica plates using benzene: EtOAc, 10:1 as developer. 373 mg of an oil was obtained whose IR spectrum and chromatographic behavior were identical to an authentic sample of 3-cyano-cyclooctanone. The bicyclic lactam present in the crude could not be isolated from the chromatogram.

3-Cyano-cycloheptanone (B, n = 4). A soln of KCN (80·0 g, 1·24 mole) in water (200 ml) was added to a soln of 2-cycloheptanone (68 g, 0·62 mole) and glacial AcOH (37·2 g, 0·62 mole) in THF (1·2 l). The two phase system was refluxed with vigorous stirring for 68 hr. After cooling and diluting with water (2·5 l) the mixture was extracted four times with CH_2Cl_2. The combined extracts were dried and solvent removed *in vacuo* to yield 71·6 g of dark brown oil. Purification was by chromatography on 1500 g of silica gel (100–200 mesh) using benzene: EtOAc, 100:2 as eluent. The yield of purified cyano ketone, as a light amber oil, was 40·0 g (47%). λ_{max}^{KBr} 4·5 μ (C≡N), 5·85 μ (C=O). The mass spectrum showed a molecular ion at 137 a.m.u. The ketone was characterized by conversion to the 2,4-dinitrophenyl hydrazone, m.p. 135–137°. (Calc. for $C_{14}H_{15}N_5O_4$ (312·30): C, 52·99; H, 4·77; N, 22·07. Found: C, 53·10; H, 4·72; N, 22·18%).

3-Cyano-cyclooctanone (B, n = 5) *and 3-cyano-cyclododecanone* (B, n = 9) were prepared in a similar manner.

2-Cyclooctenone (58 g, 0·465 mole) yielded 27·0 g (39%) of *3-cyanocyclooctanone*, m.p. 50–54°, analytical sample from hexane, m.p. 55–56°. λ_{max}^{KBr} 4·5 μ (C≡N), 5·8 μ (C=O). The mass spectrum showed a molecular ion at 151 a.m.u. (Calc. for $C_9H_{13}NO$ (151·20): C, 71·49; H, 8·67; N, 9·26. Found: C, 71·99, 71·45; H, 8·68, 8·72; N, 9·22%).

2-Cyclododecenone (58·0 g, 0·32 mole) yielded 34·0 g (52%) g *3-cyanocyclododecanone*, m.p. 67–71°, analytical sample from hexane, m.p. 69–71°. λ_{max}^{KBr} 4·47 μ (C≡N), 5·86 μ (C=O). The mass spectrum showed a molecular ion at 207 a.m.u. (Calc. for $C_{13}H_{21}NO$ (207·31): C, 75·31; H, 10·21; N, 6·76. Found: C, 75·53; H, 10·32; N, 6·96%).

3-Cyano-cycloalkanone ethylene ketals (C). The ethylene ketals were prepared by refluxing 25–35 g of ketone in benzene (1l) containing ethylene glycol (40 ml) and 0·5 g of p-TsOH for periods ranging from from 5 to 22 hr. A Dean-Stark trap was used to remove water. The yields of crude ketals ranged from 88–93% and were used without further purification in the subsequent step. The crude ketals all showed C≡N stretching at 4·5 μ and the anticipated molecular ion in the mass spectrum.

3-Cyano-cycloheptanone ethylene ketal and 3-Cyano-cyclooctanone ethylene ketal were oils. 3-Cyano-cyclododecanone ethylene ketal was a solid, m.p. m.p. 106–108° after recrystallization from hexane. (Calc. for $C_{15}H_{25}NO_2$ (251·36): C, 71·67; H, 10·03; N, 5·57. Found: C, 71·51; H, 10·06; N, 5·40%).

3-Aminomethylcycloalkanone ethylene ketals (D). LAH reduction of the 3-cyano cycloalkanone ethylene ketals gave the corresponding 3-aminomethyl cycloalkanone ethylene ketals in yields of 84–98%. A soln of 3-cyano-cycloheptanone ethylene ketal (41·5 g, 0·23 mole) in ether (700 ml) was added with stirring over 1·5 hr to a slurry of LAH (15·2 g, 0·4 mole) in ether (600 ml). After stirring for 30 min at room temp, the mixture was refluxed for two hr, cooled in an ice bath and water (15 ml), 15% NaOH aq (15 ml) and water (46 ml) were cautiously added. The white precipitate was removed by filtration and thoroughly ether washed. The combined filtrate and washings were dried and the solvent removed *in vacuo* to yield 35·8 g (84%) of 3-aminomethylcycloheptanone ethylene ketal (D, n = 4) as clear oil. The IR spectrum showed a broad N-H peak centered at 3·0 μ and no nitrile or carbonyl peaks. The mass spectrum exhibited a molecular ion at 185 a.m.u. This material was used without further purification. Similarly, 3-cyano-cyclooctanone ethylene ketal (26·0 g, 0·133 mole) gave 26·0 g (98%) of 3-aminomethylcyclooctanone ethylene ketal (D, n = 5) and 3-cyanocyclododecanone ethylene ketal (31·0 g, 0·123 mole) gave 29·0 g (92%) of 3-aminomethylcyclododecanone ethylene ketal (D, n = 9).

3-(N-Carbobenzyloxyaminomethyl)cycloalkanone ethylene ketals (E). These derivatives were prepared in the usual manner. A soln of 3-methylamino-cyclooctanone ethylene ketal (24·0 g, 0·12 mole) and Et_3N (20·2 g, 0·2 mole) in ether (500 ml) was cooled in ice A soln of carbobenzyloxy chloride (20·4 g, 0·12 mole) in ether (600 ml) was added dropwise with stirring over 1·7 hr, and stirring at 5° continued for an additional hr. The white precipitate was removed by filtration. The filtrate was washed with sat. $NaHCO_3$ aq and water. The ethereal soln was dried and concentrated *in vacuo* to yield 35 g of oil which solidified on standing. This material was slurried in 50 ml of hexane and the white crystals collected by filtration. The yield of 3-(N-carbobenzyloxy-methylamino)-cyclooctanone ethylene ketal (E, n = 5) was 29·5 g (74%), m.p. 58–61°, analytical sample from hexane, m.p. 61°–62°; λ_{max}^{KBr} 3·0 μ (N—H), 5·86 μ (C=O). (Calc. for $C_{19}H_{27}NO_4$ (333·41): C, 68·44; H, 8·16; N, 4·20. Found: C, 68·47; H, 8·27; N, 4·12%).

3-Aminomethyl-cyclododecanone, ethylene ketal (25·5 g, 0·1 mole) yielded 36·9 g (95 %) of the corresponding carbobenzyloxy derivative (E, n = 9) as an oil.

This was used subsequently without further purification. 360 mg of crude product was purified by thick layer chromatography on silica gel (2 mm) using hexane: EtOAc, 4:1 and subsequent crystallization from hexane to yield 221 mg of analytically pure 3-(N-carbobenzyloxy-aminomethyl)-cyclododecanone ethylene ketal (E, n = 9) m.p. 65–67°. λ_{max}^{KBr} 3·02 μ (NH), 5·87 μ (C=O). The mass spectrum showed a molecular ion at 389 a.m.u. (Calc. for $C_{22}H_{35}NO_4$ (389·52): C, 70·92; H, 9·06; N, 3·60. Found: C, 70·98: H, 9·26; N, 4·06, 3·83 %).

In similar manner 3-(N-Carbobenzyloxy-aminomethyl)-cycloheptanone ethylene ketal (E, n = 4) was obtained in 75% yield as a pale yellow oil, which could not be crystallized. The IR spectrum showed a sharp N–H band at 3·0 μ and a strong, broad carbonyl band centered at 5·85 μ. This was used without purification.

3-(N-*Carbobenzyloxy-N-methylaminomethyl)cycloalkanone ethylene ketals* (F). N-Methylation was carried out using MeI and NaH in DMSO. NaH (50%) in oil: 2·64 g, (55·2 mmole) was washed thrice with hexane to remove oil and then suspended in DMSO (40 ml). A solution of 3-(N-carbobenzyloxy-aminomethyl) cycloheptanone ethylene ketal (8·8 g, 27·6 mmole) in DMSO (20 ml) was added dropwise with stirring over one hr. After stirring an additional hr at room temp, MeI (8·8 ml) was added dropwise with stirring and occasional cooling over thirty min. The mixture was stirred at room temp overnight, then cooled in ice and a few ml of EtOH added, followed by cold water (200 ml). 7·0 g of crude 3-(N-carbobenzyloxy-N-methylaminomethyl)-cycloheptanone ethylene ketal (F, n = 4) was obtained as a pale amber oil by hexane extraction, drying and removing the solvent *in vacuo*. The mass spectrum showed a molecular ion at 333 a.m.u.

In a similar manner 3-(N-carbobenzyloxy-N-methylaminomethyl) cyclooctanone ethylene ketal (F, n = 5) was obtained in 85% yield as a pale yellow oil. The mass spectrum exhibited a molecular ion at 345 a.m.u. and the IR spectrum showed a strong carbonyl band at 5·87 μ and no N–H absorption.

3-(N-*carbobenzyloxy N-methylaminomethyl) cyclododecanone Ethylene ketal* (F, n = 9) was obtained in 49% yield as white crystals, m.p. 75–76. The IR spectrum showed no N–H absorption. The mass spectrum showed a molecular ion at 403 a.m.u. (Calc. for $C_{24}H_{37}NO_4$ (403·54): C, 71·43: H, 9·24. N, 3·47. Found. C, 71·05, H, 9·31; N, 3·47 %).

3-(N-*Carbobenzyloxy-N-methylaminomethyl) cycloalkanones* (G). Hydrolysis of the ketals was readily accomplished by stirring a solution of the ketal in EtOH containing 25% 1N HCl at room temp. Thus a soln of 3-N-carbobenzyloxy-N-methylaminomethyl cycloheptanone ethylene ketal (6·5 g 19·5 mmole) in 100 ml EtOH and 25 ml of 1N HCl aq was stirred at room temp for four hr, the mixture diluted with water (300 ml) and extracted four times with hexane. The combined extracts were dried and concentrated to a pale yellow oil *in vacuo*. The yield of crude ketone was 4·5 g. Purification was achieved by partition chromatography on celite, using heptane–MeOH The yield of pure ketone G, (n = 4) was 2·52 g (45 %). The mass spectrum showed a molecular ion at 289 a.m.u. The IR spectrum showed a strong broad carbonyl peak at 5·85 μ with a shoulder at 5·72 μ. (Calc. for $C_{17}H_{23}NO_3$ (289·36): C, 70·49; H, 8·01; N, 4·84. Found: C, 70·92, 70·56; H, 8·20, 8·12; N, 4·94 %).

3-(N-*Carbobenzyloxy N-methylaminomethyl) cyclooctanone* (G, n = 5) was obtained as an oil in 63% yield after purification by thick layer chromatography on silica gel using benzene: MeOH, 4:1. The mass spectrum showed a molecular ion at 303 a.m.u. The IR spectrum exhibited a broad carbonyl peak at 5·87 μ. The compound was further characterized by conversion to the semicarbazone, m.p. 140–142. (Calc. for $C_{19}H_{28}N_4O_3$ (360·45): C, 63·31; H, 7·83: N, 15·55. Found: C, 62·97, H, 7·86; N, 15·02, 15·50 %).

3-(N-*carbobenzyloxy-N-methylaminomethyl) cyclododecanone* (G, n = 9) was obtained in 90% yield as a clear oil showing one spot on TLC (silica gel: hexane: EtOAc, 4: 1). The mass spectrum showed a molecular ion at 359 a.m.u. This material was used without further purification in the subsequent step.

3-(N-*Methyl-aminomethyl)-cycloheptanone perchlorate* (5). Perchloric acid (60% aq, 0·3, *ca*, 2·7 mmole) was added to a soln carbobenzyloxy-N-methyl aminomethyl)-cycloheptanone (574 mg, 2·0 mmole) in 65 ml EtOH. The system was flushed with N_2 and 175 mg of 10% Pd/C added. Hydrogen was passed through the mixture for twenty-five min, and after flushing with N_2, the catalyst was removed by filtration. The filtrate was concentrated *in vacuo* to near dryness and the residue redissolved in 3 ml of EtOH. This solution was added with vigorous stirring to ether (100 ml). A waxy solid precipitated which gradually solidified upon cooling and was collected by filtration, washed with ether and dried *in vacuo*. The yield of 3-(N-methylaminomethyl) cycloheptanone perchlorate was 336 mg (71 %), m.p. 105°–108°. In contrast to the corresponding cyclooctanone and cyclododecanone compounds, the mass spectrum showed a strong molecular ion at 155 a.m.u. and

no ion of any size at $M^+ - 18$. The IR spectrum exhibited a sharp carbonyl band at 5·9 μ (Calc. for $C_9H_{17}NO$. $HClO_4$ (255·7): C, 42·27; H, 7·10; N, 5·47; Cl, 13·86. Found: C, 42·73, 42·45; H, 7·11, 7·23; N, 5·43; Cl, 13·67%).

3-(*N-methylaminomethyl*) *cyclooctanone perchlorate* (2). $HClO_4$ (60% aq, 1·8 ml, *ca.* 17 mmole) was added to a solution of 3-(N-carbobenzyloxy-N-methylaminomethyl)cyclooctanone (3·0 g, 10 mmole) in 125 ml EtOH. The system was flushed with N_2 and 1·0 g of 10% Pd/C added. After passing H_2 through for thirty min the mixture was processed as above to yield 1·65 g (61%) of the aminomethyl cyclooctanone perchlorate 2, m.p. 123–125°. The mass spectrum showed a weak molecular ion at 169 a.m.u. and a strong ion at 151 a.m.u. corresponding to the enamine 8 (Calc. for $C_{10}H_{17}N$: 151·13609; observed: 151·13603). The IR spectrum exhibited a carbonyl peak at 5·92 μ. (Calc. for $C_{10}H_{19}NO \cdot HClO_4$ (269·75): C, 44·53; H, 7·47; N, 5·20; Cl, 13·14. Found: C, 44·69; H, 7·48; N, 5·08; Cl, 13·16%).

3-(*N-Methylaminomethyl*) *cyclododecanone perchlorate* (1). Perchloric acid (60% aq, 0·33 ml. *ca.* 3 mmole) was added to a solution of 3-(N-carbobenzyloxy-N-methylaminomethyl)cyclododecanone (0·7 g, 1·95 mmole) in EtOH (100 ml). The system was flushed with N_2 and 200 mg of 10% Pd/C added, and the mixture hydrogenated as above. The yield of 3-(N-methylaminomethyl)cyclododecanone perchlorate (1) was 533 mg. (84%), m.p. 78–80°. The IR spectrum exhibited a strong band at 5·87 μ. The mass spectrum did not show a molecular ion, but did exhibit a strong ion at 207·1994, corresponding to the cyclic enamine 7 (calc. 207·1987). (Calc. for $C_{14}H_{27}NO \cdot HClO_4$ (325·83): C, 51·61; H, 8·66, N, 4·30; Cl, 10·88. Found: C, 51·28; H, 8·42; N, 4·22; Cl, 11·07%).

Attempted preparation of 7-*methyl*-7-*azoniabicyclo*[4.2.1]*non*-6-*ene perchlorate* (6). A soln of 3-(N-methylaminomethyl)cycloheptanone perchlorate (5) (100 mg) in 2 ml of i-PrOH was refluxed for 1·5 hr and allowed to stand at room temp overnight. Removal of solvent *in vacuo* and trituration of the residual oil with ether gave 81 mg of off-white solid. This material was identical to starting material by IR and m.p. The mass spectrum showed a molecular ion at 155 a.m.u. and no significant ion at 137 a.m.u. (M—18).

8-*Methyl*-8-*azoniabicyclo*[5.2.1.]-*dec*-7-*ene perchlorate* (4). 3-(N-methylaminomethyl)-cyclooctanone perchlorate (2·0 g, 7·4 mmole) was slurried in i-PrOH (15 ml). After refluxing for a few min, a clear soln formed. After thirty min refluxing, a solid began precipitating. The refluxing was continued for twenty min and the mixture cooled in ice. The white crystals were collected, ether washed and dried *in vacuo*. The yield of 8-methyl-8-azoniabicyclo[5.2.1]dec-7-ene perchlorate, (4) was 1·54 g (83%), m.p. darkens at 260° and decomposes explosively above 300°. The mass spectrum showed a molecular ion at 151 a.m.u. and the IR spectrum exhibited a band at 5·98 μ (C =N). (Calc. for $C_{10}H_{18}N^+ ClO_4 -$ (251·7): C, 47·72; H, 7·21; N, 5·57; Cl, 14·09. Found: C, 47·85; H, 6·96; N, 5·51; Cl, 13·99%).

The cyclic enamine perchlorate (4) could also be obtained by allowing a solution of the amino-ketone perchlorate in i-PrOH to stand at room temp. The amino-ketone perchlorate was stable in benzene at room temp for 24 hr or at reflux for 2·5 hr.

12-*Methyl*-12-*azoniabicyclo*[9.2.1]*tetra-dec*-11-*ene perchlorate* (3). A soln of 3-(N-methyl-aminomethyl) cyclododecanone perchlorate (1) (1·04 g, 3·2 mmole) in i-PrOH (12 ml) was refluxed for one hr. After cooling in ice, the white crystals which precipitated were collected and dried *in vacuo*. The yield of 12-methyl-12-azoniabicyclo[9.2.1]tetra-de-11-ene perchlorate (3) was 0·924 g (92%); m.p. 138–139°. λ_{max}^{KBr} 5·98 μ. The mass spectrum showed a molecular ion at 207 a.m.u. (Calc. for $C_{14}H_{26}N^+ ClO_4 -$ (307·8): C, 54·61; H, 8·52; N, 4·55; Cl, 11·52. Found: C, 54·54; H, 8·63; N, 4·27; Cl, 11·42%). Conversion of 1 to 3 was also accomplished in either i-PrOH or benzene at room temp in three hr.

Attempted isolation of 8-*methyl*-8-*azabicyclo*[5.2.1]*dec*-6-*ene* (8). A slurry of 8-methyl-8-azoniabicyclo [5.2.1]dec-7-ene perchlorate (4) (80 mg) in ether (10 ml) was shaken with 0·5N NaOH aq (8 ml). The clear ether solution was separated and water washed. After drying, the solution was concentrated to an oil *in vacuo*, which showed no vinyl protons in the NMR and a band at 5·9 μ in the IR. An oil with the same characteristics was obtained when the perchlorate salt 4 was neutralized with NaOMe in MeOH. This material appeared to be identical (IR) to the product obtained by neutralizing 3-(N-methylaminomethyl) cyclooctanone perchlorate (2) with NaOMe in MeOH.

12-*Methyl*-12-*azabicyclo*[9.2.1]*tetradec*-10-*ene* (7). A suspension of 12-methyl-12-azoniabicyclo[9.2.1] tetradec-11-ene perchlorate (3) (25 ml) was shaken with 20 ml of 0·5N NaOH. The clear ethereal soln was separated, washed with water and dried. The solvent was removed at or below room temp, *in vacuo* to give 104 mg of clear oil. This material exhibited a broad peak in the NMR at 3·95 δ, attributable to a vinyl proton. The IR spectrum showed a strong band at 6·02 μ (C=C) and the mass spectrum a molecular ion at 207 a.m.u. These data are consistent with the formulated bicyclic enamine structure 7. Upon standing, (cold room, desiccator) the *crude* oil rapidly turned yellow, the 6·02 μ band in the IR decreased, a new band

at 5·9 μ appeared and the peak at 3·95 δ in the NMR disappeared.* When 50 mg of freshly prepared en-amine was dissolved in ether and treated with an equivalent of 60% $HClO_4$ aq, a solid was obtained (27%) which was identical to a sample of authentic 12-methyl-12-azoniabicyclo[9.2.1]tetradec-11-ene perchlorate (3).

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* We emphasize the word crude because of the following observation. A sample of the crude product which had been pressed between salt plates to form a film for IR measurement showed a considerably longer lifetime (90 hrs, stored as indicated for the bulk crude. The spectrum measured again after this time was essentially unchanged). The apparent difference in lifetime observed for the bulk crude and the salt plate film could be due to the removal of certain trace impurities (e.g. water) by the plates which accelerated the decomposition of the enamine.