# 3-Azatricyclo[4.1.0.$0^{2,5}$]heptanes: Synthons for Novel Monocyclic 1,4-Dihetero Seven-membered Ring Compounds

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Heating the 3-azatricyclo[4.1.0.$0^{2,5}$]heptanes (**2**) prepared from pyridine *via* 2-azabicyclo[2.2.0]hex-5-enes (**1**) results in ring opening to give the corresponding 1,4-dihetero seven-membered ring compounds (**3**).

Recently, the synthesis of new conjugated seven-membered heterocyclic rings has been the object of extensive study.[1] We have reported the first syntheses of fused 1,2-,[2] 1,3-,[3] and 2,3-diazepines[4] condensed with aromatic rings such as benzene, thiophene, furan, or pyrrole. The monocyclic dihetero seven-membered ring compounds, 1,2-[5] and 1,3-diazepines[6] and 1,3-oxazepines[1] are known, but the synthesis of the corresponding 1,4-dihetero compounds has not been reported. We report that the title tricyclic compounds, readily prepared from pyridine, are useful synthons for these novel hetero seven-membered ring compounds.

2-Azabicyclo[2.2.0]hex-5-ene (**1**)[7] was prepared from pyridine by $NaBH_4$ reduction in the presence of methyl chloroformate followed by irradiation. The key tricyclic compounds (**2a**—**d**) were prepared from (**1**) by the following procedures.† Treatment of (**1**) with *m*-chloroperbenzoic acid gave the 7-oxa compound (**2a**) (m.p. 55—56 °C, 90% yield). The reaction of (**1**) with ethoxycarbonylnitrene generated from *N*-ethoxycarbonyl-*p*-nitrobenzenesulphonamide[8] by treatment with triethylamine gave the 7-aza compound (**2b**) (oil, 75% yield). Succinimide-*N*-sulphenyl chloride[9] reacted with the double bond of (**1**) to give a mixture of the 5-chloro-6-(*N*-succinimidothio)-adduct and its regioisomer, which was then reduced with $LiAlH_4$ in diethyl ether at −75 °C to give the 7-thia compound (**2c**) (m.p. 25—27 °C, 85% yield). Treatment of (**1**) with diazomethane in the presence of copper(I) chloride[10] afforded the 7-methylene compound (**2d**) (oil, *ca.* 40% yield).

Heating the tricyclic compounds (**2a**—**d**) in refluxing xylene or toluene resulted in ring opening to give the novel dihydro-1,4-dihetero seven-membered ring compounds (**3a**—**c**) and 2,5-dihydroazepine (**3d**) in 80—90% yields.‡ Similarly, heating compound (**4**) prepared from *N*-benzyl-2-pyridone by

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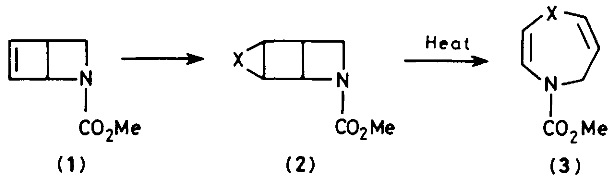
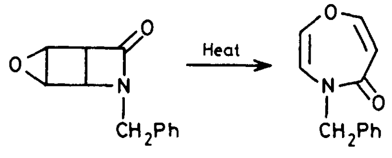
† Satisfactory elemental analyses and spectral data were obtained for the tricyclic compounds (**2**), *e.g.*, (**2a**): i.r. $\nu_{max}$ ($CHCl_3$) 1690 $cm^{-1}$ (C=O); $^1H$ n.m.r. $\delta$ ($CDCl_3$) 2.98 (1H, m, 5-H), 3.69 (3H, s, $CO_2Me$), 3.92 and 4.11 (each 1H, m, 4-$H_2$), 4.08 and 4.26 (each 1H, m, 1- and 6-H), and 4.45 (1H, m, 2-H). The stereochemistry of (**2**) is not known at present.

‡ Satisfactory elemental analyses and spectral data were obtained for the new dihetero seven-membered ring compounds (**3**) and (**5**), *e.g.*, (**3a**): b.p. (2.5 mmHg) 87—88 °C; i.r. $\nu_{max}$ ($CHCl_3$) 1700 $cm^{-1}$ (C=O); $^1H$ n.m.r. $\delta$ ($CDCl_3$) 3.77 (3H, s, $CO_2Me$), 4.21 (2H, dd, 5-H), 4.91 (1H, m, 6-H), 5.63 (1H, d, 3-H), 5.97 (1H, d, 2-H), 6.32 (1H, m, 7-H), $J_{2,3}$ 6, $J_{5,6}$ 5, $J_{6,7}$ 7, and $J_{5,7}$ 1.5 Hz; (**3b**—**d**): oil; (**5**): m.p. 106—107 °C; i.r. $\nu_{max}$ (KBr) 1660 $cm^{-1}$ (C=O); $^1H$ n.m.r. $\delta$ ($CDCl_3$) 4.63 (2H, s, $CH_2Ph$), 5.06 (1H, d, 3-H), 5.12 (1H, d, 6-H), 5.75 (1H, d, 2-H), 6.43 (1H, d, 7-H), 7.3—7.6 (5H, m, Ph-H), $J_{2,3}$ 6 and $J_{6,7}$ 7 Hz.



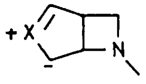
(1) (2) (3)

a; X = O
b; X = $NCO_2Et$
c; X = S
d; X = $CH_2$



(4) (5)

(6)



(7)

irradiation followed by peracid oxidation gave the 5-oxo-1,4-oxazepine (**5**) (m.p. 106—107 °C, 90% yield).

Although it is well known that cyclobutene ring systems undergo thermal electrocyclic ring opening, little has been reported of such a reaction in fully saturated molecules similar to the present system. To cite one example,[11] the thermolysis of bicyclo[2.1.0]pentane yields penta-1,4-diene as a minor product in only 0.4% yield together with cyclopentene. The isomerization of (**2**) into (**3**) may proceed *via* homolytic bond fission to the biradical intermediate (**6**) followed by ring opening of the azetidine ring. However, for compounds (**2a**—**c**) with a hetero atom in the 7-position, the ionic mechanism *via* intermediate (**7**) also seems likely, analogous to the thermal isomerization of butadienyloxiranes.[12]

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