Synthesis of Potassium 3-Methyl-9-oxo-1,4-diazatricyclo-[5.2.0.0^{4,6}]non-2-ene-2-carboxylate

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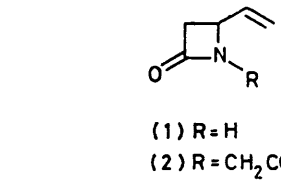
Summary The novel 9-oxo-1,4-diazatricyclo[5.2.0.0^{4,6}]non-2-ene ring system has been synthesised.

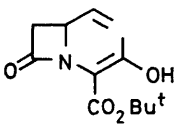
THE intramolecular cycloaddition between an olefin and an azido-group has been used to prepare a range of compounds

which contain an additional nitrogen atom in the ring fused to the β-lactam.[1] This work has now been extended to *include* the reaction between a vinyl azide and a double bond.

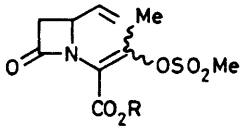
Alkylation of 4-vinylazetidin-2-one (**1**)[2] using t-butyl bromoacetate in the presence of powdered potassium hydroxide in tetrahydrofuran–dimethylformamide (THF–DMF, 3:1) gave the liquid ester (**2**)† (80%). Reaction of the ester enolate of (**2**), generated by means of lithium hexamethyldisilazide in THF at −76 °C, with acetyl chloride provided the β-keto-ester (**3**),† which was largely enolised as shown. Treatment of the enol (**3**) with methanesulphonyl chloride and triethylamine in methylene dichloride at −10 °C then gave the methanesulphonate (**4**)† (98%), as a mixture of geometrical isomers (ratio *ca.* 1:1), ν_{max} ($CHCl_3$) 1760 (β-lactam) and 1720 (ester) cm^{-1}; δ($CDCl_3$) 2·21 and 2·46 (=CCH_3) and 3·17 and 3·18 (SO_2CH_3).



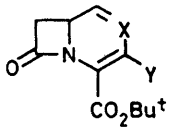
(1) R = H
(2) R = $CH_2CO_2Bu^t$



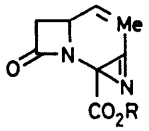
(3)



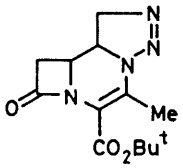
(4) R = Bu^t
(5) R = H
(6) R = $SiPh_2Bu^t$



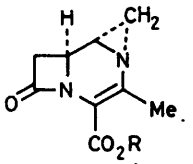
(7) X = N_3, Y = Me
(8) X = Me, Y = N_3



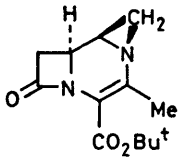
(9) R = Bu^t
(10) R = $SiPh_2Bu^t$



(11)



(12) R = Bu^t
(13) R = $SiPh_2Bu^t$
(14) R = K



(15)

The methanesulphonate (**4**) was vigorously stirred with powdered sodium azide in DMF to give the vinyl azide as a mixture of separable geometrical isomers (**7**) and (**8**), (ratio *ca.* 1:1). The *E*-isomer (**8**) was stable at room temperature, but was converted into the azirine (**9**)† on heating at reflux in benzene for 20 min. In the case of the *Z*-isomer (**7**), complete disappearance of the azide band in the i.r. spectrum occurred after 18 h at room temperature. Trituration of the product with ether gave the 1,2,3-triazoline (**11**) as a crystalline solid, δ($CDCl_3$) 4·34 and 4·64 (ABq, N–CH_2–, *J* 18 Hz, each part showing further coupling of 7 and 11 Hz, respectively). Refluxing in benzene for 5 min quantitatively converted this material (**11**) into the aziridine (**12**),†‡ m.p. 142—144 °C, λ_{max}(EtOH) 277 nm (ε 13,000); ν_{max} (Nujol) 1750 (β-lactam), 1695 (ester), and 1595 (double bond) cm^{-1}; δ($CDCl_3$) 1·38 (aziridine C–H, *J* 3·3, 1·0, and *ca.* 0·5 Hz), 1·53 (9H, s), 2·29 (3H, s), 2·55 (one of aziridine –CH_2–, *J* 4·6, 1·0, and *ca.* 0·5 Hz), 2·68 (one of aziridine –CH_2–, *J* 4·6, 3·3, and 3·5 Hz), 2·80 and 3·42 (2H, ABq, *J* 14·6 Hz, each part showing further fine coupling of 2·5 and 5·2 Hz, respectively), and 3·02 (β-lactam –CH–). The dihedral angles between the C(6) and C(7) protons for the structures (**12**) and (**15**) are *ca.* 110 and 30 °, the observed coupling constant being *ca.* ½ Hz. This leads to the assignment of (**12**) as the more likely structure for the aziridine product.

The t-butyl ester of (**12**) could not be cleaved without disrupting the ring system; however, more success was achieved using a silyl ester. Treatment of (**4**) with trifluoroacetic acid afforded the acid (**5**), which was re-esterified with t-butyldiphenylsilyl chloride to give (**6**)† as a mixture of geometrical isomers (ratio *ca.* 1:1). Progression of (**6**) as previously described then provided (**10**)† (25%), and the aziridine (**13**)† (27%), m.p. 145—146 °C. Removal of the ester protecting group using potassium fluoride/18-crown-6 in THF then gave the potassium salt (**14**)† (70%) as an amorphous solid, λ_{max}(EtOH) 261 nm (ε 11,100). The product was antibacterially inactive. All compounds showed the expected spectroscopic properties.

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† Satisfactory elemental analysis and/or accurate mass data were obtained.

‡ This and all other compounds are (±) mixtures, but only one enantiomer is depicted for convenience.

[1] C. L. Branch and M. J. Pearson, *J. Chem. Soc., Chem. Commun.*, preceding Communication.
[2] T. Durst and M. J. O'Sullivan, *J. Org. Chem.*, 1970, **35**, 2043.