

## Ring Enlargement of Bicyclo[3.3.1]nonan-2-one with Diazomethane

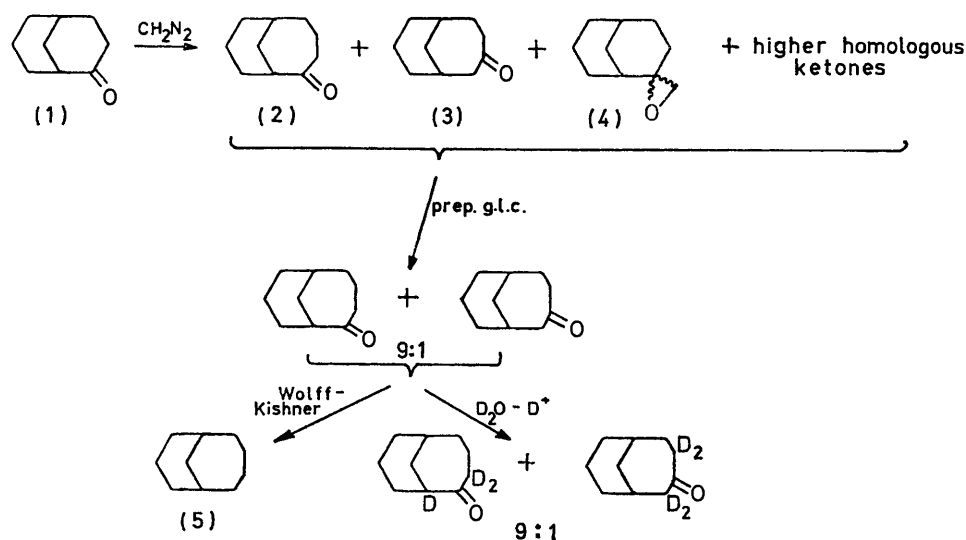
By Francesco Del Cima and Francesco Pietra,\* Department of Chemistry, Università di Pisa, 56100 Pisa, Italy

Bicyclo[3.3.1]nonan-2-one reacted with ethyl *N*-nitrosomethylcarbamate to give bicyclo[4.3.1]decan-2- and -3-one, reduction of which gave the parent bicyclodecane, and a small amount of bicyclo[3.3.1]nonane-2-spiro-oxiran.

THERE is continuing interest in application of the reactions of bridged ketones with diazoalkanes<sup>1</sup> and of bridged  $\beta$ -amino-alcohols with nitrous acid<sup>2</sup> to the synthesis of higher homologues of the bridged systems. Skeletons which have been recently obtained by such methods include bicyclo[3.3.3]undecane,<sup>1a</sup> bicyclo[5.2.1]decane,<sup>1b</sup> bicyclo[4.2.1]nonane,<sup>1b,2c</sup> bicyclo[3.2.1]octane,<sup>1b,2b,c</sup> bicyclo[3.1.1]heptane,<sup>1c</sup> homodiamantane,<sup>1d</sup> and bishomoadamantane.<sup>2a</sup> However, synthesis of the

mixture from which bicyclo[4.3.1]decan-2- (2) and -3-one (3) (3:2) could be easily separated from unchanged (1) and minor products by g.l.c. However, the separation of the ketones (2) and (3) from one another proved difficult: we were only able to obtain a 9:1 mixture by g.l.c.

Wolff-Kishner reduction of a mixture of the ketones (2) and (3) smoothly led to the parent bicyclo[4.3.1]decane (5), identified from its <sup>1</sup>H n.m.r. spectrum, which



bicyclo[4.3.1]decane system has received only scanty attention and problems of its conformational analysis and reactivity have not been touched. The skeleton is not included in an extensive recent list of bridged bicyclic hydrocarbons the conformational energies of which have been calculated.<sup>2d</sup> The parent hydrocarbon has not been reported, but the bicyclo[4.3.1]decan-10-one system has been made from cyclohexanones carrying an olefinic  $\alpha$ -side-chain<sup>3</sup> and from cycloheptanones carrying an aldehydic  $\alpha$ -side-chain,<sup>4</sup> and bicyclo[4.3.1]deca-2,4,7-triene has been obtained as an iron carbonyl complex by thermal rearrangement of a bicyclo[3.2.2]decadieneiron complex.<sup>5</sup>

We report here an approach to bicyclo[4.3.1]decane involving the diazoalkane reaction. Treatment of bicyclo[3.3.1]nonan-2-one (1) with 3 equiv. of ethyl *N*-nitrosomethylcarbamate in methanol-ether gave a

shows signals for the two bridgehead protons at lower field than those for the sixteen methylene protons, and by the mass spectrum, which shows fragmentation of the molecular ion by loss of either the three-carbon bridge (metastable  $m^*$  66.8) or the four-carbon bridge ( $m^*$  48.7), or by loss of a neutral fragment of mass 41 (C<sub>3</sub>H<sub>5</sub>) ( $m^*$  68.2). Thus compounds (2) and (3) must also have the bicyclo[4.3.1]decane skeleton. The mass spectrum of the mixture shows the expected molecular ion.

In order to establish which ketone was which, the 9:1 mixture was deuterated in CH<sub>3</sub>OD-D<sub>2</sub>O under acidic conditions, giving a mixture of deuterated ketones. G.l.c.-mass spectroscopy showed two peaks

<sup>1</sup> (a) N. J. Leonard and J. C. Coll, *J. Amer. Chem. Soc.*, 1970, **92**, 6685; (b) G. Fachinetti, F. Pietra, and A. Marsili, *Tetrahedron Letters*, 1971, 393; (c) T. Gibson, *J. Org. Chem.*, 1972, **37**, 700; (d) I. Tabushi, Y. Aoyama, N. Takahashi, T. M. Gund, and P. v. R. Schleyer, *Tetrahedron Letters*, 1973, 107.

<sup>2</sup> (a) T. Sasaki, S. Eguchi, T. Toru, and K. Itoh, *J. Amer. Chem. Soc.*, 1972, **94**, 1357; (b) E. Volpi and F. Pietra, *Tetrahedron Letters*, 1972, 4867; (c) E. Volpi, F. Del Cima, and F. Pietra, *J.C.S. Perkin I*, 1974, 703; (d) E. M. Engler, J. D. Andose, and P. von R. Schleyer, *J. Amer. Chem. Soc.*, 1973, **95**, 8005.

<sup>3</sup> R. D. Sands, *J. Org. Chem.*, 1964, **29**, 2488; 1969, **34**, 2794.

<sup>4</sup> F. Leyendecker, G. Mandville, and J. M. Conia, *Bull. Soc. chim. France*, 1970, 549.

<sup>5</sup> R. Anmann, *Angew. Chem. Internat. Edn.*, 1971, **10**, 190.

in the ratio 9 : 1,  $M^+$  155 and 156, respectively. This suggests that the major ketone has structure (2).

The diazomethane reaction also afforded a low yield of the oxiran(s) (4). This contrasts with the case of norcamphor, which reacts with diazomethane under similar conditions to give a variety of ring-enlarged ketones but no oxiran.<sup>1b</sup> In the light of previous reasoning,<sup>1b,2c</sup> it is tempting to attribute formation of (4) to a lesser strain in the closure of the oxiran ring, than in the case of norcamphor.<sup>1b</sup> However, conformational factors in the betaine intermediate may also be important,<sup>1b,2b,c</sup> and these cannot be assessed without knowing the preferred direction of attack of diazomethane on the carbonyl system. Along with the results of similar stereochemical studies of the ring enlargement of norcamphor<sup>2b</sup> and bicyclo[3.2.1]octan-2-one<sup>2c</sup> with diazomethane, such knowledge would help to clarify, for reasons which have been previously discussed,<sup>2b,c</sup> (i) why in the case of compound (1) migratory aptitudes for secondary and tertiary carbon do not differ much from one another and (ii) why compound (1) is less reactive toward ethyl *N*-nitrosomethylcarbamate than other ketones containing a cyclohexanone system. The order of decreasing reactivity, established by previously described techniques,<sup>1b,2c</sup> is cyclohexanone ~ bicyclo[3.2.1]octan-2-one > cyclopentanone ~ norcamphor ~ bicyclo[3.3.1]nonan-2-one.

#### EXPERIMENTAL

Analytical g.l.c. was carried out on a Perkin-Elmer 810 or a Hewlett-Packard 5740A or 5750 instrument. For preparative g.l.c. an Autoprep 705 instrument was used. Coupling with a mass spectrometer was achieved by use of capillary columns. <sup>1</sup>H N.m.r. spectra were taken with a JEOL PS 100 spectrometer for solutions in C<sub>6</sub>D<sub>6</sub> with Me<sub>4</sub>Si as internal standard.

*Bicyclo[4.2.1]decan-2-* (2) *and -3-one* (3).—To a mixture of bicyclo[3.3.1]nonan-2-one (1) (5 g) [obtained, under previously reported conditions,<sup>6</sup> in a better yield (75%, from 0.24 mol of the morpholino-intermediate) than previously stated (56%)<sup>6</sup>] and a catalytic amount of anhydrous potassium carbonate in methanol (100 ml) and diethyl ether (50 ml), ethyl *N*-nitrosomethylcarbamate (3 equiv.) was added with stirring, with the temperature kept below 40°. After one day, g.l.c. analysis (2 m 15% polypropylene glycol on Chromosorb W) revealed three main peaks in the ratio 1.5 : 1.5 : 1 (in order of increasing retention time). The first peak corresponded to unchanged (1) and both the second and third gave a mass spectral molecular ion at  $m/e$  152. Preparative g.l.c. (2 m silicone column) allowed the separation of a crystalline 9 : 1 mixture corresponding to the second [ $m/e$  152 (3.3%), 134 (1.2), 119 (1.7), 110 (3.3), 109 (2.4), 108 (3.3), 97 (4.6), 84 (5.0), 81 (10), 79 (3.9), and 67 (0.6)] and third peaks (because of partial overlapping of bands, no clean fragmentation pattern could be obtained, although the molecular

ion at  $m/e$  152 was unequivocally detected), analytical figures for which corresponded to the constitution C<sub>10</sub>H<sub>18</sub>O. Better purification was not achieved although a variety of other chromatographic columns were tried.

This mixture (50 mg) in CH<sub>3</sub>OD (1 ml), D<sub>2</sub>O (0.5 ml), and phosphoric trichloride (0.015 ml) was sealed in a glass ampoule under N<sub>2</sub> and heated at 78° for 4 days. G.l.c.–mass spectrometric analysis of the product (2 m K 1540, 10%) revealed two peaks in the ratio 9 : 1,  $M^+$  155 and 156, respectively, as well as peaks with higher retention times, giving  $m/e$  168, 169, 170, 185, 200, 201, 202, 252, and 253.

*Bicyclo[4.3.1]decane*.—To an 8 : 2 mixture of the ketones (2) and (3) (0.39 g, 2.58 mmol) in freshly distilled diethylene glycol (40 ml) were added 85% hydrazine hydrate (2.5 ml) and glacial acetic acid (5 drops). The solution was heated at 80–90° for 24 h in a nitrogen atmosphere with stirring under a reflux condenser. The latter was replaced with a water-cooled Liebig condenser, then solid potassium hydroxide (1 g) was added and the mixture was heated at 190–200° for 6 h with the collecting flask at –80°. A liquid collected in the flask at –80° and a white sublimate soluble in pentane, collected in the condenser. Pentane extracted no material from the liquid distillate. The white solid was twice sublimed at 50° and 20 mmHg to give white crystals (0.23 g, 63%), m.p. 95–97°, which afforded a single g.l.c. peak (2 m Apiezon, 148°) (Found: C, 87.0; H, 13.0. C<sub>10</sub>H<sub>18</sub> requires C, 86.9; H, 13.1%);  $\delta$  3.1br (16H) and 4.0br (2H);  $m/e$  138 (10%), 111 (2.7), 109 (2.9), 97 (4.7), 96 (10), 45 (6.9), and 93 (0.9) [ $m^*$  91 (95 → 93)], 82 (9.2), 81 (10), 79 (2.0) [ $m^*$  77 (81 → 79)], 77 (0.7) [ $m^*$  75 (79 → 77)], 67 (9.8) [ $m^*$  66.8 (138 → 96)], 55 (5.0) [ $m^*$  54.7 (82 → 67),  $m^*$  48.7 (138 → 82)], 41 (4.4), and 39 (1.9).

*By-products of the Diazomethane Reaction*.—A minor g.l.c. peak was detected with a higher retention time than that of the ketone (3) (polypropylene glycol column). When a 2 m Carbowax 1500 column was used, two peaks,  $m/e$  152, were detected at shorter retention times than that of the starting ketone (1). Therefore, the mixture obtained after the ethyl *N*-nitrosomethylcarbamate treatment was carefully evaporated and the residue was treated with lithium-ethylenediamine reagent under standard conditions.<sup>7a</sup> G.l.c. of the resulting mixture showed a minor peak which had the same retention time as the major product either from the reaction of the ketone (1) with methylmagnesium iodide or from treatment of the distillate (0.5 mmHg; 42°) from the reaction of the ketone (1) with dimethyloxosulphonium methylide under standard conditions<sup>7b</sup> with lithium-ethylenediamine.<sup>7a</sup>

We acknowledge financial support from the C.N.R., Rome, and thank Mr. V. Bellotti for mass spectral determinations.

[3/2566 Received, 18th December, 1973]

<sup>6</sup> M. Hartmann, *Z. Chem.*, 1966, **6**, 182.

<sup>7</sup> M. Fieser and L. F. Fieser, 'Reagents for Organic Synthesis,' Wiley-Interscience, New York, (a) vol. 3, 1972, p. 186; (b) vol. 1, 1967, p. 315.