

NOVEL RING CONTRACTIONS INDUCED BY LAH REDUCTION OF ADDITION PRODUCTS
OF IODINE AZIDE TO ALKYL SUBSTITUTED CYCLOBUTENES

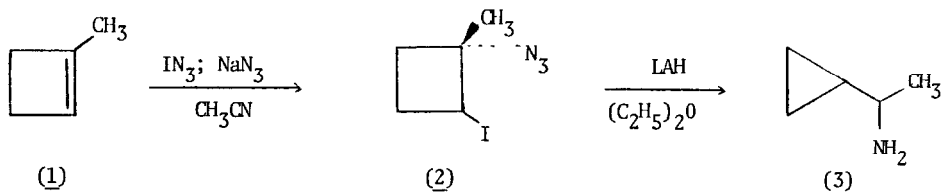
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The synthetic utility of adding the pseudohalogen, IN_3 , to olefins has been demonstrated by Hassner.¹ The addition of IN_3 to olefins proceeds via trans addition and, with unsymmetric olefins, is both regiospecific and stereospecific.² Furthermore, the reduction of α,β -iodoazide adducts with lithium aluminum hydride (LAH) is an excellent procedure for making aziridines.³ The present study deals with our attempt to prepare 5-azabicyclo[2.1.0]pentanes by addition of IN_3 to alkyl substituted cyclobutenes followed by reduction with LAH. Surprisingly, this method gave products that can only be rationalized by an unusual ring contraction under LAH reduction conditions. In addition, the anomalous behavior of 1,2 dimethylcyclobutene towards iodine monochloride and excess sodium azide in acetonitrile will also be reported.

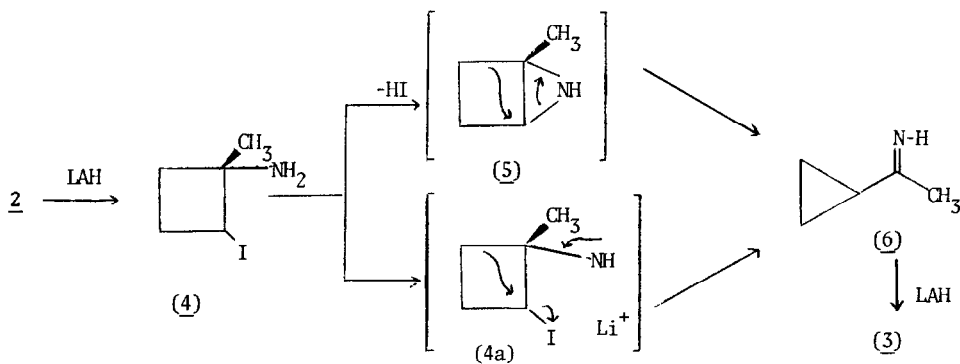
Addition of IN_3 to alkyl substituted cyclobutenes gives good yields of α,β -cyclobutyl-iodoazides. The reaction is illustrated in Scheme I with 1-methylcyclobutene (1),⁴ but we have obtained similar results with 1,2- and 1,3-dimethylcyclobutene. The general procedure of Hassner was employed.¹ Thus, from 1 (2.0 g, 29.4 mmoles), iodine monochloride (5.37 g, 33.1 mmoles) and sodium azide (5.20 g, 80.0 mmoles) in acetonitrile (40 ml) the trans- α,β -iodoazide (2) was obtained as a colorless liquid (5.0 g), bp 48°/1.0 torr, in 70% yield [ir 3000, 2120, 1460, 1390, 1275, 1100 and 1065 cm^{-1} ; nmr δ 4.60 (1H) t; 2.20 (4H) m; and 1.48 (3H) s].⁵ Reduction of 2 with LAH in diethyl ether at room temperature gave, instead of 1-methyl-5-azabicyclo[2.1.0]pentane, the unexpected ring contracted product (3), which was easily characterized by nmr spectroscopy (cyclopropyl protons appear upfield in the region δ 0.6 to -0.1).⁶ For confirmation of its structure, the benzamide derivative of 3 was prepared; it was identical with the known compound.⁷



Scheme I

Similarly, with 1,3-dimethylcyclobutene and IN_3 in CH_3CN , the α,β -iodoazide adduct was obtained as a crude product in 65% yield [ir 3000, 2110, 1450, 1380, 1250, 1120, 1100, 1075 and 860 cm^{-1} ; nmr δ 4.90 (1H) m; 2.50 (1H) m; 2.00 (2H) m; 1.50 (3H) s; and 1.20 (3H) dd]. Treatment of the crude iodoazide adduct with LAH gave 1-(2-methylcyclopropyl)-1-aminoethane as a colorless hygroscopic liquid, bp $108\text{--}112^\circ$ [ir 3100, 3000, 1450, 1400, 1375, 1320, 1290, 1240, 1170, 1120, 1020 and 1010 cm^{-1} ; nmr δ 2.20 (1H) m; 1.90 (2H) d; 1.00 (6H) t; 0.62 (3H) m; and -0.11 (1H) m].

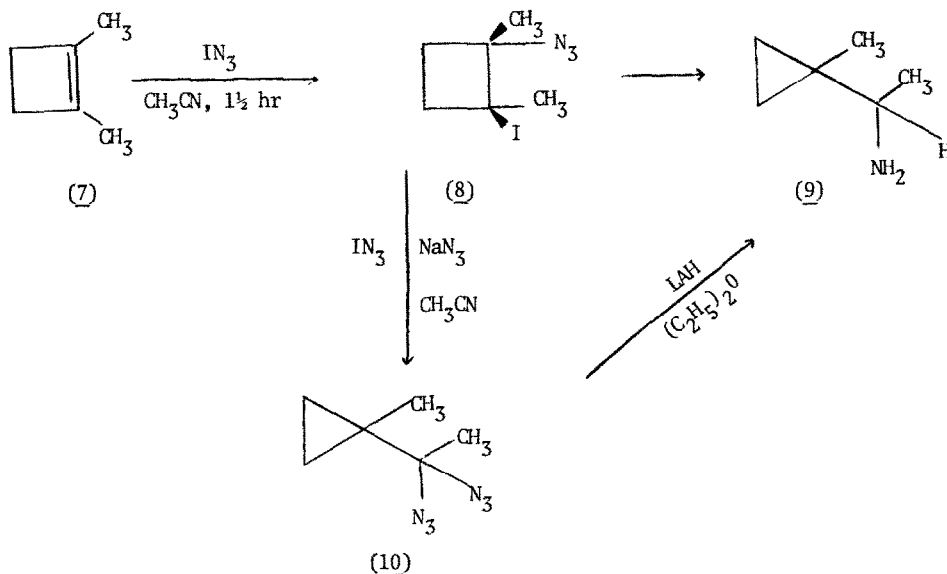
The sequence of events in the reduction of 2 to 3 by LAH (Scheme II) has not yet been conclusively established. One reasonable pathway is initial reduction of the azide function to yield 4, followed by ring closure with elimination of HI to form the fused aziridine (5) as an intermediate. Rearrangement of 5 by a (2a + 2s) pericyclic ring contraction leads to imine (6) which on further reduction by LAH gives the observed product (3). An alternate pathway, which involves the amide anion of 4 (4a), also explains the ring contraction of the α,β -iodoazide adduct (2) by LAH and that pathway cannot be ruled out at this time. The latter route has precedent in the reported work on hydride reduction⁸ and is closely related



Scheme II

to the semibenzilic rearrangement proposed for ring contractions in α -halocyclobutanones.⁹ On treatment of 2 with diborane in THF, 1-amino-2-iodo-1-methylcyclobutane (4) was isolated as the hydrochloride salt in 50% yield, mp 172-175° [ir 3000, 1600, 1500, 1450, 1380, 1320, 1255, 1160, 1140, 1075, 885 and 850 cm^{-1} ; nmr δ (D_2O) 4.86 (1H) m; 2.50 (4H) m; and 1.58 (3H) s]. Compound 4 was then converted to the same ring contraction product (3) on reaction with LAH.

The addition of IN_3 to 1,2-dimethylcyclobutene¹⁰ (7) (Scheme III) gave a normal adduct (8) only when equimolar amounts of ICl and NaN_3 in CH_3CN were employed and the reaction worked up within 90 min, giving a pale yellow liquid (8), bp 62°/0.6 torr, in 65% yield. Adduct (8) was identified mainly by an ir band at 2110 cm^{-1} , nmr signals at δ 2.24 (4H) m; 2.20 (3H) s; 1.74 (3H) s; and a positive test (sodium fusion) for iodine. Adduct (8) can be stored at -20° in the dark but is unstable and decomposes on standing at room temperature for three days. Treatment of 8 with LAH gave amine (9) which was isolated as its benzamide derivative, mp 91-2°, in 63% yield [ir 3470, 3090, 3000, 2880, 1675, 1520, 1490, 1460, 1280, 1150, and 1020 cm^{-1} ; nmr δ 7.70 (2H) m; 7.36 (3H) m; 6.20 (1H) broad; 3.70 (1H) p ($J = 7$ cps); 1.16 (3H) d ($J = 7$ cps); 1.02 (3H) s; 0.60 (2H) m; and 0.30 (2H) m].⁵



Scheme III

When a mixture of 7 (2.4 g, 29.4 mmoles), ICl (6.3 g, 39.0 mmoles) and NaN_3 (5.2 g, 80.0 mmoles) was stirred overnight, the totally unanticipated ring contracted geminal diazide (10) was isolated as the sole product in 65% yield by high vacuum distillation (caution), bp $45^\circ/0.5$ torr [ir 3095, 3000, 2900, 2130, 2110, 1450, 1240, 1150, 1120, 1090, 930 and 860 cm^{-1} ; nmr δ 1.50 (3H) s; 1.20 (3H) s; 0.80 (2H) t; and 0.30 (2H) t].¹¹ Support for structure (10) was obtained by its reduction with LAH to amine (9) in 25% yield. The isolated α,β -iodoazide adduct (8) was also converted to the same diazide (10) by treatment with IN_3 and NaN_3 in CH_3CN . The mechanism for the ring contraction process (7 to 10) has not yet been established but it seems likely that 8 is an intermediate. The possibility that 8 might be converted to 1,2-dimethyl-1,2-diazidocyclobutane by solvolysis-displacement of iodide by azide was discarded because the nmr spectrum of 10 clearly shows upfield cyclopropyl (and not cyclobutyl) protons.

Finally, it may be possible to prepare a series of new cyclopropyl-gem-diazides by the in situ ring contraction of 1,2-disubstituted cyclobutenes on reaction with iodine monochloride and excess sodium azide in acetonitrile.

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