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A SYNTHESIS OF TRICYCLO[3.3.0.$0^{3,7}$]OCTANE (BISNORADAMANTANE); SOLVOLYSIS OF ITS MONO AND DICARBINOLS

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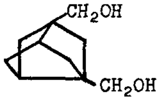
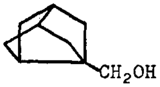
We wish to report the synthesis of tricyclo[3.3.0.$0^{3,7}$]octane (I) by a structurally unambiguous route and to describe the ring expansion of the derived carbinols II and III. Hydrocarbon I, for which we suggest the trivial name "bisnoradamantane", may be regarded as a lower homolog of adamantane (IV), derived from IV by the deletion of two oppositely situated methylene bridges:

I

IV



II



III

Freeman, Rao and Bigam (1) recently described I as a hydrogenation product of tetracyclo [3.3.0.$0^{2,4}$.$0^{3,7}$]octane, which itself was obtained from the decomposition of the tosyl hydrazone of tricyclo[3.2.1.$0^{3,6}$]octan-2-one by a carbene insertion. While the spectral data reported for I (pmr, IR) were consistent with the assigned structure, the route used was not unequivocal. To our knowledge the only other bisnoradamantane mentioned in the literature is the 1,3-dicarboxylic acid V, prepared by Webster and Sommer (2). We were able to convert diacid V to the parent hydrocarbon I by dehalogenation of the derived 1,3-dihalo compounds VI. Support for the identity of the bisnoradamantane skeleton was furnished by ring expansion of the 1,3-dicarbinol VII (obtained from V) to 1,3-dihydroxyadamantane. To prepare the monocarbinol (III), 1-bromo-9-keto-tricyclo[3.3.1.$0^{3,7}$]nonane-3-carboxylic acid (IX) (3) was converted to the dibromoketone X by a

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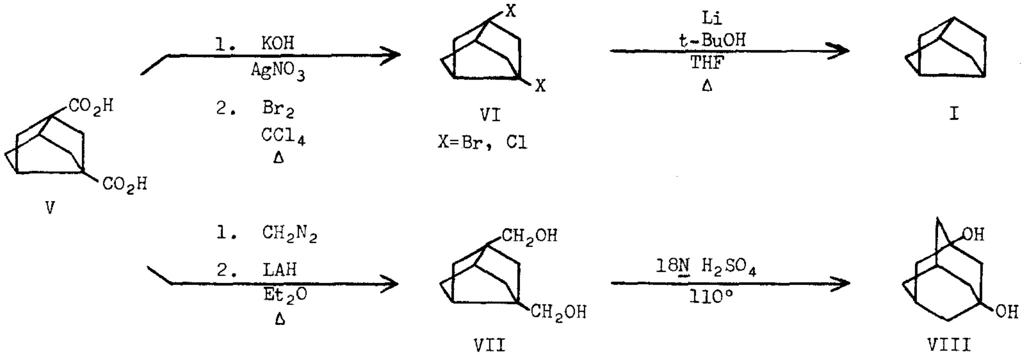
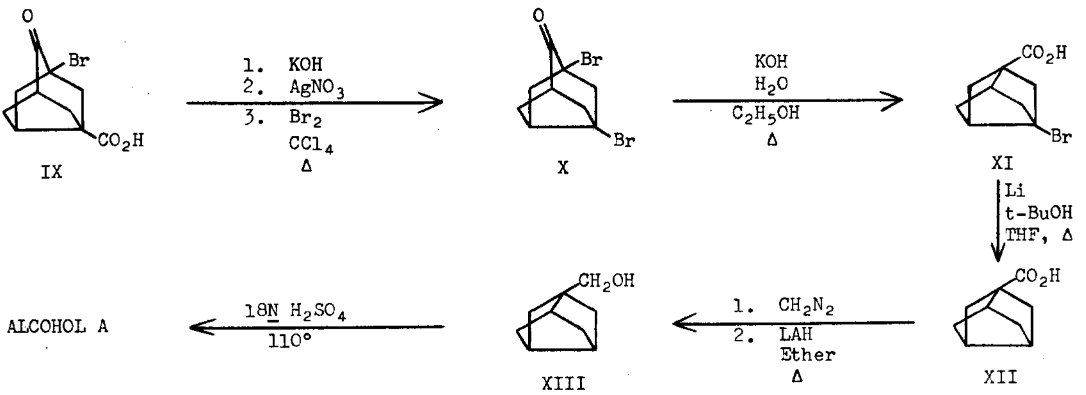
Hunsdiecker reaction. X was then subjected to a Favorskii-type ring contraction and the resultant bromocarboxylic acid XI was reductively dehalogenated to give bisnoradamantane-1-carboxylic acid(XII). Reduction of the ester of XII afforded the carbinol XIII which on solvolysis rearranged to a tertiary alcohol (alcohol A) tentatively assigned the structure of noradaman-1-ol (XIVb).



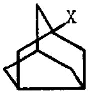
Thus V, upon neutralization and treatment with silver nitrate, was converted to its disilver salt, which on refluxing with bromine for two hours in carbon tetrachloride (4) gave a mixture of the chloro and bromo bisnoradamantanes (VI) in 66% yield from the acid. Subsequent reductive dehalogenation of this mixture with lithium and t-butyl alcohol in tetrahydrofuran furnished bisnoradamantane (I) [yield, 30%; mp 103-104° (totally submerged sealed capillary), reported (1) mp 105-105.5°]. The pmr spectrum of I exhibited two singlets at δ 2.24 (4H methine) and at δ 1.30 (8H methylene) which agrees with the previously reported data (1). The hydrocarbon gave a molecular ion peak at m/e 108 (relative abundance 27) with more intense peaks at m/e 93 (ra 71), 80 (ra 89), 79 (ra 90), 67 (ra 100) and 66 (ra 91).

The dimethyl ester of V (from diazomethane) was reduced with lithium aluminum hydride in refluxing ether to the 1,3-dicarbinol VII [yield, 60% from the acid; mp 76-77°; OH stretch ($CHCl_3$) 2.92 μ; sharp singlet at δ 3.86 ($-CH_2O$)] (5). This, when heated with $18\underline{N}$ sulfuric acid at 110° for two hours, gave 1,3-dihydroxyadamantane (VIII) which was indistinguishable (VPC, IR, mp) from a sample prepared by the method of Geluk and Schlatmann (7) [yield 82%; mp 324-326° (8); OH stretch 3.13 μ] (9).

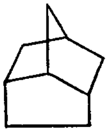


To prepare the monocarbinol XIII, the silver salt of 1-bromo-9-ketotricyclo[3.3.1.$0^{3,7}$]nonane-3-carboxylic acid (IX) (2) was refluxed with bromine in carbon tetrachloride, affording the dibromoketone X [yield 57%; mp 132-133°; C=O stretch, 5.78 μ]. X was subjected to a Favorskii-type ring contraction (10) by refluxing in aqueous ethanolic potassium hydroxide for two hours to give the bromoacid XI [yield 90%; mp 93-94°; C=O stretch, 5.85 μ]. Reductive dehalogenation of XI with lithium and t-butyl alcohol in tetrahydrofuran gave bisnoradamantane-1-carboxylic acid (XII) [yield 75%; mp 97-99°; C=O stretch 5.87 μ]. The methyl ester of XII (from diazomethane) was reduced by heating with lithium aluminum hydride in ether for three hours to the monocarbinol XIII [yield 75%; mp 107-108°; OH stretch 3.02 μ; molecular ion peak at m/e 138; sharp singlet at δ 3.67 (CH_2O, benzene solution). When XIII was stirred in 18N sulfuric acid at 110° for two hours a new alcohol A was isolated in 80% yield [mp 219-221°; OH stretch 3.08 μ]. The pmr spectrum of A (in benzene after shaking with DCl) showed two broad humps at δ 2.21 (3H) and δ 1.70 (4H) and a broad triplet at δ 1.37 (6H).

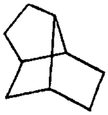
While conclusive proof is lacking, we believe alcohol A is best represented by structure XIVb for the following reasons: Of the possible tricyclononane skeletons obtainable from the ring expansion of XIII, only four (XIVa, XV-XVII) are without either three or four membered rings or improbably strained structures (11). Of these four only XIVa does not possess the rather highly strained bicyclo[2.2.1]heptane moiety.



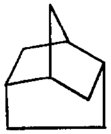
XIV
a. X=H
b. X=OH



XV



XVI



XVII

Thus XIVa should represent the most stable isomer and, under suitable thermodynamically controlled conditions, rearrangements of the other three should ultimately result in the final formation of derivatives of XIV. This conclusion is supported by the work of Schleyer and Wiskott (11) who prepared noradamantane (XIVa) by the aluminum bromide catalyzed rearrangement of brexane (XVI) and by the results of Nickon, et al (12) who found that an acetoxy derivative of XVI (exo-brexan-4-ol acetate) isomerizes to a corresponding derivative of XV (exo-brendan-2-ol acetate) and under more forcing conditions, a hydroxy derivative of XV (exo-brendan-2-ol) rearranges to noradamantan-2-ol and not to the tricyclo system XVII (tricyclo[4.3.0.$0^{3,8}$]nonan-2-ol), as might have been expected. Hence, it appears that XIVa is the most stable tricyclononane isomer and that, considering the conditions employed in the ring expansion of XIII, XIVb is the most likely product on the basis of stability.

REFERENCES

1. P. K. Freeman, V. N. M. Rao and G. E. Bigam, Chem. Commun., 511 (1965).
2. O. W. Webster and L. H. Sommer, J. Org. Chem., **29**, 3103 (1964).
3. B. R. Vogt and J. R. E. Hoover, Tetrahedron Letters, 2841 (1967).
4. J. Cason and R. L. Way, J. Org. Chem., **14**, 31 (1949).
5. All new crystalline compounds gave satisfactory elemental analysis (with the exception of XIII, see reference 6). All exhibited pmr absorptions (60 mc, $CDCl_3$ solution, TMS internal standard) consistent with their assigned structures. Infrared spectra were taken in Nujol mull. Melting points were taken in sealed capillary tubes (liquid bath). The mass spectra (70 ev) were carried out by the Morgan-Schaffer Corporation, Montreal.
6. Analysis for XIII. Calc. C, 78.21; H, 10.21. Found: C, 77.12 and H, 10.21. The mass spectrum suggested traces of a brominated impurity.
7. H. W. Geluk and J. L. M. A. Schlatmann, Chem. Commun., 426 (1967).
8. H. Stetter and C. Wulff, Ber., **93**, 1366 (1960) reported a melting point of 315°.
9. For an analogous ring expansion of a similar polycyclic system see reference 3.
10. Analogous contractions have been used in recent preparations of other strained cage systems. See, for example: P. E. Eaton and T. W. Cole, Jr., J. Am. Chem. Soc., **86**, 3157 (1964); G. L. Dunn, V. J. DiPasquo and J. R. E. Hoover, Tetrahedron Letters, 3737 (1966); R. J. Stedman, L. S. Miller and J. R. E. Hoover, Tetrahedron Letters, 2721 (1966) and reference 3.
11. P. von R. Schleyer and E. Wiskott, Tetrahedron Letters, 2845 (1967).
12. A. Nickon, G. D. Pandit and R. O. Williams, Tetrahedron Letters, 2851 (1967).