Tetrahedron Letters No. 36, pp 3239 - 3240, 1974. Pergamon Press. Printed in Great Britain.

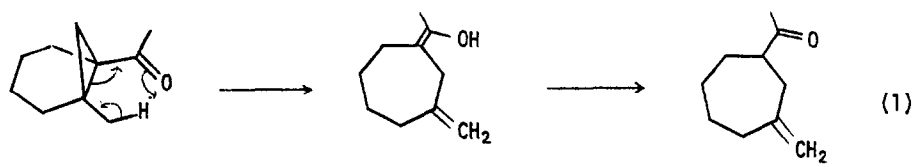
A RING EXPANSION ROUTE TO CYCLOHEPTANE DERIVATIVES[1]

Stephen A. Monti* and Thomas W. McAninch

Department of Chemistry, The University of Texas at Austin, Austin, Texas 78712

(Received in USA 2 July 1974; received in UK for publication 29 July 1974)

The development of new methods for the construction of odd-membered rings, particularly five- and seven-membered cycles, has been stimulated by the increasing number of biologically active, naturally occurring substances which contain these structural characteristics.[2] We wish to report an efficient, general method for the preparation of functionalized seven-membered rings via a one-carbon ring expansion[3] of cyclohexane derivatives. This transformation involves the cleavage of the internal bond of a bicyclo[4.1.0]heptane moiety by a thermal homo[1,5]hydrogen shift or enolene rearrangement[4] as shown in eq 1.



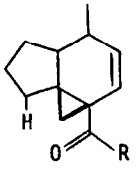
(1)

1 2

Cyclopropyl ketone 1 was prepared from 1-acetyl-2-methylcyclohexene[5] by the sequence: lithium aluminum hydride reduction (90%), Simmons-Smith[6] cyclopropanation (81%), and Collins oxidation (70%).[7,8] Neat pyrolysis of 1 at 200° for 2 hr under a nitrogen atmosphere yielded the ring expanded acetylcycloheptane[7] 2 in 80% yield.[9] The presence of a seven-membered ring in 2 was confirmed by degradation to 3-methylcycloheptanone by catalytic hydrogenation, Baeyer-Villiger oxidation to 3-methylcycloheptyl acetate, ester hydrolysis, and oxidation (35% overall yield).

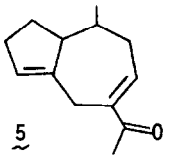
This ring expansion procedure was then extended to the preparation of a functionalized hydroazulene skeleton. Using the method of Dauben[10] the conjugate addition of (1-cyclopenten-1-ylmethylene)triphenylphosphorane with ethyl sorbate furnished the cyclopropyl ester[7] 3 in 40% yield which was converted to methylketone[7] 4 using standard procedures.[11] Thermal

rearrangement of 4 at 175° for 2 hr yielded hydroazulene 5 in 70% yield. The spectral properties of 5 (nmr: two one-proton vinyl signals at δ5.4, and 6.7 ppm; ir 1670 cm^{-1}; uv λmax 238 nm, ε 13,600, calc λmax 237 nm) support the proposed structure assignment. In terms of specific synthetic design, it should be noted that ketone 5 contains carbon substituents and/or differentiated functionality at those sites common to many naturally occurring hydroazulenes.[12]



3 R = OEt

4 R = CH_3



5

References

1. Financial support of this research by the Robert A. Welch Foundation is gratefully acknowledged.

2. For a summary of recent synthetic efforts, see: (a) Cyclopentane rings: B. M. Trost and M. J. Bogdanowicz, J. Amer. Chem. Soc., 95, 5311 (1973) and refs. cited; R. F. Romanet and R. H. Schlessinger, ibid., 96, 3701 (1974); P. L. Fuchs, ibid., 96, 1607 (1974); T. Hiyama, M. Tsakanaka, and H. Nozaki, ibid., 96, 3713 (1974); R. A. Ellison, Synthesis, 397 (1973). (b) Cycloheptane rings: J. A. Marshall, ibid., 517 (1972); R. Noyori, Y. Baba, and Y. Hayakawa, J. Amer. Chem. Soc., 96, 3336 (1974) and refs. cited; A. E. Hill, G. Greenwood, and H. M. R. Hoffmann, ibid., 95, 1338 (1973).

3. C. D. Gutche and D. Redmore, Advances in Alicyclic Chemistry, Suppl. 1, Academic Press, New York, N. Y., 1968.

4. R. M. Roberts, R. G. Landolt, R. N. Greene, and E. W. Heyes, J. Amer. Chem. Soc., 89, 1404 (1967).

5. S. B. Kulkarni and S. Dev, Tetrahedron, 24, 561 (1968).

6. J. M. Denis, C. Girard, and J. M. Conia, Synthesis, 549 (1972).

7. All new compounds gave satisfactory spectral data and elemental analyses.

8. The conjugate addition of dimethyloxosulfonium methylide to the starting enone failed: cf. H. O. House, Modern Synthetic Reactions, 2nd Edition, W. A. Benjamin, Inc., Menlo Park, California, 1972, p 719-720.

9. Isolated 2 contained some endocyclic carbon-carbon double bond isomer(s).

10. W. G. Dauben and A. P. Kozikowski, Tetrahedron Lett., 3711 (1973).

11. M. K. Jorgenson, Org. Reactions, 18, 1 (1970).

12. T. K. Devon and A. I. Scott, Handbook of Naturally Occurring Compounds, Volume II, Terpenes, Academic Press, N. Y., 1972.