Tetrahedron Letters No. 38, pp 3597 - 3600. 0040-4039/79/0915-3597$02.00/0

BOND FIXATION IN ANNULENES. 7. DIRECT RESOLUTION OF CHIRAL CYCLOOCTATETRAENES[1]

John M. Gardlik[2] and Leo A. Paquette*

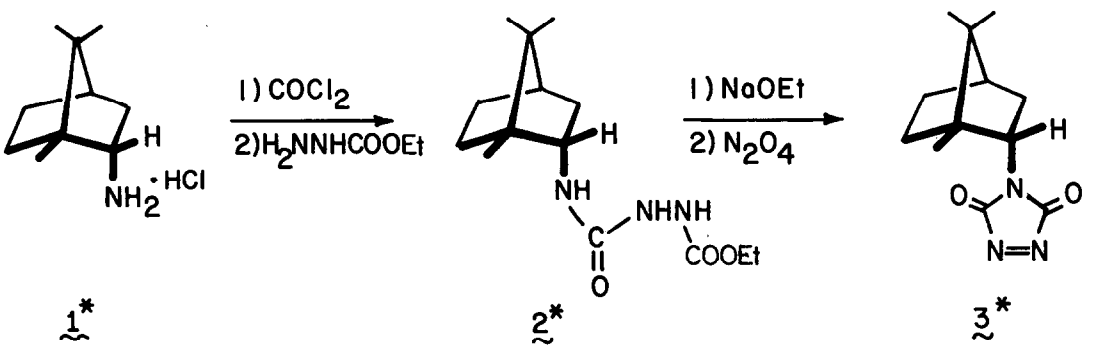
Evans Chemical Laboratories, The Ohio State University, Columbus, Ohio 43210

Summary: Cycloaddition of an optically pure triazolinedione to a racemic cyclooctatetraene, followed by separation of the resulting diastereomers and hydrolysis-oxidation, delivers the polyolefin in high enantiomeric purity.

The position of the cyclooctatetraene nucleus as the annulene ring system most ideally suited for probing cyclic polyolefin asymmetry[3] would be significantly augmented by the availability of a direct, nondestructive method of resolution. Immediately precluded by these restrictions is our consideration of either procedure heretofore developed for the purpose of resolving alkenes. Thus, the type of kinetic resolution introduced by Brown and coworkers in the form of (+)-tetra-2-pinanylborane[4] and used successfully, for example, by Moore in the preparation of a series of chiral allenes,[5] is successful only at the expense of valuable substrate. Chiral platinum complexes have also been used for these purposes,[6] but the cost is prohibitive on a large scale and success in the cyclooctatetraene area did not appear promising because of the availability of four possible (and usually different) coordination sites. We now describe promising new technology based upon Diels-Alder chemistry with chiral triazolinediones.

Enantiomerically pure (-)-endo-bornyl-1,2,4-triazolinedione (3*) was prepared from endo-bornylamine hydrochloride [1*, $[\alpha]_D$ +23° (c 4.4, EtOH)][7] by suitable adaptation of existing methodology (Scheme I).[8] Stable for prolonged periods when stored cold in the absence of light,

SCHEME I

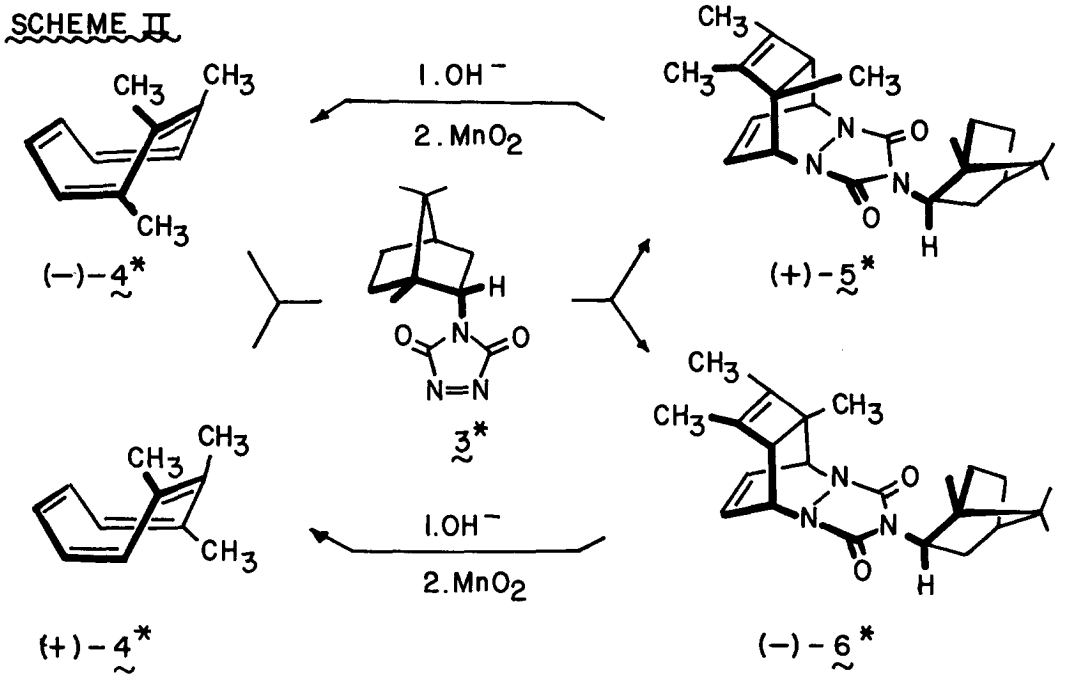


1* 2* 3*

3* was obtained as a red solid, mp 152-154°C, $[\alpha]_D$ -77° (c 5.7, CH_2Cl_2).

Heating of 3* with racemic 1,2,3-Me_3COT (4) in ethyl acetate (65°C, 40 hr) afforded a mixture of the stereoisomeric adducts 5* and 6* (45%) as the only crystalline product (Scheme II). Repeated recrystallization of the admixed urazoles from ethyl acetate-hexane solution produced a selection of various diastereomeric mixtures whose composition was assessed

SCHEME II



through admixture with 0.2 mol equiv of tris-(3-(trifluoromethylhydroxymethylene)-d-camphorato) europium(III).[9] Under these conditions, the bridgehead methyl group originally at δ 1.34 was resolved into two peaks (δ 1.20 and 1.17), thereby allowing for the development of a linear correlation involving $[\alpha]_D$ and percent levorotatory isomer (Figure 1). From such data, it could easily be determined that our purest sample of adduct, mp 219-221°C, $[\alpha]_D$ +34.6°, contained 92% of the dextrorotatory and 8% of the levorotatory diastereoisomers. Hydrolysis-oxidation of this sample gave 4*, $[\alpha]_D$ -161°, after isolation by Florisil chromatography at -30°C. Since the hydrocarbon racemized completely when heated at 50°C for 24 hr, it was considered not to contain optically active impurities. With prior knowledge of the absolute configuration of (-)-4*,[3b] the

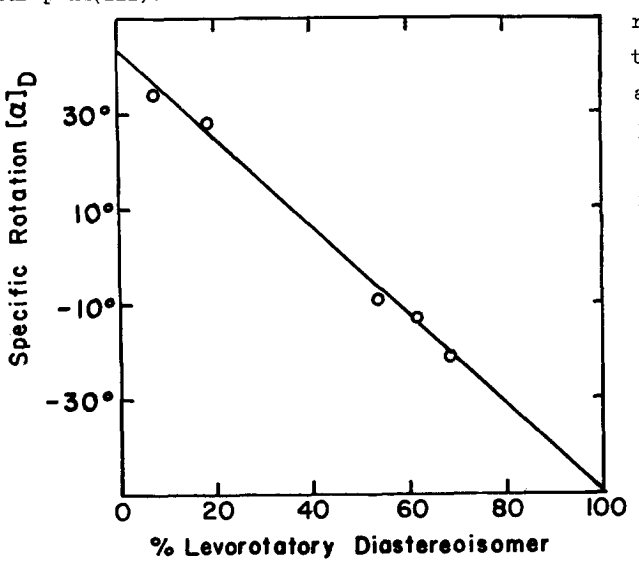
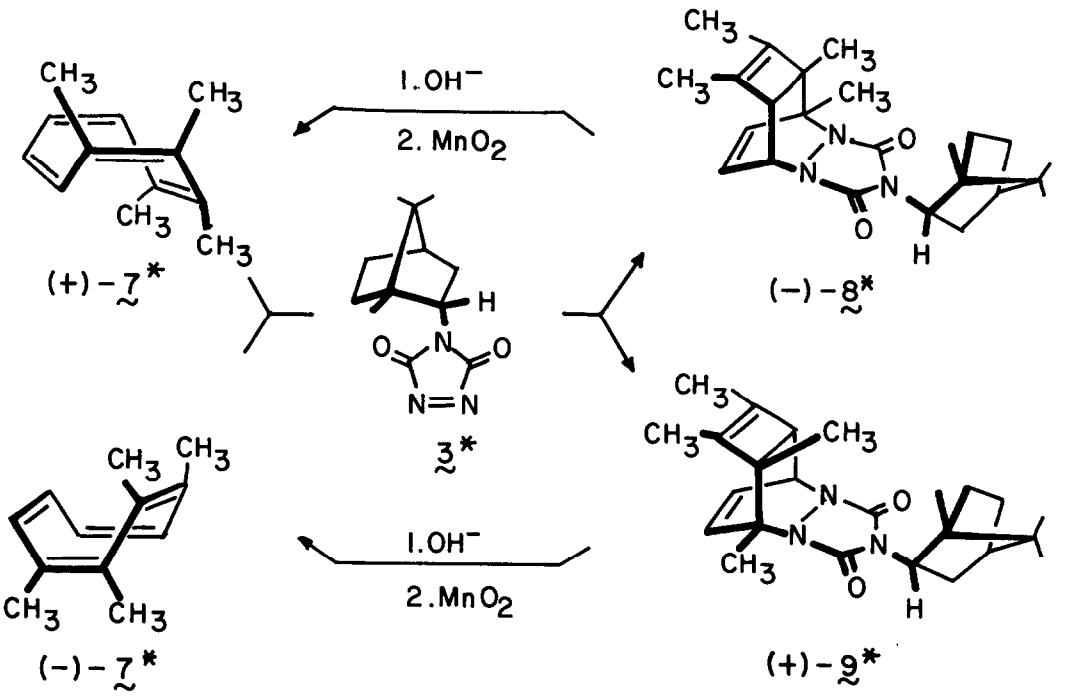


Figure 1

stereochemical assignments given the individual urazoles in Scheme II follow unambiguously.

Application of the chiral triazolinedione procedure to racemic 1,2,3,4-Me_4COT (7) similarly provided an effective solution to our previous supply problem for obtaining quantities of 7* (Scheme III). In this instance, recrystallization of the 8*/9* mixture (obtained in 45% yield, refluxing ethyl acetate, 20 hr) gave two purified diastereomers:

SCHEME III



A, mp 166-168°C, $[\alpha]_D$ -26.10°; B, mp 155-157°C, $[\alpha]_D$ +10.60°. Efforts to determine the purity of these solids by chiral lanthanide-induced shifting were to no avail. However, utilization of R-(-)-1,1,1-trifluoro-2-(9-anthryl)ethanol[10] as a chiral solvating agent in $CDCl_3$ differentially shifted the original bridgehead methyl singlet (δ 1.28) to give a pair of well resolved lines at δ 1.17 and 1.14. Through suitable integration, it again proved possible to obtain a linear correlation of diastereomeric purity with specific rotation comparable to Figure 1. On this basis, A was shown to be composed of 95% of the levorotatory diastereomer and B was comparably enriched in the dextrorotatory form.

Submission of the latter sample to hydrolysis-oxidation gave 7*, $[\alpha]_D$ -310°. Comparable treatment of 8*, $[\alpha]_D$ -12.0°, led to (+)-7*, $[\alpha]_D$ +54.8°. Our prior determination of the absolute stereochemistry of (+)-7*[3] permits direct assignment of the absolute configurations of 8* and 9* as shown. The heightened rotation of the present samples attests to the greater resolvability attainable with the triazolinedione procedure.

The present methodology provides the basis for much further experimentation. We plan to report later on studies involving the application of chiral triazolinediones to asymmetric induction and to the synthesis of optically active olefins and saturated hydrocarbons in the near future.[11]

Acknowledgment. This investigation was supported by the National Science Foundation and the National Cancer Institute, DHEW by means of Grants CHE-76-08764 and CA-12115, respectively.

References and Footnotes

(1) Part 6. J. M. Gardlik, L. A. Paquette, and R. Gleiter, J. Am. Chem. Soc., 101, 1617 (1979).

(2) The Ohio State University Dissertation Fellow, 1977-1978.

(3) (a) L. A. Paquette, J. M. Gardlik, and J. M. Photis, J. Am. Chem. Soc., 98, 7096 (1976); (b) J. M. Gardlik, L. K. Johnson, L. A. Paquette, B. A. Solheim, J. P. Springer, and J. Clardy, ibid., 101, 1615 (1979).

(4) H. C. Brown, N. R. Ayyangar, and G. Zweifel, J. Am. Chem. Soc., 86, 397, 1071 (1964).

(5) W. R. Moore, H. W. Anderson, and S. D. Clark, J. Am. Chem. Soc., 95, 835 (1973).

(6) (a) A. C. Cope, C. R. Ganellin, H. W. Johnson, Jr., T. V. Van Auken, H. J. S. Winkler, J. Am. Chem. Soc., 85, 3276 (1963); (b) A. C. Cope, K. Banholzer, H. Keller, B. A. Pawson, J. J. Whang, H. J. S. Winkler, ibid., 87, 3644 (1965); A. C. Cope, J. K. Hecht, H. W. Johnson, Jr., H. Keller, H. J. S. Winkler, ibid., 88, 761 (1966); (d) A. Panunzi, A. DeRenzi, G. Paiaro, Inorg. Chim. Acta, 1, 475 (1967); (e) R. Lazzaroni, P. Salvadori, P. Pino, Tetrahedron Lett., 2507 (1968); (f) A. C. Cope, W. R. Moore, R. D. Bach, H. J. S. Winkler, J. Am. Chem. Soc., 92, 1243 (1970).

(7) (a) K. v. Auwers, Chem. Ber., 22, 605 (1889); (b) M. O. Forster, J. Chem. Soc., 73, 386 (1898); (c) W. Hückel and P. Rieckmann, Justus Liebigs Ann. Chem., 625, 1 (1959).

(8) (a) R. C. Cookson, S. S. H. Gilani, and I. D. R. Stevens, Tetrahedron Lett., 615 (1962); (b) R. C. Cookson, I. D. R. Stevens, and C. T. Watts, Chem. Commun., 744 (1966); (c) R. C. Cookson, S. S. H. Gilani, and I. D. R. Stevens, J. Chem. Soc. (C), 1905 (1967); (d) R. C. Cookson, S. S. Gupta, I. D. R. Stevens, and C. T. Watts, Org. Synth., 51, 121 (1971); (e) J. C. Stickler and W. H. Pirkle, J. Org. Chem., 31, 3444 (1966).

(9) H. L. Goering, J. N. Eikenberry, and G. S. Koermer, J. Am. Chem. Soc., 93, 5913 (1971).

(10) W. H. Pirkle, D. L. Sikkenga, and M. S. Pavlin, J. Org. Chem., 42, 384 (1977).

(11) R. Doehner and J. A. Jenkins, unpublished findings.

(Received in USA 21 May 1979)