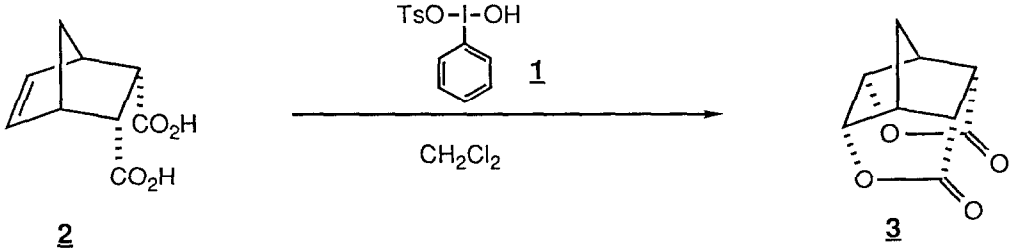
Tetrahedron Letters, Vol.27,No.45,pp 5437-5440,1986 0040-4039/86 $3.00 + .00
Printed in Great Britain Pergamon Journals Ltd.

BISLACTONIZATIONS OF OLEFINIC DIACIDS WITH [HYDROXY(TOSYLOXY)IODO]BENZENE

Mayur Shah, Michael J. Taschner*, Gerald F. Koser*, Nancy L. Rach,
Thomas E. Jenkins, Patrick Cyr, and David Powers
Department of Chemistry, The University of Akron
Akron, Ohio 44325

Abstract: The reactions of [hydroxy(tosyloxy)iodo]benzene with a series of olefinic diacids to produce bislactones are reported. The products are the result of a stereospecific cis-addition of the two carboxylic acid functions to the double bond.

The conversion of olefinic diacids into bislactones is a transformation for which there are currently two synthetically useful methods. There are the silver salt-iodine-silver acetate bislactonization developed by Yoshikoshi[1] and the lead tetraacetate mediated bislactonization reported by Corey,[2] the latter of which has found application in the total synthesis of picrotoxinin.[3] During the course of an investigation of the tosyloxylactonization of alkenoic acids with [hydroxy(tosyloxy)iodo]benzene (**HTIB**,**1**), we found that the reaction of 5-norbornene-endo-2,3-dicarboxylic acid(**2**) with HTIB produced bislactone **3**.[4]

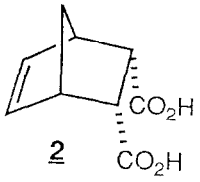
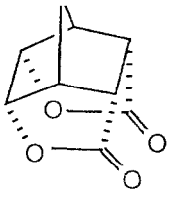
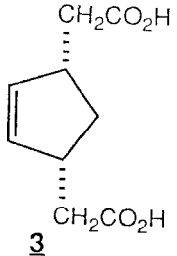
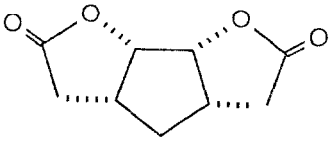
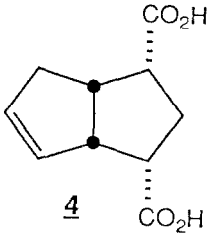
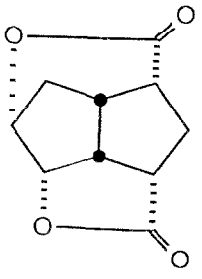
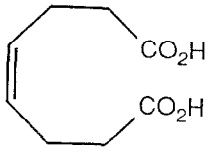
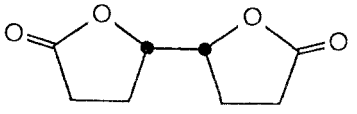
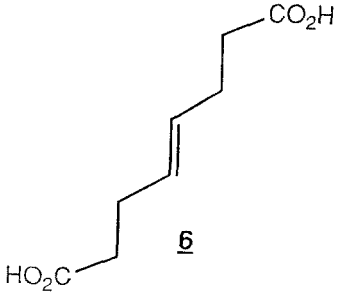
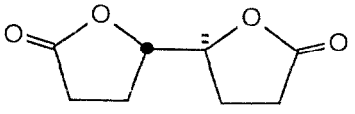


2 **3**

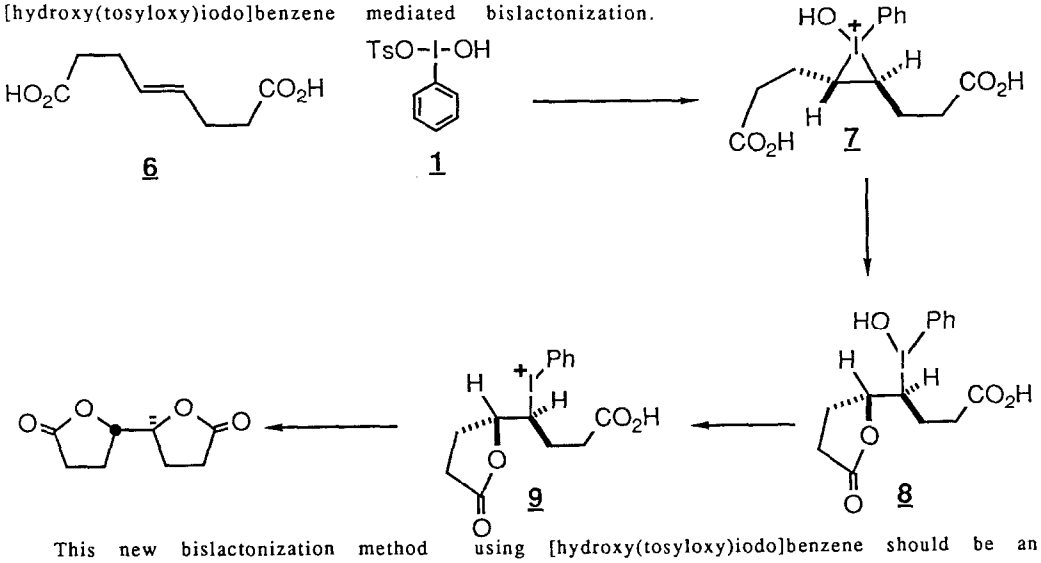
The mildness and operational simplicity of this transformation encouraged us to further investigate the scope and utility with a series of representative olefinic diacids. This report describes the results of that study in terms of the stereochemistry and mechanism of the bislactonization of olefinic diacids induced by [hydroxy(tosyloxy)iodo]benzene.

Under one set of normalized conditions, mixtures of 2.0 mmol each of the olefinic diacid and HTIB in 30 mL of CH_2Cl_2 were stirred for 4-18 hours at ambient temperature. The reactions are monitored by the disappearance of HTIB, which is largely insoluble in CH_2Cl_2. The reaction mixtures were washed (H_2O, sat'd. $NaHCO_3$) to remove the p-toluenesulfonic acid produced as a by-product, dried($MgSO_4$), and concentrated in vacuo. The bislactones were obtained either by direct crystallization of the concentrate with ether or by flash chromatography.[5] As can be seen in the Table, the bislactones are delivered stereospecifically in good yield.

TABLE: BISLACTONIZATION OF OLEFINIC DIACIDS

SUBSTRATE	TIME	PRODUCT	YIELD, mp
 2	8 h		66%, 272-73° C
 3	4.5 h		57%, 114-15° C
 4	11.5 h		58%, 243-45° C
 5	14.5 h		64%, 104-5° C
 6	18 h		64%, 55-56.5° C

Due to the geometrical restrictions of the diacids 2[6], 3[7], and 4[8], the two carboxylic acid functions are constrained to add in a cis fashion to the carbon-carbon double bond. As in the earlier studies of Yoshikoshi[1] and Corey,[2] the stereospecificity of the bislactonization procedure with HTIB was tested with cis- and trans-4-octene-1,8-dioic acids as the substrates.[9,10] When the cis-diacid was subjected to the HTIB mediated bislactonization, the meso-bislactone was produced as the sole lactonic product. Treatment of the trans-diacid with HTIB led to the sterospecific formation of the d, l-bislactone. This is consistent with a mechanism (illustrated below for trans-4-octene-1,8-dioic acid) involving initial electrophilic addition of the phenyl(hydroxy)iodonium ion to the carbon-carbon double bond, similar to the proposed first step in the vicinal bis-tosyloxylation of alkenes with HTIB.[11] The hypothesis that HTIB undergoes ionization prior to electrophilic addition is based in part on the analysis of its X-ray structure.[12] This reveals an elongation of the I-OTs bond relative to the sum of the iodine and oxygen covalent radii and therefore appears to be endowed with ionic character.[11] This is followed by intramolecular capture of the cyclic organoiodine intermediate 7 by one of the carboxylic acid groups, with inversion of configuration at carbon, to form the lactone-hydroxyiodinane intermediate 8. Acid catalyzed dehydration of the hydroxyiodinane produces the phenyl(alkyl)iodonium ion 9. This undergoes a second intramolecular nucleophilic displacement of iodobenzene by the second carboxylic acid group, again with inversion of configuration at carbon. The overall double inversion at carbon results in the net cis-addition of the two carboxyl groups in the [hydroxy(tosyloxy)iodo]benzene mediated bislactonization.



This new bislactonization method using [hydroxy(tosyloxy)iodo]benzene should be an excellent complement to the silver salt-iodine-silver acetate and lead tetraacetate procedures. We are currently working on the development of soluble iodine reagents to effect similar transformations, the results of which will be reported in due course.[13, 14]

References and Notes

1. Kato, M.; Kageyama, M.; Tanaka, R.; Kuwahara, K.; Yoshikoshi, A. *J. Org. Chem.* **1975**, *40*, 1932.
2. Corey, E. J.; Gross, A. W. *Tetrahedron Letters* **1980**, *21*, 1819.
3. Corey, E. J.; Pearce, H. L. *J. Am. Chem. Soc.* **1979**, *101*, 5841.
4. Shah, M.; Taschner, M. J.; Koser, G. F.; Rach, N. L. *Tetrahedron Letters*, in press.
5. Still, W. C.; Kahn, M.; Mitra, A. *J. Org. Chem.* **1978**, *43*, 2923.
6. Diels, O.; Alder, K. *Liebigs Ann. Chem.* **1928**, *460*, 98.
7. Gassman, P. G.; Creary, X. *J. Chem. Soc. Chem. Commun.* **1972**, 1214.
8. Ogino, T.; Mochizuki, K. *Chem. Letters* **1979**, 443.
9. (a) Nagarkatti, J.; Ashley, K. *Tetrahedron Letters* **1973**, 4599;
   (b) Pollini, G.; Tadia, R.; Barco, A.; Benetti, J. *Org. Prep. and Proc. Int.* **1973**, *6*, 217.
10. The trans-diacid was prepared from trans-1,4-dibromo-2-butene as described in Ref. 2.
11. Rebrovic, L.; Koser, G. F. *J. Org. Chem.* **1984**, *49*, 2462.
12. Koser, G. F.; Wettach, R. H.; Troup, J. M.; Frenz, B. A. *J. Org. Chem.* **1976**, *41*, 3609.
13. Satisfactory ^{1}H-NMR spectra, infrared spectra, and combustion analyses were obtained for all products.
14. This research was assisted financially by the Dow Chemical Company, the National Institues of Health, and a University of Akron Faculty Research Grant.

(Received in USA 11 August 1986)