

**Acknowledgment.** We are grateful to Dr. K. E. Fahrenholtz of Hoffmann-La Roche, Nutley, N. J., for a sample and spectra of *dl*-VII.

R. Mechoulam, P. Braun  
Laboratory of Natural Products, The School of Pharmacy  
The Hebrew University of Jerusalem, Jerusalem, Israel

Y. Gaoni  
Department of Chemistry, The Weizmann Institute of Science  
Rehovoth, Israel

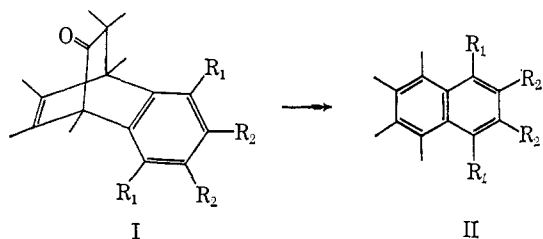
Received April 14, 1967

## A General Naphthalene Synthesis, Illustrated with a Viable Preparation of Octamethylnaphthalene

Sir:

The distorted geometry of octamethylnaphthalene<sup>1,2</sup> suggests that it (and related compounds) may show unusual chemical behavior. Unfortunately the previous synthesis<sup>3</sup> is tedious and not amenable to the preparation of sufficient quantities for extensive studies. We now report a simple, high-yield synthesis of octamethylnaphthalene which also has the virtue of great generality for the synthesis of substituted naphthalenes and other ring structures.

Addition of benzyne<sup>4</sup> to the readily available<sup>5</sup> hexamethyl-2,4-cyclohexadienone furnished adduct I ( $R_1 = R_2 = H$ ), mp 108–108.5°, in 73% yield. In a similar fashion, addition of 3,6-dimethylbenzyne (from 3,6-



dimethylantranilic acid) gave I ( $R_1 = CH_3$ ;  $R_2 = H$ ), mp 103–104°, and 4,5-dimethylbenzyne gave I ( $R_1 = H$ ;  $R_2 = CH_3$ ), mp 62–65°, each in 76% yield.<sup>6,7</sup>

The aryne adducts I were converted to the corresponding naphthalenes II by one of several routes. The most convenient is illustrated by the preparation of 1,2,3,4,5,8-hexamethylnaphthalene from I ( $R_1 = CH_3$ ;  $R_2 = H$ ) in 87% yield by reaction at 70° for 4.5 hr with dimethylsodium<sup>8</sup> in DMSO. The mechanism presumably involves the intermediate III; isobutyric acid was isolated and identified.<sup>9</sup>

(1) D. M. Donaldson and J. M. Robertson, *J. Chem. Soc.*, 17 (1953). There is some controversy regarding this early X-ray determination; see G. Gafner and F. H. Herstein, *Nature*, **200**, 130 (1963).

(2) For a stimulating review of *peri* interaction in naphthalenes, see V. Balasubramanian, *Chem. Rev.*, **66**, 567 (1966).

(3) B. J. Abadir, J. W. Cook, and D. T. Gibson, *J. Chem. Soc.*, 8 (1953).

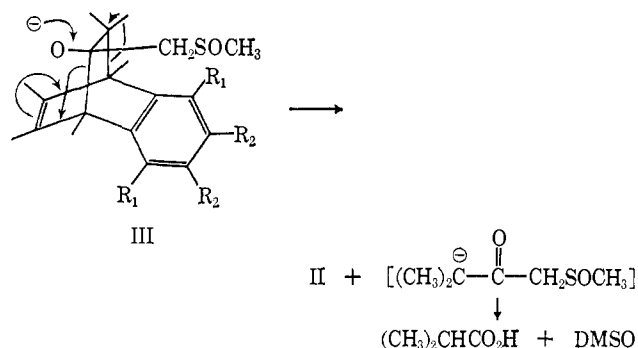
(4) L. Friedman and F. M. Logullo, *J. Am. Chem. Soc.*, **85**, 1549 (1963); M. Stiles, R. G. Miller, and U. Burckhardt, *ibid.*, **85**, 1792 (1963).

(5) H. Hart, P. M. Collins, and A. J. Waring, *ibid.*, **88**, 1005 (1966).

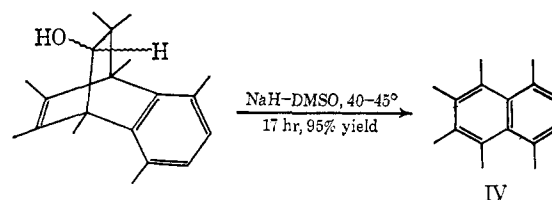
(6) All new compounds gave satisfactory analyses and had infrared and nmr spectra consistent with the assigned structures.

(7) In the case of substituted benzyne, we used a modification of the published procedure, which gives improved yields. We are indebted to Professor Friedman for kindly communicating this procedure in advance of publication.

(8) E. J. Corey and M. Chaykovsky, *J. Am. Chem. Soc.*, **87**, 1345 (1965).



Alternatively, adducts I were reduced quantitatively with lithium aluminum hydride to a mixture of epimeric alcohols which, with NaH in DMSO, gave the corresponding naphthalene IV (and, presumably, isobutyraldehyde).



A third method for effecting the conversion of I → II is pyrolysis. I ( $R_1 = CH_3$ ;  $R_2 = H$ ) at 450° was converted to IV (17.8%), dimethylketene (17.9%, trapped as the anilide), and 80% of recovered I; undoubtedly a higher temperature would improve the conversion.

Octamethylnaphthalene was best prepared<sup>10</sup> from IV by bischloromethylation<sup>11</sup> and reduction ( $LiAlH_4$ ), in over-all 71% yield, mp 179.5–181.0°; it had two equal singlets in the nmr, at  $\tau$  7.59 (1,4,5,8- $CH_3$ ) and 7.75 (2,3,6,7- $CH_3$ ).<sup>12</sup> Its ultraviolet spectrum agreed with that previously reported.<sup>13</sup>

Since the dienone and aryne components of this synthesis can be broadly selected, this method constitutes a versatile naphthalene synthesis; it should be capable of extension (*via* other arynes) to many ring systems. We are exploiting the method as well as the ground- and excited-state chemistry of octamethylnaphthalene.<sup>14,15</sup>

(9) The dimethylsilyl need not be prepared directly; I ( $R_1 = CH_3$ ;  $R_2 = H$ ) with NaH in DMSO at 70–75° for 4 hr gave the corresponding II in 83% yield.

(10) Clearly octamethylnaphthalene could be produced directly if tetramethylbenzyne were used. However, the commercial availability of 4,7-dimethylisatin (Research Organic/Inorganic Chemical Co., Sun Valley, Calif.), the immediate precursor of 3,6-dimethylantranilic acid, makes this benzyne somewhat easier to obtain than tetramethylbenzyne.

(11) This reaction goes in excellent yield directly to the bis(chloromethyl) product. It goes very poorly, however, with the isomeric 1,2,3,4,6,7-hexamethylnaphthalene; for similar difficulties in chloromethylating *peri* positions, see ref 3.

(12) Nmr spectra of 24 methylnaphthalenes have been studied by F. F.-H. Yew, R. J. Kurland, and G. J. Mair, *Anal. Chem.*, **36**, 843 (1964).

(13) H. Dannenberg and D. Dannenberg-von Dresler, *Chem. Ber.*, **89**, 1326 (1956).

(14) For example, octamethylnaphthalene forms a deep blue complex with TCNE in benzene, chloroform, or *n*-hexane, the color of which is rapidly discharged with ethanol. Octamethylnaphthalene gives a Diels-Alder adduct with benzyne.

(15) We are grateful to the National Science Foundation for support of this research.

(16) To whom inquiries should be addressed.

Akira Oku, Tsuyoshi Kakihana, Harold Hart<sup>16</sup>  
Department of Chemistry, Michigan State University  
East Lansing, Michigan 48823

Received June 29, 1967