methylenecyclohexane systems by peroxybenzimidic acid systems to give predominantly equatorial epoxides, in contrast to expoxidation by peracids, which gave predominantly products from an axial attack.

Experimental Section

Melting points were determined on a Thomas-Hoover capillary melting-point apparatus and are uncorrected. ^{1}H NMR spectra were recorded in $CDCl_3$ solutions at 90 MHz on a Varian Em 390 instrument. Chemical shifts are reported in parts per million (δ) downfield from tetramethylsilane as an internal standard, and multiplicity of NMR signals are described as s = singlet, d = doublet, dd = doublet of doublets, q = quartet, and m = multiplet. Mass spectra were recorded on a AEI MS 902 instrument. Thin-layer chromatography (TLC) was performed on silica gel 60 F 254 plates (Merck) of 0.25 mm thickness and visualized under ultraviolet light. High-pressure liquid chromatography (HPLC) was performed on a DuPont Model 820 instrument.

***N*-Oxide of Pirprofen (3).** To a solution of 2.5 g of pirprofen in 10 mL of ethyl acetate was added 2 mL of 25% peroxyacetic acid solution in ethyl acetate, and the solution was stirred overnight at room temperature. The crystalline solid formed was filtered and recrystallized from a mixture of methanol and ether (1:5) to yield 2.3 g of a white solid: mp 146–48 °C dec; mass and ^{1}H NMR spectrum in Table I. Anal. Calcd for $C_{13}H_{14}O_3NCl$: C, 58.32; H, 5.23; N, 5.23. Found: C, 58.09; H, 5.51; N, 4.99.

2-[3-Chloro-4-(6-oxa-3-azabiocyclo[3.1.0]hex-3-yl)-phenyl]propionic Acid (2). A solution of 2.6 g of pirprofen in ether was treated with a solution of diazomethane in ether. After 30 min, ether was evaporated and the residue dissolved in 50 mL of methanol. To the methanol solution was then added 3.5 mL of acetonitrile, 4 mL of 30% H_2O_2 solution, and 1 g of potassium bicarbonate, and the mixture was stirred at room temperature for 2.5 h. Methanol was removed by evaporation under reduced pressure and the residue treated with water. The mixture was then extracted with ether, and the ether extract was dried ($MgSO_4$) and evaporated to give 2.5 g of a light yellow oil, which was then chromatographed on a column of silica gel. Elution with toluene removed the faster moving minor component (identified by ^{1}H NMR spectroscopy as the pyrrole analogue of pirprofen). The column was then eluted with ethyl acetate. Removal of ethyl acetate from the eluate gave 1.5 g of the methyl ester of **2** as a light yellow oil: ^{1}H NMR δ 1.41 (d, 3 H), 3.31, 3.85 (dd, 4 H), 3.60 (s, 3 H), 3.65 (m, 1 H), 3.70 (s, 2 H), 6.80 (d, 1 HO, 7.02 (m, 1 H), 7.20 (m, 1 H); mass spectrum, *m/e* (rel intensity) 281 (52), 263 (16), 222 (100), 204 (18). Anal. Calcd for $C_{14}H_{16}O_3NCl$: C, 59.68; H, 5.72; N, 4.97. Found: C, 59.62; H, 5.94; N, 4.88.

To 0.5 g of the above yellow oil was added 20 mL of 5% methanolic KOH solution, and the mixture was stirred at room temperature for 2 h. Methanol was removed and the residue dissolved in water. The aqueous solution was acidified (pH 5.5–6.0) and extracted with ether. The ether solution was dried ($MgSO_4$) and evaporated to give a light yellow oil, which was then chromatographed on a column of silica gel. Ethyl acetate eluate gave 0.3 g of the epoxy acid **2**, which was crystallized from a mixture of ether and cyclohexane (1:6); mp 94–96 °C;mass and ^{1}H NMR spectrum in Table I. Anal. Calcd for $C_{13}H_{14}O_3NCl$: C, 58.32; H, 5.23; H, 5.23. Found: C, 58.21; H, 5.29; N, 5.26.

2-[3-Chloro-4-(3,4-*trans*-dihydroxypyrrolidino)phenyl]-propionic Acid (4). The methyl ester of the epoxide **2** (3.5 g) was heated with 50 mL of 10% NaOH solution for 3 h under reflux. The solution was cooled, acidified (pH 4.5), and extracted with ether. The ether extract was dried ($MgSO_4$) and evaporated to dryness to give an oily residue, which was then chromatographed on a column of silica gel. Elution with ether (which removed an impurity) was followed by elution with ethyl acetate. The ethyl acetate eluate on evaporation gave an oil, which became solid after drying in high vacuum. All attempts at crystallization failed. TLC in ethyl acetate showed one spot; mass spectrum *m/e* 285, 240, 225, 212, 197, and 180; ^{1}H NMR (Me_2SO-d_6) δ 1.42 (d, 3 H), 2.33 (s, 2 H), 3.21 (m, 2 H), 3.6 (q, 1 H), 3.8 (dd, 2 H), 4.15 (br, 2 H), 6.9 (d, 1 H), 7.2 (m, 1 H), 7.3 (d, 1 H). Anal. Calcd for $C_{13}H_{16}O_4NCl$: C, 54.64; H, 5.60; N, 4.90. Found: C, 54.84; H, 5.91; N, 4.64. The methyl ester of **4** was prepared by treatment of **4** with diazomethane and worked up in the usual way to give an oil; *m/e* (rel intensity) 299 (80), 240 (100), 226 (18), 211 (40); ^{1}H NMR 1.43 (d, 3 H), 3.1 (s, 2 H), 3.21 (dd, 2 H), 3.52 (q, 1 H), 3.65 (s, 3 H), 3.7 (dd, 2 H), 4.15 (br, 2 H), 6.73 (d, 1 H), 7.1 (m, 1 H), 7.2 (d, 1 H). Anal. Calcd for $C_{14}H_{18}O_4NCl$: C, 56,10; H, 6.01; N, 4.67. Found: C, 56.44; H, 6.35, N, 4.39.

2-[3-Chloro-4-(3,4-*cis*-dihydroxypyrrolidino)phenyl]-propionic Acid (5). To a solution of 2 g of pirprofen in 40 mL of ether were added 1 mL of pyridine and a solution of 2 g of osmium tetraoxide in 20 mL of ether, whereupon a brown precipitate was formed. The reaction mixture was diluted with 40 mL of ether and left overnight at room temperature. The brown solid was filtered and transferred to a 250-mL flask. Ethanol (50 mL) and a solution of 10 g of sodium sulfite in 50 mL of water were then added to the solid, and the mixture was heated under reflux for 5 h. The reaction mixture was cooled and filtered. The filtrate was concentrated to a small volume, acidified (pH 4.5–5.0), and extracted with ethyl acetate. The extract was dried ($MgSO_4$) and evaporated to dryness. The residue was then stirred with ether and filtered. The filtrate was evaporated to dryness and the residue crystallized from a mixture of ether and benzene. The crystalline material on recrystallization from a mixture of ethyl acetate and petroleum ether gave 1.4 g of a white crystalline solid: mp 115–16 °C; mass spectrum, *m/e* 285, 240, 212, 197, 180; ^{1}H NMR (Me_2SO-d_6) δ 1.44 (d, 3 H), 3.3 (dd, 2 H), 3.5 (q, 1 H), 3.62 (dd, 2 H), 4.25 (m, 2 H), 6.75 (d, 1 H), 7.1 (m, 1 H), 7.22 (d, 1 H). Anal. Calcd for $C_{13}H_{16}O_4NCl$: C, 54.64; H, 5.60; N, 4.90. Found: C, 54.77; H, 5.42; N, 4.84. The methyl ester of **5** was prepared by treatment of **5** with diazomethane and worked up in the usual way to give an oil: *m/e* (rel intensity) 299 (80), 240 (100), 226 (20), 211 (45); ^{1}H NMR δ 1.43 (d, 3 H), 3.3 (dd, 2 H), 3.42–3.7 (m, 8 H), 4.25 (br, 2 H), 6.7 (d, 1 H), 7.1 (m, 1 H), 7.2 (d, 1 H). TLC of a mixture of **4** and **5** was run in ethyl acetate as well as in chloroform–methanol–formic acid system, where the *cis*-diol **5** moved slightly faster than the *trans*-diol **4**. HPLC of a mixture **1**, **2**, **4**, and **5** was performed on a Zorbax C_{18} column with retention times of 14, 9.6, 4.0, and 4.7 min, respectively, the solvent system being methanol–water–perchloric acid (55:45:0.2).

Acknowledgment. We are grateful to Dr. J. Karliner and his staff of the Corporate Research Department for the ^{1}H NMR and mass spectra and R. Luders for the HPLC.

Registry No. 1, 31793-07-4; 1 methyl ester, 59235-36-8; 2, 59235-33-5; 2 methyl ester, 82537-12-0; 3, 31796-82-4; 4 (isomer 1), 82537-09-5; 4 (isomer 2), 82537-10-8; 4 methyl ester, 82537-11-9; 5, 82570-90-9.

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Dianions of 2,5-Dimethyl-2,4-hexadiene. Evidence for the Stability of an 8-π-Electron Cross-Conjugated System

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Neutral linearly conjugated systems are generally recognized to possess greater stabilization than the isomeric cross-conjugated systems;[1] however, this tendency is frequently reversed in polyanionic systems.[2,3] We found, for

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(2) For purposes of the following discussion, dilithio- and dipotassioalkenes will be referred to as dianions with the understanding that there may be significant covalent character in the carbon–metal bond.

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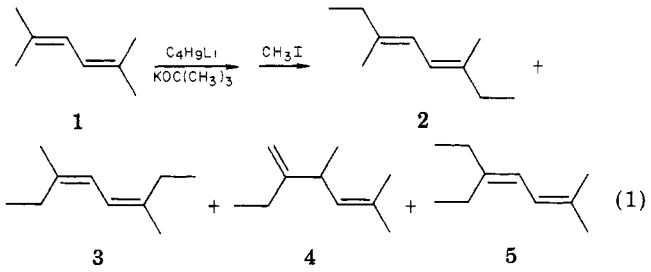
Table I. Metalation of 2,5-Dimethyl-2,4-hexadiene

metalating system[a] (mol)[b]	duration of metalation, h	products[c] (%[d])	ratio of cross vs. linearly conjugated dianions
n-BuLi (2), *t*-OBuK (2)	24	**2** (21), **3** (7), **4** (43), **5** (29)	72:28
n-BuLi (2), *t*-OBuK (2)	48	**2** (26), **3** (9), **4** (43), **5** (22)	65:35
n-BuLi (2), *t*-OBuK (2)	72	**2** (28), **3** (7), **4** (43), **5** (21)	64:36
n-BuLi (2), *t*-OBuK (2)	216	**2** (16), **3** (8), **4** (52), **5** (24)	76:24
n-BuLi (4), *t*-OBuK (4)	144	**2** (33), **3** (26), **4** (39), **5** (2)	41:59
n-BuLi (2), TMEDA (2)	72	**4** (69), **5** (31)	100:0
n-BuLi (2), TMEDA (2)	120	**4** (63), **5** (37)	100:0
n-BuLi (2), TMEDA (2)	168	**4** (62), **5** (38)	100:0
n-BuLi (2), TMEDA (2)	216	**4** (64), **5** (36)	100:0
n-BuLi (3), TMEDA (3)	216	**4** (67), **5** (33)	100:0
n-BuLi (4), TMEDA (4)	216	**4** (55), **5** (45)	100:0

[a] The reaction was performed in hexane at room temperature. [b] Moles relative to the substrates. [c] After treatment with methyl iodide. [d] Percent of dialkylated products.

example, that dimetalation of 2-methyl-2-butene gave exclusively the cross-conjugated dianion as the thermodynamic product.[4] These results have been explained by the theory of Y aromaticity[5,6] which states that certain polyanionic species tend to adopt a closed-shell Y-delocalized 6-π-electron configuration. Because Y aromaticity has been evoked only with compounds possessing $(4n + 2)$ π electrons,[7] we have prepared the 8-π-electron dianions of 2,5-dimethyl-2,4-hexadiene, which show predominant to exclusive formation of a cross-conjugated dianion, depending on the metalating system.

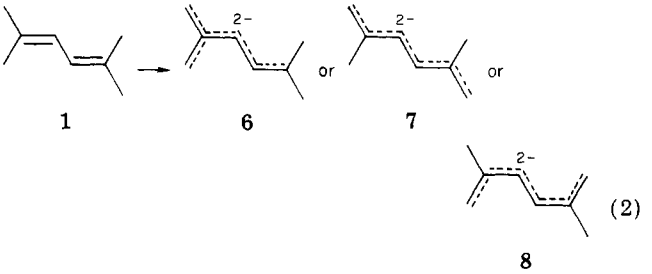
The treatment of 2,5-dimethyl-2,4-hexadiene (1) with 2 equiv of *n*-butyllithium in hexane in the presence of an equimolar amount of potassium *tert*-butoxide,[8] followed by alkylation with methyl iodide gave (Table I) a 4:1 mixture of mono- and dialkylated products (eq 1). The



(1)

dialkylated product mixture consists of the following dienes: **2**, (*E*,*E*)-3,6-dimethyl-3,5-octadiene (21% of the dialkylated products); **3**, (*Z*,*Z*)-3,6-dimethyl-3,5-octadiene (7%); **4**, 3,5-diethyl-2-ethyl-1,4-hexadiene (43%); **5**, 5-ethyl-2-methyl-2,4-heptadiene (29%).

The products result from alkylation of either the cross-conjugated dianion **6** or linearly conjugated dianions



(2)

7 and **8**. As shown in Table I, the ratio of products obtained from cross-conjugated dianion **6** to those obtained from linearly conjugated dianions (**7** and **8**) is invariant within experimental error between time intervals of 24–216 h. An increase in the ratio of metalating system/alkene to 4:1, in an unsuccessful attempt to form the 12-π-electron cross-conjugated tetraanion, led to an increase in the amount of linearly conjugated dianion (Table I).

The structure of product **5** could not be unambiguously proved from its H^1 NMR spectrum because of its close similarity to the spectrum of (*E*,*Z*)-3,6-dimethyl-3,5-octadiene. The structure was proved by ozonolytic degradation of the isolated alkadiene, reductive workup of the ozonide, and treatment of the resulting ketone(s) with (2,4-dinitrophenyl)hydrazine. Two 2,4-dinitrophenylhydrazones were distinguishable by thin-layer chromatography, and their R_f values were identical with the 2,4-dinitrophenylhydrazones of acetone and 3-pentanone. Chromatographic comparison with the 2,4-dinitrophenylhydrazone of 2-butanone, which would have been formed by ozonolysis of (*E*,*Z*)-3,6-dimethyl-3,5-octadiene, demonstrated conclusively that the alkadiene was not a product from the *E*,*Z* linearly conjugated dianion. The dialdehyde from ozonolytic cleavage of **5** was not characterized, but the presence of a TLC spot with a very small R_f value was presumed to result from the third cleavage product.

Metalation of **1** with *n*-butyllithium in hexane and an equimolar amount of tetramethylethylenediamine (TMEDA), followed by alkylation with methyl iodide gave a 1:3 mixture of monoadduct and diadduct, with the diadduct resulting from exclusive formation of the cross-conjugated dianion **6** (Table I). Again, examination of the reaction within time intervals of 72–216 h showed the presence of no products from alkylation of the linear dianion. An increase in the ratio of *n*-butyllithium/TMEDA to alkene of 3:1 and 4:1 led, as would be expected, to an increase in the concentration of dianion **6** with respect to that of the monoanions (Table I).

The metalation of **1** with *n*-butyllithium/TMEDA could also be followed by ^1H NMR spectroscopy. Within seconds after the addition of alkene to the NMR tube containing 2 equiv of *n*-butyllithium/TMEDA, the spectrum of a monoanion, **9**, was observed. The sickle shape of **9** was deduced primarily from the diminished size of the downfield methyl peak on the starting material at δ 1.83 and the concomitant growth of a set of protons at δ 2.8 and 2.9. The chemical shifts from the 3-methinyl (δ 3.5, J = 12) and 4-methinyl (δ 5.7, J = 12) protons are also consistent with, although not precisely the same as, the analogous peaks for the pentadienyl anion.[9] Formation of dianion **6** was

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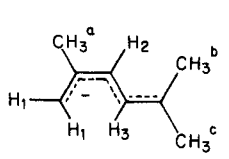
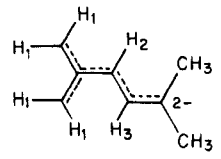


9

H_1, δ 2.9
H_2, δ 3.5, J = 12 Hz
H_3, δ 5.7, J = 12 Hz
CH_3^a, δ 1.81
CH_3^b, δ 1.79
CH_3^c, δ 1.81

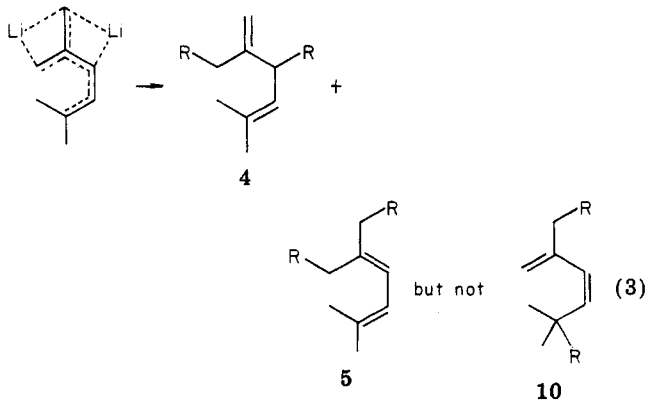


6

H_1, δ 1.64
H_2, δ 3.54, J = 12
H_3, δ 6.00, J = 12
CH_3, δ 1.79

evident after 5 min. The chemical shifts and coupling constants are in good agreement with the analogous values for the parent 2-methylpentadienyl dianion.[10] The only evidence for formation of a linearly conjugated dianion was in the observation of a singlet at δ 3.1 for the 3- and 4-methinyl protons which appeared within 2 min of the addition of alkene to the metalating system. The peak diminished in size with the concomitant increase in the doublet at δ 3.54 due to dianion **6**.

The extreme preference for metalation of **1** to yield the cross-conjugated dianion rather than any of the linearly conjugated dianions when the metalating system is *n*-butyllithium/TMEDA was not totally unexpected. The second lithiation of the monoanion of **1** would yield in dianion **6** a system with complete charge alternation. Such a tendency for compounds to dimetalate with introduction of the second negative charge on the same set of atoms as the first was also observed by Klein et al.[11] Dimetalation of *p*-xylene with *n*-butyllithium/TMEDA did not lead to the *p*-xylene dianion, but dimetalation of *m*-xylene led easily to the corresponding dianion. The stringent requirement for charge alternation in dilithio compounds may be due to stabilization through lithium bridging, similar to that found in benzyllithium.[12] The existence of such bridging in **6** is suggested by the formation of **4** and **5** but not **10** in the alkylation with methyl iodide (eq 3). The effect of lithium bridging is also implied in the



4 5 10 (3)

strong tendency of the dianion of 2-methyl-1,4-pentadiene[10] to be alkylated in the 1,3- and in the 1- and 2(1-methyl)-positions, those positions most effectively stabilized by lithium bridging.

When the metalating system is changed to *n*-butyllithium/potassium *tert*-butoxide, the formation of linearly conjugated dianions is observed. The major factor in this system undoubtedly is the diminished ability of the potassium cation from butylpotassium to function as part of a bridging system in order to facilitate metalation to yield a cross-conjugated dianion. Similar results were seen by Klein and Medlik-Balan in their metalations of polymethylbenzenes.[11] Interestingly, the transmetalation which they observed with time with butylpotassium appears to diminish in our experience, with periods of time up to 24 h.

Whereas metalation of conjugated dienes with *n*-butyllithium/TMEDA is generally unsuccessful due to competing addition, we observed no products from addition of *n*-butyl anion to the conjugated system.

The preference for formation of the cross-conjugated dianion over the linear dianions can be explained by an examination of their relative resonance energies per atom (REPA).[13] The REPA's for **6** and **7**/**8**, computed in this manner,[14] are 0.065β and 0.028β, respectively. The relationship between thermodynamic stability and a larger REPA for isomeric polyanions has already been demonstrated for the isomeric C_4 dianions, the isobutylene dianion (REPA = 0.034), and the butadiene dianion (REPA = −0.040). As mentioned earlier, when both are allowed to form in the same hydrocarbon system, 2-methyl-2-butene, the dianion with the larger REPA forms at the expense of the other.[4] Other acyclic polyanions which have been formed with high REPA values include the dianion of 2,3-dimethylbutadiene (REPA = 0.062β),[15] the 4-methylheptatrienyl dianion (REPA = 0.061β),[7] and the 3-vinylhexatriene dianion (REPA = 0.040β).[14] The larger REPA for dianion **6** compared with dianions **7**/**8** agrees with its ease of formation and suggests its greater stability. The greater stability of cross-conjugated dianions has been used to substantiate the theory of Y aromaticity,[4] allowing dianion **6** to be considered as the Y-aromatic dianion with $4n$ π electrons.[18]

Experimental Section

General Procedures. ^{1}H NMR spectra were recorded on a Varian T-60 spectrometer. Tetramethylethylenediamine (TMEDA) and pentane were each purified by distillation from benzophenone ketyl. Potassium *tert*-butoxide and *n*-butyllithium were used as obtained from the manufacturer. Elemental analyses were performed by Galbraith Laboratories.

A Perkin-Elmer Sigma 3-B gas chromatography equipped with a thermal-conductivity detector was used for preparative separations. Helium was used as the carrier gas at a flow rate of 30 mL/min. Retention times (t_R) are reported relative to the time of injection.

General Procedure for Metalation. (a) With Lochman's Base. Potassium *tert*-butoxide (3.2 g, 28.4 mmol) in pentane and *n*-butyllithium (12.0 mL, 28.4 mmol) were combined in a septum-capped test tube under argon to form a beige complex. To the metalating system at 0 °C was added 2,5-dimethyl-2,4-hexadiene (2.1 mL, 14.2 mmol). The metalated hexadiene was quenched with methyl iodide (2.17 mL, 35 mmol), and the solution was extracted with aqueous ammonium chloride, dried, and flash distilled [180 °C (10^{-1} torr)]. The products were separated by temperature-programmed GC (85–125 °C; 2.7 m, 6% OV-17 column).

(b) With *n*-Butyllithium/TMEDA. *N,N,N′,N′*-Tetramethylethylenediamine (TMEDA) (4.4 mL, 28.4 mmol) and *n*-butyllithium (12.0 mL, 28.4 mmol) were combined in a septum-capped test tube under argon. To the metalating system was added 2,5-dimethyl-2,4-hexadiene (2.1 mL, 14.2 mmol) to give a deep red-brown solution. Methyl iodide (2.17 mL, 25 mmol) was added to the solution at 0 °C to quench the anions, and the

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reaction mixture was worked up as described above.

(*E*,*E*)-3,6-Dimethyl-3,5-octadiene (2):[16] H^1 NMR (CCl_4) δ 1.8 (t, 6 H, J = 8 Hz), 1.77 (s, 6 H), 2.2 (q, 4 H, J = 8 Hz), 5.5 (m, 2 H); t_R = 29.6 min. Anal. Calcd for $C_{10}H_{18}$: C, 86.88; H, 13.12. Found: C, 86.76; H, 13.19.

(*Z*,*Z*)-3,6-Dimethyl-3,5-octadiene (3):[16] H^1 NMR (CCl_4) δ 1.8 (t, 6 H, J = 8 Hz), 1.75 (s, 6 H), 2.2 (q, 4 H, J = 8 Hz), 5.9 (m, 2 H); t_R = 33.1 min. Anal. Calcd for $C_{10}H_{18}$: C, 86.88; H, 13.12. Found: C, 86.76; H, 13.19.

3,5-Dimethyl-2-ethyl-1,4-hexadiene (4): H^1 NMR (CCl_4) δ 1.05 (superimposed t and d, 6 H, J = 8 Hz), 1.65 (s, 3 H), 1.70 (s, 3 H), 2.0 (q, 2 H, J = 8 Hz), 3.05 (dd, 1 H, J = 8, 10 Hz), 4.8 (m, 2 H), 4.9 (d, 1 H, J = 10 Hz); t_R = 15.2 min. Anal. Calcd for $C_{10}H_{18}$: C, 86.88; H, 13.12. Found: C, 86.76; H, 13.19.

5-Ethyl-2-methyl-2,4-heptadiene (5):[17] H^1 NMR (CCl_4) δ 1.10 (t, 3 H, J = 8 Hz), 1.14 (t, 3 H, J = 8 Hz), 1.80 (s, 3 H, 1.75 (s, 3 H), 2.20 (q, 2 H, J = 8 Hz), 2.24 (q, 2 H, J = 8 Hz), 5.7 (m, 2 H); t_R = 33.3 min. Anal. Calcd for $C_{10}H_{18}$: C, 86.88; H, 13.12. Found: C, 86.76; H, 13.19.

Ozonolysis of 5-Ethyl-2-methyl-2,4-heptadiene (5). Ozone was added to 50 mL of 8 dissolved in 3 mL of methylene chloride at −70 °C until the solution turned a clear light blue. A mixture of 0.5 g of sodium iodide, 1 mL of methanol, and 0.25 mL of acetic acid was added to this solution and the mixture allowed to stir overnight. The solution was decolorized to a pale yellow with sodium bisulfite, neutralized with sodium carbonate, and gravity filtered to remove any remaining solid. The 2,4-dinitrophenylhydrazones were prepared by classical methods. Because they were soluble in the methylene chloride solution, after vacuum filtration the solution was used directly for TLC analysis on silica gel with toluene as the developing solvent. The mixture gave three spots, R_f 0.01, 0.34, and 0.51. The retention times for the 2,4-dinitrophenylhydrazones of acetone, 3-pentanone, and 2-butanone are 0.34, 0.51, and 0.46, respectively.

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Registry No. 1, 764-13-6; 2, 56755-47-6; 3, 54248-59-8; 4, 83463-93-8; 5, 39491-74-2.

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Preparation of a Tetrahydrobenzocycloheptene and Its Intramolecular Cyclization

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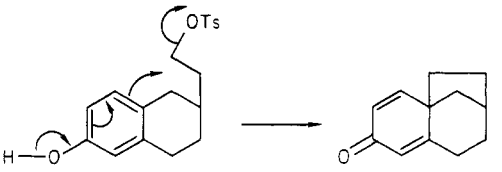
In connection with our interest in preparation of tetracyclic diterpenes of the kuarene group,[1] we sought to determine the feasibility of formation of the BCD rings through an intramolecular cyclization of a tetrahydrobenzocycloheptene precursor. Masamune[2] had shown that a tetrahydronaphthalene precursor could be successfully closed intramolecularly to the BCD ring skeleton. However, no one has explored the utilization of the conformationally less flexible[3] tetrahydrobenzocycloheptene. In order to examine the possible utilization of a tetrahydrobenzocycloheptene, we needed a convenient method of preparation of that ring system. We report herein such a method and an exploration of the practicality of its intramolecular cyclization.

Scheme I



I

The synthesis of 6,7,8,9-tetrahydro-4a,7-methano-4a*H*-benzocyclohepten-2(5*H*)-one (I) has been reported.[2] Masamune, utilizing the so-called Ar_15 participation, has prepared I from a tetrahydronaphthalene tosylate by treatment with strong base (Scheme I).

The dienone I can in principle be prepared by similar intramolecular cyclization of the tetrahydrobenzocycloheptene derivative II. Toward this goal the synthesis of II from the readily available 6-methoxy-2-tetralone was undertaken (Scheme II).

The synthesis of ethyl 2-hydroxy-6-methoxy-1,2,3,4-tetrahydronaphthalene-2-acetate (III) and its subsequent dehydration have been reported.[2] Dehydration of the hydroxy ester III produced a mixture of isomeric olefins IV and V. These isomers were partially separable by distillation and could be readily distinguished spectrally. In the IR spectrum, the carbonyl absorption of IV occurred at 1738 cm^{-1}, and in the ^1H NMR spectrum, the vinyl hydrogen resonance of IV appeared as a singlet at 6.30 ppm while that of V appeared as a broad singlet at 5.70 ppm.

The dehydration could be effected with any of several agents, but none was wholly satisfactory. The preferred method of dehydration involved refluxing a benzene solution of III in the presence of a catalytic amount of concentrated sulfuric acid. This procedure afforded, in 91% yield, a 76:24 mixture of olefins IV and V, respectively.

The mixture of isomers IV and V, which was not readily separable, was ozonolized, and the resulting ozonide was reduced with zinc in acetic acid to afford a mixture of 6-methoxy-2-tetralone and keto aldehyde VI. The oxidation could also be effected with osmium tetraoxide and sodium periodate by using the procedure of Lemieux and Johnson,[4] but lower yields were obtained than with ozonolysis.

The aldehyde VI was not stable, and on silica gel chromatography or, more efficiently, on treatment with fused potassium bisulfate in benzene, it underwent a facile intramolecular aldol condensation with concomitant loss of water to yield the dihydrobenzocycloheptene VII. This substance was characterized by elemental analysis and spectroscopic techniques, but owing to its instability, it was normally hydrogenated over palladium on carbon to the tetrahydrobenzocycloheptene VIII without purification.

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