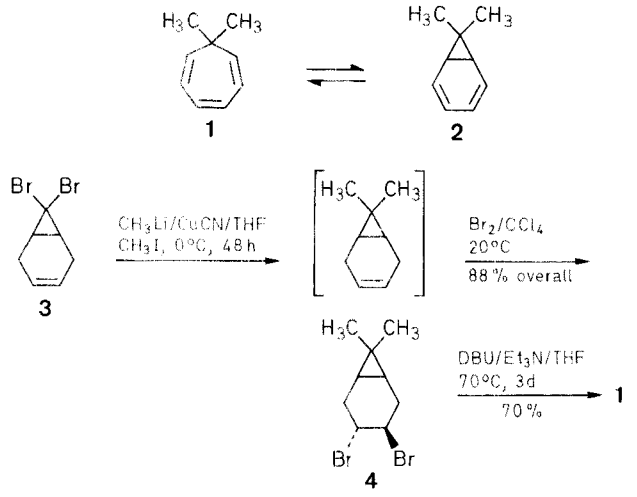

A Convenient Preparation of 7,7-Dimethyl-1,3,5-cycloheptatriene

James H. Rigby,* Anne-Roberte Bellemin

Department of Chemistry, Wayne State University, Detroit, MI 48202, USA

Described is a four-step synthesis of 7,7-dimethyl-1,3,5-cycloheptatriene, which starts from readily available 1,4-cyclohexadiene. Monocyclopropanation of this compound with dibromocarbene followed by replacement of the halogens with methyl groups using a higher order cuprate reagent provides the corresponding norcarene which is subjected to a bromination–dehydrobromination sequence to give the title compound.

Recently, we required quantities of 7,7-dimethyl-1,3,5-cycloheptatriene (**1**) for use in connection with a total synthetic effort that is currently ongoing in our laboratory. Compound **1** is of particular general importance due to the continuing interest in various aspects of the well-known cycloheptatriene–norcaradiene tautomerism.[1] Surprisingly, a preparatively convenient synthesis of this potentially useful material has not been reported to date. Existing preparations require either specialized and relatively inaccessible starting materials,[2] such as *gem*-dimethylcyclopropene, or provide the product contaminated with substantial amounts of impurities.[3] We wish to report a convenient synthesis of compound **1** that employs relatively common reactions and reagents and that is amenable to providing gram amounts of the triene product.

Our synthesis commences with readily available 1,4-cyclohexadiene.[4] Exposure of this hydrocarbon to a deficiency of dibromocarbene prepared under phase-transfer conditions[5] yields the desired monocyclopropane **3** in 50% yield based on bromoform. Only traces of the *bis*-adduct are obtained. Next, the dibromocyclopropane **3** is treated with a cuprate reagent prepared from methyllithium and copper(I) cyanide.[6,7] This yields the corresponding *gem*-dimethylcyclopropane derivative, which is not isolated but is immediately treated with bromine in carbon tetrachloride to give dibromide **4** in 88% overall yield for the two steps from compound **3**. Efforts to effect the bismethylation of dibromide **3** using dimethylcopperlithium gave decidedly inferior yields. Initial efforts to dehydrohalogenate compound **4** employing conventional protocols[8,9] produced the desired cycloheptatriene in only modest yields accompanied by substantial quantities of cumene. This by-product presumably arises from an extremely facile acid-mediated process involving the norcaradiene **2**. This undesired side-reaction was substantially suppressed by utilizing a large excess of a mixed base system comprised of 1,8-diazabicyclo[5.4.0]undec-7-ene (DBU) in triethylamine. Large amounts of cumene were produced in the reaction in the absence of excess triethylamine. Homogeneous 7,7-dimethyl-1,3,5-cycloheptatriene could be obtained in 70% yield from this modified dehydrobromination procedure.

All reagents are of commercial quality from freshly opened containers. Bromoform, CuCN and 1,8-diazabicyclo[5.4.0]undec-7-ene (DBU) were purchased from Aldrich Chemical Co. Reagent quality solvents were used without further purification. All reactions are performed under an argon atmosphere unless stated otherwise. Melting points were obtained on a Thomas-Hoover melting point apparatus and are uncorrected. Microanalyses were obtained from Spang Microanalytical Laboratories. Mass spectra were obtained using a Kratos MS 80 spectrometer with DEI ionization. IR spectra were obtained using a Nicolet 20-Dx spectrophotometer. ^{1}H-NMR and ^{13}C-NMR were obtained using a General Electric QE-300 spectrometer.

7,7-Dibromobicyclo[4.1.0]hept-3-ene (3); Typical Procedure:

1,4-Cyclohexadiene (16 g, 0.20 mol) in Et_2O (50 mL), bromoform (25.6 g, 0.10 mol) and catalytic cetyltrimethylammonium bromide (0.47 g) are added to 50% aq. NaOH (30 mL), and the resultant mixture is rapidly stirred at r.t. for 7 d using a high efficiency magnetic stirrer set at maximum. The reaction mixture is then washed with H_2O until the washings are neutral to pH paper. The organic phase is dried (Na_2SO_4), and the solvent is removed *in vacuo*, to give a crude oil. Crystallization from 95% EtOH gives white crystals; yield: 11.7 g (50%); mp 38–39°C (Lit.[10] mp 37–38°C).

^{1}H-NMR ($CDCl_3$): δ = 1.91 (dd, 2H, J = 5.3, 2.4 Hz, 2CH); 2.10 (d, 2H, J = 17 Hz, 2CH); 2.43–2.51 (m, 2H, 2CH); 5.50 (br s, 2H, $2CH_{vinyl}$).

^{13}C-NMR ($CDCl_3$): δ = 21.04, 25.11, 97.03, 122.57.

***trans*-3,4-Dibromo-7,7-dimethylbicyclo[4.1.0]heptane (4); Typical Procedure:**

CuCN (35.6 g, 0.397 mol) is dried by suspending in toluene (70 mL) and removing the solvent under high vacuum. This operation is performed three times to give dry CuCN. The resultant tan powder is then suspended in dry THF (60 mL) under an atmosphere of argon. The slurry is cooled to −78 °C and MeLi (1.4 M in Et_2O, 567 mL, 0.794 mol) is added dropwise over a period of 0.5 h. The heterogeneous mixture is allowed to warm to 0 °C for 2–3 min and then recooled to −78 °C. Dibromide **3** (10 g, 0.0394 mol) is added at −78 °C and stirred with a magnetic stirrer at 0 °C for 48 h. A large excess of MeI (20 mL) is added dropwise, and after 10 min the reaction mixture is quenched with a 10% solution of NH_4Cl in 28% ammonia water (50 mL) and extracted with Et_2O (4 × 150 mL). The organic phase is washed with the 10% NH_4Cl/NH_4OH solution (4 × 100 mL), sat. aq. $NaHCO_3$ (3 × 100 mL), and brine (3 × 100 mL). The ether solution is dried (Na_2SO_4). Next, CCl_4 (100 mL) is added, and the Et_2O is carefully removed *in vacuo*. To this solution is added a 0.65 M solution of Br_2 in CCl_4 (140 mL, 0.091 mol) until a permanent red-brown color resulted. The reaction mixture is washed with sat. aq. $NaHCO_3$ (3 × 200 mL) and brine (3 × 200 mL), and the solvent is removed *in vacuo* to give 9.86 g (88% for two steps) of off-white crystals, mp 47 °C.

$C_9H_{14}Br_2$	calc.	C 38.33	H 5.00	Br 56.66
(281.9)	found	38.61	4.63	56.96

MS (EI): *m/z*(%) = 203 (10); 121 (100).

IR (CCl_4): ν = 3010, 2964, 2924, 2877 cm^{-1}.

^{1}H-NMR ($CDCl_3$): δ = 0.78–0.85 (m, 2H, 2CH); 1.01 (s, 3H, CH_3); 1.05 (s, 3H, CH_3); 1.73 (m, 1H, CH); 2.30 (m, 1H, CH); 2.47 (m, 1H, CH); 2.69 (m, 1H, CH); 4.20 (m, 2H, 2CH).

^{13}C-NMR ($CDCl_3$): δ = 15.84, 18.24, 20.36, 20.51, 28.11, 30.61, 30.85, 54.17, 55.25.

7,7-Dimethyl-1,3,5-Cycloheptatriene (1); Typical Procedure:

3,4-Dibromo-7,7-dimethylbicyclo[4.1.0]heptane (**4**; 8.08 g, 28.64 mmol) is dissolved in freshly distilled THF (200 mL), and NEt_3 (240 g, 2.3 mol) and DBU (34.6 g, 28 mmol) are added. The resultant solution is heated at 70 °C for approximately 3 d. The reaction mixture is cooled to r.t. and extracted with Et_2O (3 × 250 mL). The combined ether fractions are washed quickly with *cold* (0–5 °C) 1% aq. HCl (1 × 100 mL), then with sat. aq. $NaHCO_3$ (2 × 250 mL), and brine (3 × 100 mL). The ether layer is dried (Na_2SO_4). Careful removal of solvent *in vacuo* and column chromatography on a 4 × 35 cm column (pentane as eluent) provides 3.4 g (70% yield) of cycloheptatriene **1** contaminated with a trace of cumene. The material is sufficiently clean after column chromatography for most applications. An analytical sample is obtained by gas chromatographic separation (1.5 cm × 2.5 cm column with 10% OV-101, 80 °C), and the spectral data are in accord with literature values.[2,3]

^{1}H-NMR ($CDCl_3$): δ = 1.00 (s, 6H, $2CH_3$); 5.20 (d, 2H, J = 9 Hz, $2CH_{vinyl}$); 6.12 (m, 2H, $2CH_{vinyl}$); 6.48 (m, 2H, $2CH_{vinyl}$).

^{13}C-NMR ($CDCl_3$): δ = 25.97, 35.31, 124.14, 129.89, 134.43.

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