A New and Simple Synthesis of Tropones

Martin G. Banwell†

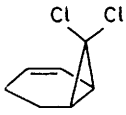
Department of Organic Chemistry, University of Adelaide, Adelaide, South Australia, 5000

3- and 4-Halogenocycloheptatrienones can be prepared from the Δ^2- and Δ^3-norcarenes (**1**), (**2**), and (**3**) by an allylic oxidation–dehydrohalogenation sequence; evidence for the intermediacy of the bicyclic enones (**4**)—(**7**) in the formation of the troponoid skeleton is presented.

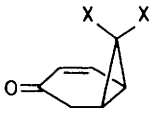
Troponoid compounds are of considerable synthetic, biological, and theoretical interest.[1–3] Single-carbon enlargement of phenol derivatives, *via* carbene addition–ring expansion sequences, has provided a useful route to these non-benzenoid aromatic species.[1,2] Frequently, however, the conditions required to effect cleavage of the intermediate cyclopropanols or cyclopropyl alkyl ethers are rather vigorous and low yields often result.[1] In addition such strategies restrict the transposition of cyclopropyl substituents to the 2- or 3-positions of the cycloheptatrienone nucleus.

In connection with work[4,5] on the fragmentation of ring-fused halogenocyclopropanes, it occurred to us that the troponoid skeleton might be available by a formal 1,4-elimination[5] of a hydrogen halide from halogenobicyclo[4.1.0]-heptenones such as (**4**)—(**7**). We have now established the viability of this strategy which overcomes the previous problems, as demonstrated by the synthesis of the tropones (**9**), (**10**), (**12**), and (**13**) which are key intermediates in the preparation of a variety of 3- and 4-substituted tropones including β- and γ-tropolones, (**14**) and (**11**), respectively.[6]

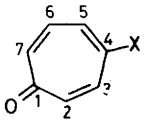
Allylic oxidation of 7,7-dichlorobicyclo[4.1.0]hept-2-ene, (**1**),[7] using the chromic anhydride–3,5-dimethylpyrazole complex[8] (12 mol. equiv., CH_2Cl_2, *ca.* −10 °C, 4 h) afforded the bicyclic enone (**6**)‡ [33%; ν_{CO}(neat) 1670 cm^{-1}] and 4-chlorotropone (**9**)[6c] (36%; m.p. 104 °C, lit.[6c] 104 °C). The



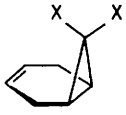
(**1**)



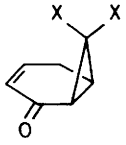
(**4**) X = Cl
(**5**) X = Br



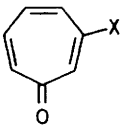
(**8**) X = H
(**9**) X = Cl
(**10**) X = Br
(**11**) X = OH



(**2**) X = Cl
(**3**) X = Br



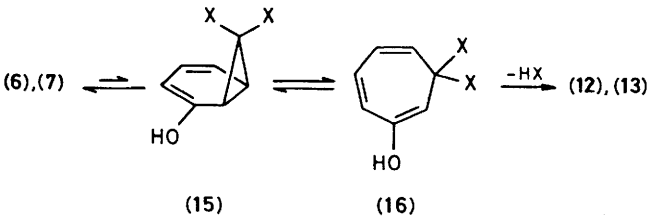
(**6**) X = Cl
(**7**) X = Br



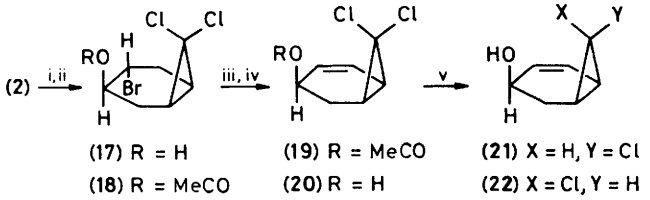
(**12**) X = Cl
(**13**) X = Br
(**14**) X = OH

† Please address any correspondence to the author at the Department of Chemistry, The University of Auckland, Private Bag, Auckland, New Zealand.

‡ Satisfactory analytical and spectroscopic data have been obtained for all new compounds.



Scheme 1



Scheme 2. *Reagents and conditions:* i, NBS, Me_2SO, H_2O, 15 °C, 0.5 h; ii, $(MeCO)_2O$, pyridine, 25 °C, 24 h; iii, DBN, 1.1 equiv., Me_2SO, 100 °C, 3 h; iv, NaOH, MeOH, 25 °C, 24 h; v, Zn, KOH, EtOH, reflux, 48 h.

ketone (**6**) underwent acid-catalysed (10 mol % $MeSO_3H$, CH_2Cl_2, 22 °C, 4 h) conversion into 3-chlorotropone (**12**)[6a] (94%). Oxidation of 7,7-dichlorobicyclo[4.1.0]hept-3-ene (**2**)[9] under the same conditions gave the enone (**6**) (31%) and 4-chlorotropone, (**9**) (38%). Similarly, oxidation of 7,7-dibromobicyclo[4.1.0]hept-3-ene (**3**)[10] yielded 7,7-dibromobicyclo[4.1.0]hept-3-en-2-one (**7**) [31%; ν_{CO}(neat) 1660 cm^{-1}] and 4-bromotropone (**10**)[6b] (36%; m.p. 110 °C, lit.[6b] 110 °C). Treatment of the enone (**7**) with methanesulphonic acid as described above, gave 3-bromotropone (**13**) [89%; ν_{max} (neat) 1630 and 1580 cm^{-1}].

A plausible mechanism for the conversion of the enones (**6**) and (**7**) into the tropones (**12**) and (**13**) is illustrated in Scheme 1. Keto to enol tautomerism of (**6**) and (**7**) would yield the norcaradienols, (**15**), and their subsequent ring opening to give cycloheptatrienols, (**16**), is expected to occur readily.[11] Loss of the elements of HX would then deliver the fully conjugated products.

A similar mechanism for the conversion of (**1**), (**2**), and (**3**) into the corresponding 4-halogenotropones requires the intermediacy of the 7,7-dihalogenobicyclo[4.1.0]hept-2-en-4-ones (**4**) and (**5**). In an attempt to establish the involvement of these latter species we have synthesised the allylic alcohol (**20**) (Scheme 2). Thus, treatment of (**2**) with *N*-bromosuccinimide (NBS) in wet dimethyl sulphoxide[12] afforded the bromohydrin (**17**) (81%). Acetylation of (**17**) gave the bromo-acetate (**18**) (100%); dehydrobromination of (**18**) with 1,5-diazabicyclo-[4.3.0]non-5-ene (DBN) yielded the allylic acetate (**19**) (78%), which on hydrolysis gave the alcohol (**20**) (100%). Oxidation of (**20**) with pyridinium chlorochromate[13] (1.7 mol. equiv., CH_2Cl_2, 25 °C, 3 h) yielded 4-chlorotropone (**9**) (94%) directly. Sodium acetate buffered oxidation of (**20**) did not permit the isolation of the enone (**4**).

Non-halogenated tropones are also available by the procedures decribed above. Half-reduction[4a] of the dichloride (**20**) afforded a 1:3 mixture of the *exo*- and *endo*-chlorocyclopropanes (**21**) and (**22**), respectively (68% combined yield). Pyridinium chlorochromate promoted oxidation of this mixture gave tropone, (**8**), in 77% yield.

I thank Dr. D. P. G. Hamon (University of Adelaide) and Professor A. L. J. Beckwith (Australian National University) for stimulating discussions. Financial support from the University of Adelaide is gratefully acknowledged.

Received, 6th April 1982; Com. 390

References

1 F. Pietra, *Chem. Rev.*, 1973, **73**, 293.
2 D. M. G. Lloyd, 'Carbocyclic Non-benzenoid Aromatic Compounds,' Elsevier, London, 1966, p. 98; T. L. Macdonald, *J. Org. Chem.*, 1978, **43**, 3621; T. Hiyama, Y. Ozaki, and H. Nozaki, *Tetrahedron*, 1974, **30**, 2661.
3 S. Tabinga, E. Koolani, and F. Miyazaki, *J. Chem. Soc., Chem. Commun.*, 1974, 300; H. Takaya, Y. Hayakawa, S. Makino, and R. Noyori, *J. Am. Chem., Soc.* 1978, **100**, 1778; D. A. Evans, S. P. Tanis, and D. J. Hart, *J. Am. Chem. Soc.*, 1981, **103**, 5813.
4 (a) M. G. Banwell and B. Halton, *Aust. J. Chem.*, 1979, **32**, 84; (b) *Tetrahedron Lett.*, 1979, 3191; *Aust. J. Chem.*, 1979, **32**, 2689; *ibid.*, 1980, **33**, 2673, 2685.
5 M. G. Banwell and C. Papamihail, *J. Chem. Soc., Chem. Commun.*, 1981, 1182.
6 (a) B. Ricciarelli, G. Biggi, R. Cabrino, and F. Pietra, *Synthesis*, 1975, 189; (b) M. Cavazza and F. Pietra, *J. Chem. Soc., Perkin Trans.* 2, 1979, 112; (c) J. D. Hobson and J. R. Malpass, *J. Chem. Soc. C*, 1969, 1499; (d) M. Cavazza, M. P. Colombini, M. Martinelli, L. Nucci, L. Pardi, F. Pietra, and S. Santucci, *J. Am. Chem. Soc.*, 1977, **99**, 5997.
7 M. G. Banwell, R. Blattner, A. R. Browne, J. T. Craig, and B. Halton, *J. Chem. Soc., Perkin Trans.* 1, 1977, 2165.
8 W. G. Salmond, M. A. Barta, and J. L. Havens, *J. Org. Chem.*, 1978, **43**, 2057.
9 W. E. Billups, A. J. Blakeney, and W. Y. Chow, *Org. Synth.*, 1976, **55**, 12.
10 K. Hofmann, S. F. Orochena, S. M. Sax, and G. A. Jeffrey, *J. Am. Chem. Soc.*, 1959, **81**, 992.
11 A. J. Bellamy, W. Crilly, J. Farthing, and G. M. Kellie, *J. Chem. Soc., Perkin Trans.* 1, 1974, 2417.
12 D. R. Dalton, V. P. Dutta, and D. C. Jones, *J. Am. Chem. Soc.*, 1968, **90**, 5498.
13 E. J. Corey and J. W. Suggs, *Tetrahedron Lett.*, 1975, 2647.