

NEW APPLICATIONS OF THE WITTIG REACTION TO
THE PREPARATION OF STRAINED BRIDGEHEAD OLEFINS¹

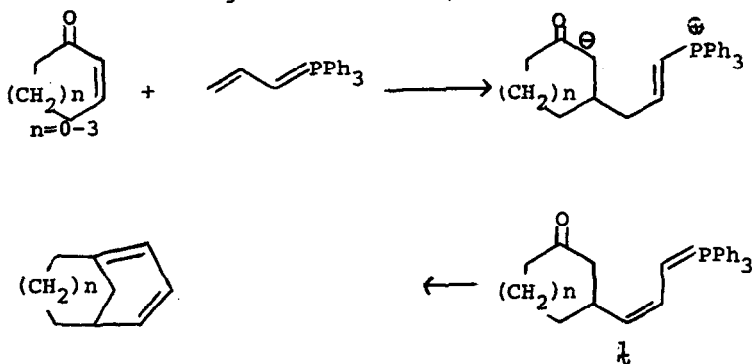
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In the past few years there has been a rapid growth of interest in the preparation of strained bridgehead olefins². Until recently the reported synthetic approaches all involved a separate construction of the ring system prior to introduction of the double bond. In 1973, however, a facile synthesis for such olefins was reported³ from this laboratory which utilized the intramolecular Wittig reaction⁴ and therefore effected ring closure and double bond formation in a single reaction step.



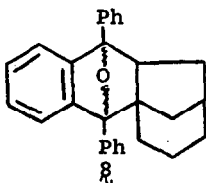
It is apparent that the above reaction is not applicable to the preparation of compounds in which the bridge that includes the strained double bond contains less than three carbon atoms. The utility of the intramolecular Wittig reaction, itself, for the preparation of strained bridgehead double bonds has now been investigated in the attempted synthesis of bicyclo[2.2.1]-hept-1-ene (2) and bicyclo [3.2.1]-oct-5-ene (3). For this purpose the keto-phosponium salts 4 and 5 were synthesized.⁵ In each case the salt was



prepared by heating the corresponding bromo compound (6 or 7) and triphenylphosphine without solvent.^{4a} The bromoketone 7 was obtained in a straightforward fashion from the known⁶ 3-(2'-hydroxyethyl)cyclohexanone ethylene ketal and 6 was prepared following procedures used with a related system.⁷

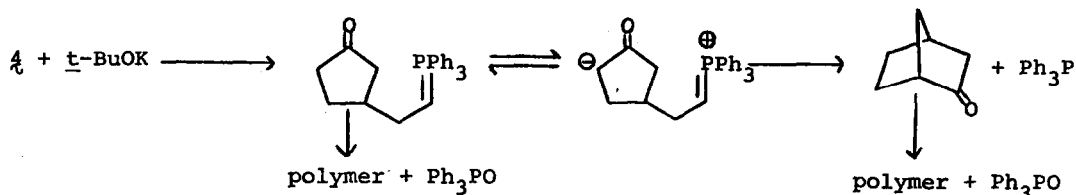


When the salt 5 was stirred with a refluxing solution of potassium t-butoxide (1 eq.) and diphenylisobenzofuran (1 eq.), the two isomeric Diels-Alder adducts 8 were formed (15% yield) in a ratio of 4:3. The isomeric mixture was separated by preparative tlc; major isomer, mp 188-199°⁸; minor isomer, mp 218-220°; mass spectra of both isomers, m/e 378. This reaction sequence constitutes the first efficient synthesis of 3 .⁹

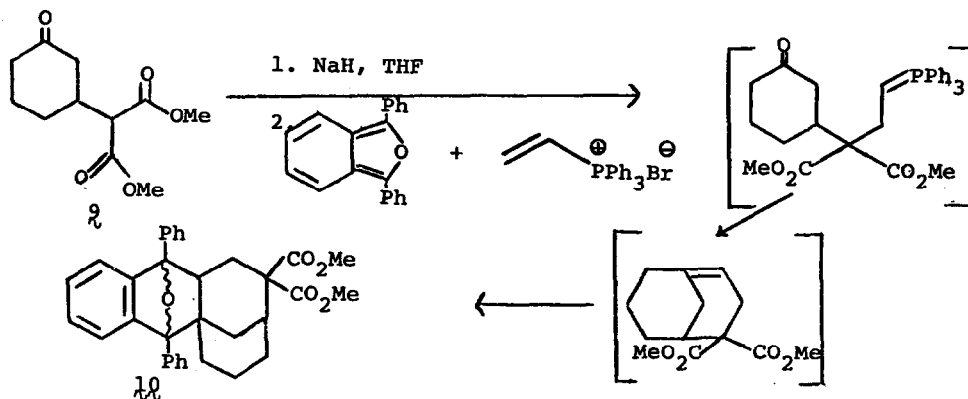


The ketophosphonium salt 4 was subjected to the conditions described above. In this case, furan, which is known¹⁰ to react with bicyclo[2.2.1]hept-1-ene (2), was employed in large excess as the trapping agent. The major monomeric products isolated were triphenylphosphine (18%) and triphenylphosphine oxide (~25%); no evidence was found for the presence of the adducts of 4 among the various minor products. The formation of triphenylphosphine by

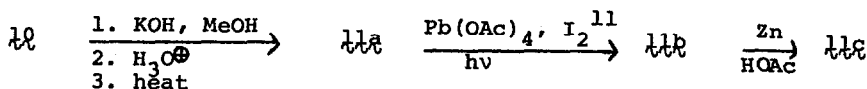
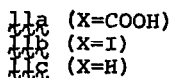
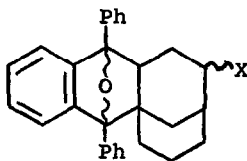
intramolecular displacement (see equation) has precedence.



An alternate procedure for this type of intramolecular Wittig ring closure is based upon the cycloolefin synthesis of Schweizer.^{4b} The sodium enolate of 3-(dicarbomethoxymethyl)-cyclohexanone (**9**) was prepared in THF, treated with an equivalent amount of diphenylisobenzofuran and a slight excess of triphenylvinylphosphonium bromide, and the mixture allowed to react at reflux for 16 hr. The two isomeric Diels-Alder adducts **10** (19% yield; 5:4 ratio) were separated by silica gel chromatography and by fractional crystallization; the major isomer has mp 238.5-240.0° and the minor isomer a mp of 185-199°⁸.



The structures of the two isomeric adducts **10** were established by degradation of each isomer to the two known isomers of **11c**; the degradation scheme is shown in the equations. The isomer of **11c** that was prepared from the lower melting isomer of **10** had mp 180-184° and possessed ir and nmr spectra identical to those obtained by Wiseman and Pletcher^{2a,12} from authentic material (mp 179-180°) prepared from bicyclo[3.3.1]non-1-ene. The isomer of **11c** that was derived from the higher melting isomer of **10** had mp of 199-200° and was shown to be identical with the compound previously prepared in this laboratory.³



These studies clearly show that the intramolecular Wittig reaction is of general utility in the preparation of bridgehead olefins; the synthetic sequence failed to yield the extremely highly strained bicyclo[2.2.1]hept-1-ene.

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- We would like to thank Professor J.R. Wiseman for the spectra of the authentic material.