SYNTHESIS AND FACILE RING OPENING OF 2,3,4-TRIPHENYL-3-AZABICYCLO[3.2.0]HEPTA-1,4-DIENE

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Abstract–The first synthesis of 2,3,4-triphenyl-3-azabicyclo[3.2.0]-hepta-1,4-diene (pyrrolocyclobutene) that has no substituent in the cyclobutene moiety, is described. This compound underwent an extremely facile electrophilic attack at the β position to give the ring opened product.

Benzocyclobutene and related compounds including heteroanalogues represent a unique compromise between the thermodynamic stability associated with an aromatic system and the kinetic reactivity of a strained cyclobutene.[1] Although the parent 3-thiabicyco[3.2.0]hepta-1,4-diene and its derivatives are relatively well known,[2,3] the only one example of the corresponding aza-analog has been reported by Garratt *et al.* who have synthesized 6,7-di-*tert*-butyl-3-thiabicyco[3.2.0]hepta-1,4-diene and its pyrrole and furan analogues by the base-catalyzed rearrangement of the corresponding 4-heterohepta-1,6-diynes.[4]

We now report the first synthesis of 2,3,4-triphenyl-3-azabicyclo[3.2.0]hepta-1,4-diene (**1**) that has no substituent in the cyclobutene moiety along with an extremely facile ring opening of the cyclobutene ring with electrophiles.

The compound (**1**) was prepared by1,3-dipolar cycloaddition of 1,2,3-triphenylaziridine with dimethyl cyclobutene-1,2-dicarboxylate,[5] followed by hydrolysis[6] and oxidative

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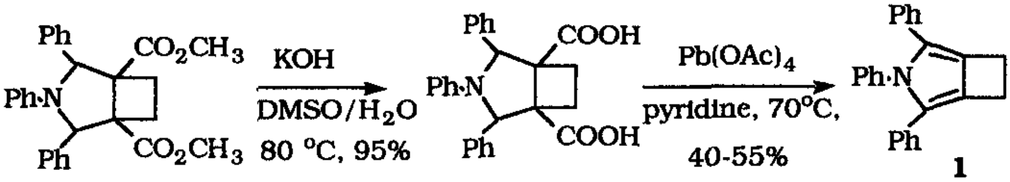
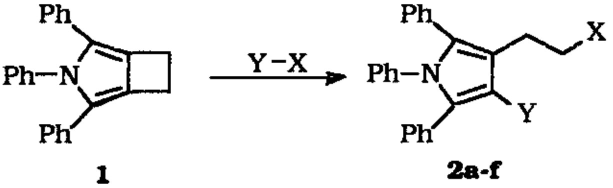
Dedicated to the memory of Professor Shunichi Yamada, Professor Emeritus Tokyo University.



Scheme 1

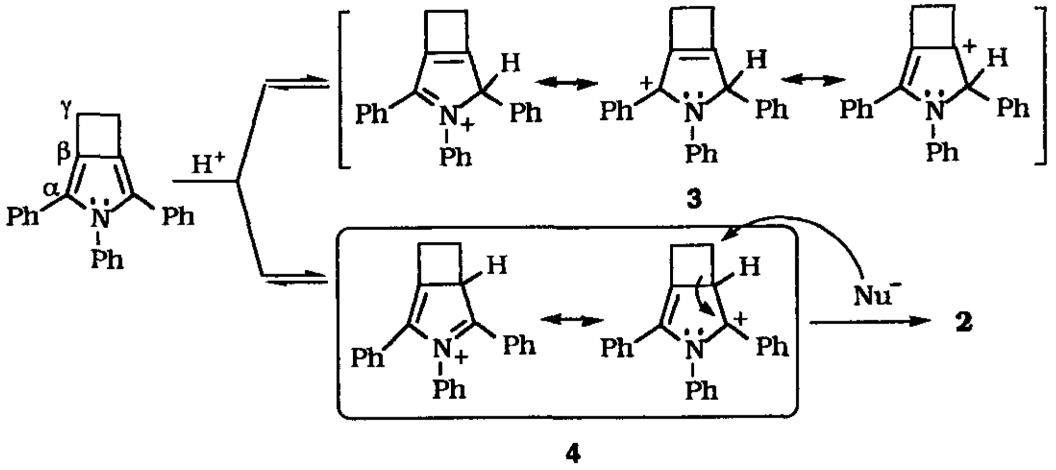
Table 1. Reaction of 2,3,4-triphenyl-3-azabicyclo[3.2.0]hepta-1,4-diene (**1**) with electrophiles



Run	Y-X	Temp. (°C)	Reaction Time (h)	**2** Yield [a] (%)
1[b]	H–ONO_2	rt	a few min	(**2a**) quant.
2[b]	H–Cl	rt	2.5	(**2b**) quant.
3[c]	H–$OCOCH_3$	rt	76	(**2c**) 73
4[c]	H-OCH_3	reflux	14 (days)	(**2d**) quant.
5[d]	H-OCH_3	rt	16	(**2d**) quant.
6[e]	Br-Br	rt	a few min	(**2e**) quant.

[a] Isolated yields. [b] An adequate amount of 1*N*-HX aqueous solution was used in benzene. [c] HX was used as solvent. [d] Catalytic amount of 1N-HNO_3 was used. [e] In chloroform.

decarboxylation[7] with lead tetraacatate.[8,9] The method is well documented for the synthesis of benzocyclobutene and related compounds.[1] The yields were moderate. This method was not, in our hands, applicable to the similar adducts from the aziridines such as 1-benzyl-2,3-diphenylaziridine and 1-cyclohexyl-2-aroylazirizines. During the work up after decarboxylation of *trans*-2,3,4-triphenyl-3-azabicyclo[3.2.0]heptane-1,5-dicarboxylic acid, we have found an extremely facile ring opening of **1** in the cyclobutene moiety. Thus, treatment of **1** with 1 N nitric acid in benzene at room temperature afforded the corresponding ester (**2a**) in quantitative yield. Even in methanol, though after refluxing for 2 weeks, such conversion took place quantitatively. The representative result is summarized in Table 1.[10] The reaction can readily be explained by an initial electrophilic addition of proton to form the carbocation stabilized by nitrogen atom which undergoes nucleophilic attack at γ-position, giving the product



Scheme 2

(**2**). The reaction can formally be regarded as a retro-Friedel-Crafts reaction. The driving force of the reaction must be not only strain of the cyclobutene ring but also the stabilized carbocation by nitrogen atom. Although pyrroles usually undergo an electrophilic attack at α-position, it is not the case but it took place at β-position probably because of the unfavorable resonance structure (strained cyclobutene) derived from electrophilic attack at α-position. Indeed, according to semiempirical molecular orbital calculations, the heat of formation of **3** is higher than that of **4**.[11] In contrast to **1**, the parent 3-thiabicyclo[3.2.0]hepta-1,4-diene was reported to react with bromine affording the tetrabromide .[2]

Further studies on synthesis and properties of similar pyrroloyclobutenes are in progress using non-stabilized azomethine ylides.[12]

ACKNOWLEDGEMENT

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8. All the new compounds had satisfactory elemental analyses.

9. **1**:mp 218.0-219.0 °C (hexane/ethyl acetate); ^{1}H NMR (270 MHz, $CDCl_3$) δ 3.41(s, 4H),6.92-7.32(m, 15H).

10. **2a**:mp 156.7-157.1°C (hexane/dichloromethane); ^{1}H NMR (270 MHz, $CDCl_3$) δ 2.94(t, J =7.3 Hz, 2H, $ArCH_2$), 4.61(t, J =7.3 Hz, 2H, OCH_2), 6.42(s, 1H), 6.43-7.23(m, 15H); **2b**:mp 145.2-147.8°C (hexane/dichloromethane) ; ^{1}H NMR (270 MHz, $CDCl_3$) δ 3.00(t, J =7.6 Hz, 2H, $ArCH_2$), 3.69(t, J =7.6 Hz, 2H, $ClCH_2$), 6.43(s, 1H), 6.90-7.23(m, 15H); **2c**:mp 165.8-166.5°C (methanol/dichloromethane) ; ^{1}H NMR (270 MHz, $CDCl_3$) δ 2.03 (s, 3H), 2.86(t, J =7.3 Hz, 2H, $ArCH_2$), 4.27(t, J =7.3 Hz, 2H, OCH_2), 6.43(s, 1H), 6.92-7.21(m, 15H); **2d**:mp165.5-166.5°C (hexane/dichloromethane); ^{1}H NMR (270 MHz, $CDCl_3$) δ 2.82(t, J =7.3 Hz, 2H, $ArCH_2$), 3.63(t, J =7.3 Hz, 2H, OCH_2), 6.44(s, 1H), 6.91-7.20(m, 15H); **2e**:mp 196.0-197.0°C(decomp)(ethanol/dichloromethane); ^{1}H NMR (270 MHz, $CDCl_3$) δ 3.11(t, J =7.8 Hz, 2H, $ArCH_2$), 3.54(t, J =7.8 Hz, 2H, $BrCH_2$), 6.84-7.25(m, 15H, aromatic).

11. The heats of formation of the carbocations (**3**) and (**4**) were obtained using CAChe systems (Version 3.7, CAChe Scientific, Oxford Molecular Group; AM1: M. J. S. Dewar, E. G. Zoebisch, E. F. Hearly, and J. J. P. Stewart, *J. Am. Chem. Soc.*, 1985, **107**, 3902). Heat of formation of cation (**3**):331.63 kcal/mol; heat of formation of cation (**4**): 311.62 kcal/mol.

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